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# TANK CLOSURE PLAN

FOR

TANKS 53 AND 56

TANK FARM 5

NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

PREPARED BY:

Environmental Resource Associates, Inc.

Warwick, Rhode Island

April 15, 1988

Philip P. Virgadamo, P.E., Principal

Robert F. Angilly Jr., P.E.

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# CLOSURE PLAN - NETC TANK FARM 5
# TANKS 53 AND 56

## I. INTRODUCTION

Rhode Island Department of Environmental Management (RIDEM) Underground Tank Regulation requires a tank closure plan to include the following:

a. Identify steps necessary for the closure of the facility to control, minimize, or eliminate hazards to protect the public health and the environment.

b. Description of location of tanks, monitoring wells, and boundaries closed.

c. Estimate inventory of used oil stored on site and description of the methods of removal, transport, treatment, storage, or disposal of used oils, water and sludge from the tanks.

d. Description of the steps needed to remove or decontaminate all residues and containment system components, equipment, structures, and soils during closure, including, but not limited to, procedures for cleaning equipment and removing contaminated soils, methods for sampling and testing surrounding soils, and criteria for determining the extent of decontamination required to satisfy the closure standard;

e. Description of other activities necessary during the closure period to ensure that all partial closures and final closure satisfy the closure performance standards, including, but not limited to, ground-water monitoring, leachate collection, and run-off control;

f. Closure schedule for the tanks and the time required to dispose of used oil, water and sludge, to clean the tanks, and to close the tanks.

g. Cost estimate for closure plan.

## II. DESCRIPTION AND HISTORY OF TANK FARM 5

Tank Farm #5 is located in Middletown, Rhode Island on approximately 85 acres. The tank farm is bordered by Defense Highway and Greene Lane, private residential property and Saint Columba Catholic Cemetery. Figure 1 shows the layout at Tank Farm #5 and identifies Tanks 53 and 56.

The tank farm was designed for the bulk storage and pumping of Navy residual fuel oil for use on ship board boilers. Eleven 60,000 barrel prestressed concrete underground storage tanks constructed during 1942 and 1943 are located on the site. Each tank is 116 feet in diameter and 33.5 feet deep and covered by approximately 4 feet of soil. The concrete floor and inside walls of the tanks were waterproofed with silicate of soda treatment. The outside walls and roof were waterproofed with an applied bituminous coating.

Adjoining each storage tank is an underground full-depth pump pit which houses the equipment necessary to heat and pump the fuel oil and to pump the groundwater from the surrounding backfill to prevent structural tank drainage or tank flotation. A 12 inch reinforced concrete pipe, ring drain with open joints was constructed around the bottom of each tank. The drain is connected to the sump pump for collection of the subsurface (groundwater) drainage. The sump pump is also used to remove bottom water and sediment from the tanks. The discharge from the sump pump leads to an oil water separator pit.

These tanks were used for fuel product storage from World War II until 1974. The operating and maintenance procedures were in accordance with normal practices for the operation of fuel oil storage facilities. After 1974, Naval operations were reorganized and the tank farm was closed for fuel product storage. The tanks, for the most part, were emptied of product and filled with water to prevent tank flotation.

In 1975, the Navy implemented a used oil recovery program for energy conservation and resource recovery. Tanks 53 and 56 became the storage tanks for used oil as part of Navy's oil recovery program in the New England area.

From 1975 through 1982, Tanks 53 and 56 received used oil intended for use in the Building 86 heating plant at NETC. The types of oil stored were diesel, lubricant, hydraulic and motor oil. Approximately 1.2 million gallons of used oil was stored in Tanks 53 and 56 during this seven year period of time.

After 1982, it was determined that the oil recovery program was no longer economical and possibly damaging to the boiler's operations. In 1982, the Rhode Island Department of Environmental Management (RIDEM) adopted hazardous waste regulations and the used oil stored in the tanks at that time and similar waste oils added to the tanks, became considered as a hazardous waste due to metal content. During 1984, the

Navy decided to close this facility and discontinue operation as a used oil storage facility. At that time, the closure of these underground used oil storage tanks was considered to be in the purview of the RIDEM regulations for hazardous waste storage facilities.

In 1986 RIDEM implemented new regulations for the operation and closure of underground storage tanks used to hold oils and hazardous materials. Tanks 53 and 56, which were used to store fuel oils and used oils, are now considered to be within the jurisdiction of the new underground storage tank regulations. Therefore, this closure plan is being prepared in accordance with the RIDEM Underground Storage Tank Regulations.

## III. BACKGROUND INVESTIGATION

In 1983, the Navy hired Tibbetts Engineering Corporation to sample all tanks, measure depths of water, oil and sludge, and analyses for hazardous waste characteristics. The results of the Tibbetts Engineering sample analyses are presented in the Appendix A. In a letter dated January 12, 1984, from John Leo of RIDEM to Tibbetts Engineering a hazardous waste determination was made of the analyses.

The results show that Tank 53, oil phase, is hazardous based on the level of 53 ppm and 53.2 ppm lead. It is not a chlorinated waste oil. The water phase of Tank 53 is non hazardous. Low level of organics are present

The sludge layer in Tank 53 is hazardous based on the levels of Barium - 1,244 ppm; Cadmium - 13.7 ppm; Chromium - 212 ppm, Lead - 22,500 ppm; Mercury - 1.6 ppm and Silver - 5.9 ppm. the levels for these metals above which the State of Rhode Island considers it hazardous are Barium - 100 ppm; Cadmium - 1 ppm; Chromium - 5 ppm; Lead - 5 ppm; Mercury - .2 ppm and Silver 5 ppm.

Tank 56, oil phase, is hazardous based on the level of lead in the oil at 44.9 and 45.4 ppm. The water phase in Tank 56 is non-hazardous even though it contains a small amount of lead and a small amount of organics. The sludge phase of Tank 56 is hazardous based on the levels of Barium - 804 ppm; Cadmium - 17.3 ppm; Chromium - 248 ppm; Lead - 14,700 ppm; Mercury - .83 ppm and Silver - 21.0 ppm.

The Navy retained Environmental Resource Associates (ERA) to prepare a tank closure plan for Tanks 53 and 56, which included installation of monitoring wells and chemical analyses of the tank contents and groundwater.

In 1985, four groundwater monitoring wells were placed in the ring drains of Tanks 53 and 56. Tables 1 and 2 show the results of chemical analyses performed on samples drawn from the wells. The results indicated the groundwater around Tank 53 to have elevated levels of

organic compounds. At the request of Rhode Island Department of Environmental Management, an additional six monitoring wells were installed to intercept groundwater flow upgradient and downgradient of Tanks 53 and 56. Figure 2 shows the locations of the monitoring wells. Subsurface analyses indicate that the strata is composed of soft shale and fragmented schistose sandstone. Groundwater levels were measured and the groundwater flow was determined to be in a northwesterly direction.

Additional samples were drawn from the six monitoring wells and from the four observation wells previously installed in the ringwell perimeter of the two subject tanks. Analytical results are presented in Tables 1 and 3. Analyses performed on the samples indicate contamination in the groundwater is most likely due to the leaking of product contained in Tank 53. Tank 56 is not suspected to be a source of contamination.

A detailed report of the subsurface explorations and groundwater monitoring conducted by Environmental Resource Associates is presented in Appendix B.

The results of the subsurface investigations and groundwater monitoring in the vicinity of Tank 53 lead to the conclusion that low level contamination exists downgradient of the tank. The extent of the contamination appears to be within a 150 foot radius westerly from the tank walls. A higher degree of contamination exists within the ring drain area which surrounds the tank. This suggests that Tank 53 is a source of contamination.

Since the aqueous portion of Tank 53 contained significant concentrations of volatile organics, it was necessary to consider the type and configuration of equipment needed to reduce these concentrations to acceptable levels. Based upon the identity of the solvents found in the aqueous phase, an air stripping process was deemed the most feasible treatment process for removing the major amount of solvents.

Air stripping is a process that takes advantage of the solvents' natural tendency to escape a water solution when contacted by air. Contaminated water is allowed to trickle down a column containing plastic packing material and exit the bottom. Simultaneously, air is forced into the bottom of the column, concurrently contacting the wastewater as it travels up the column and exits the top. The packing's high surface area promotes good physical contact between the two phases resulting in the transfer of the solvents from water to air.

ERA conducted an air stripping pilot plant study using aqueous waste from Tank 53 to obtain design and performance data. The results of the pilot plant study indicate removal efficiencies of 50 to 90 percent for various volatile organics. Detailed design of the airstripping system cannot be performed until waste water discharge limits are set by RIDEM

for the tank closure plan. A summary of the pilot plant equipment, performance tests, and resulting preliminary design for a full scale system is presented in Appendix C.

## IV. GENERAL DESCRIPTION OF THE CLOSURE ALTERNATIVES

Based on a groundwater investigation performed at the site, three distinct alternatives are evaluated for closure of the tanks. Alternative 1 is no action. Alternative 2A is the removal and disposal of the contents of the tanks and leaving tanks in place. Alternative 2B is Alternative 2A plus cleaning the tank interior then filling the tank with water. Alternative 3A is the same as Alternative 2B with the exception that the tank is backfilled with an inert material such as sand. Alternative 3B is the same as Alternative 2B except to demolish and remove the tank after cleaning.

### DISCUSSION OF ALTERNATIVES

#### Alternative 1 - No Action

The "No Action" alternative requires minimum initial expense. There are no costs associated with waste disposal or tank cleaning. The initial cost would be the addition of several monitoring wells, preferably nested at three or more locations to detect the migration of contaminants at the boundary of the NETC property. Since the affected boundary is the east shore of Narragansett Bay, the line of monitoring should be along the westerly side of the Defense Highway ("Burma Road".) The wells would be monitored on an annual or semiannual basis.

At such time in the future that contaminants may be found in these wells, further action will be required. This action may include the requirements of Alternative 2 as well as the possibility of soil and bedrock removal and disposal. This alternative is not acceptable to the Rhode Island Department of Environmental Management, since the underground storage tank regulations prohibit "abandonment in place". This alternative is also not consistent with either Navy future plans for Tank Farm #5 or Navy environmental policy. Alternative 1 is not recommended. While the potential for environmental damage may be low, the risk of expensive restoration activity in the future is sufficient to discount further consideration.

#### Alternative 2 - Removal and Disposal of Contents

Alternative 2 is two parts which include 2A - Removal and Disposal of the Contents of Tanks 53 and 56, and 2B - Removal and Disposal of Contents, Clean and Fill Tanks with Water Ballast.

The tanks each presently contain a quantity of an oily layer, a contaminated water phase and a bottom sludge. The amounts of these phases within the tanks are presented in Table 4. The oily layer and the water phase can be removed by pumping. The sludge layer must be removed by personnel who must enter the tanks. The sludge removal is one of the initial steps of the cleaning operation. The final disposition of the tanks depends upon any future plans which NETC has for the use of this site.

The disposal of the tank contents requires several operations. The oil layer must be scavenged from the tank and contracted for disposal as a hazardous substance. The estimated amount of oil is 46,000 gallons in Tank 53 and 36,000 gallons in Tank 56. This material can be disposed by tank truck to a licensed disposal or recycle facility. The sludge which must be removed can be disposed in a similar manner. Tank 53 contains an estimated quantity of 118,000 gallons of sludge. There is also a considerable amount of sludge in Tank 56, which contains an estimated 79,500 gallons. Sludge removal can be accomplished by pumping. Pneumatic, duplex diaphragm, or progressing cavity pumps can be used to remove the sludges. It is anticipated that entry of the tanks will be necessary to complete this task.

The water phase removal and disposal may differ between the two tanks. The ultimate disposal of the aqueous fraction of the tank contents will be by discharge to the City of Newport Wastewater Treatment Facility or by discharge through an existing permitted outfall at the Defense Fuel Supply Point in Melville. Discharge to either location will require construction of a temporary pipeline to the discharge area with a pumping operation from 30 to 90 days depending upon the constraints of the regulatory agencies. Analysis of the contaminants in the water phase and airstripping pilot tests of the water indicate that the volatile organics in the water can be removed to acceptable discharge levels.

Preliminary discussions with the City of Newport and RIDEM Water Resources Division personnel indicates that the discharge to the City of Newport Wastewater Treatment Facility will require "off-peak" use and consequently a prolonged operation. The Defense Fuel Support Point (DFSP) discharge has been recommended as the disposal point for the treated water from the stripping operation, but a temporary discharge permit must be obtained from the Rhode Island Department of Environmental Management for permission to make temporary discharge at this outfall. Detailed design of the stripping column, pumping system, and temporary discharge pipeline cannot be performed until the constraints of the proposed discharge are finalized with RIDEM.

The DFSP discharge permit limits appears to be similar to the treated water from Tanks 53 and 56. The water phase from Tank 56 may be discharged with only oil/water separator treatment. The water from Tank 53 has higher levels of contaminants and will probably require air-stripping treatment prior to discharge.

Once the oily layer and water phase have been removed from the tanks, the tanks can be entered for sludge removal. The specifications for the sludge removal requires consideration of health and safety standards for the personnel as well as the standards of acceptable completion of this task. Occupational Health and Safety Act (OSHA) standards and American Petroleum Institute Guidelines (API) will be followed. The acceptable level of cleanliness will be such that the tanks no longer contain loose material, fuel, oil, sludge or grease. The surface contamination of the walls and floor would remain.

Alternative 2A

Alternative 2A removes the source of the contamination, but does not address the surface contamination of the concrete tanks. Although the walls were treated with silicate of soda, the residual oils and used oils stored in the tanks have probably soaked into the surface of the walls and floors. Also, the empty tank may float out of the ground causing a structural hazard to personnel and future building construction on the site. The damaged tank could increase the potential for the spread of groundwater and soil contamination away from the site.

At Tank 53, the ring drain space contained water with some degree of contamination. As part of Alternative 2, removal and treatment of the water phase at Tank 53, the ring drain area will be pumped, treated and disposed. Since leakage may occur during the pumping operation, this task should be repeated at the end of the removal operation.

Alternative 2B - Alternative 2A, Clean and Fill with Water

Alternative 2B is similar to Alternative 2A but in addition the tank walls are cleaned and the tank is then filled with water. Using water as a ballast eliminates the problem of the tank becoming a floating structural hazard but does not provide for an adequate foundation to in the event of future building construction. Alternative 2B does not address RIDEM underground tank regulations which require backfilling the tanks with an inert material such as sand as opposed to water.

Alternative 3A - Alternative 2B, Fill with Inert Material

Alternative 3A is similar to Alternative 2B; but instead of filling the tank with water ballast, Alternative 3A is to demolish the top and bottom of the tank and then fill with inert material (i.e. sand). This alternative addresses both the environmental issues and the future construction problems. Although the concrete tank walls are left in place, all potential oil contamination is removed and no future groundwater contamination is possible. This alternative allows future building construction on the tank sites.

Alternative 3B - Alternative 3A with removal of all concrete & backfill

Alternative 3B would remove all tank construction material from the site and any contaminated soil. This alternative is the most expensive and the solid waste disposal of thousands of tons of concrete rubble and soil will cause additional environmental impacts beyond any of the previous alternatives.

Once Alternative 2 cleaning operation has been completed and accepted by RIDEM, the tanks are considered to be decontaminated. Disposition of the structure would no longer require special consideration. Demolition of the tanks will not require any special consideration for the disposal of debris. Any decision to select Alternative 2B or 3A to fill the tanks will be based on the Navy's future plans for land use.

## PROPOSED CLOSURE PLAN

The closure plan for Tanks 53 and 56 will take the following format based upon the implementation of Alternative 2B or 3A, the removal and disposal of contents, cleaning of the interior surfaces, and filling the tanks with water or inert material.

1. Prepare detailed cost estimates of the tasks required by the selected course of action (assumed as Alternative 3A).

2. Negotiate a temporary discharge permit at the DFSP discharge for the disposal of the treated water phase of the tank contents.

3. Design counter current aeration stripping treatment system to remove pollutants to the limits specified in the negotiated discharge permit.

4. Prepare detailed specifications for the oily water scavenging operation, water removal pumping system, and cleaning operation.

5. Present final plans and specifications to DEM for approval prior to commencement of closure operations.

6. Notify RIDEM of intent to commence closure operations.

7. Commence closure operations.

8. Remove oily layer from Tank 56, then Tank 53.

9. Construct temporary pipeline to discharge point.

10. Remove water phase from Tank 56 and discharge.

11. Construct stripping system (concurrent with item 9).

12. Operate stripping system, pumping wastewater from Tank 53 and discharge.

13. Construct and operate circulation system to remove groundwater from ring drain and treat through stripping system concurrently with item 12.

14. Complete stripping operation, disassemble stripping unit, dismantle temporary discharge system.

15. Notify RIDEM that temporary discharge is completed.

16. Prepare tank for cleaning by vapor-freeing the interior, in accordance with OSHA and API procedures.

17. Review all applicable safety procedures and preparedness of cleaning contractor.

18. Enter tank and commence sludge removal.

19. Dispose sludges as hazardous waste, complete sludge removal.

20. During the sludge removal operation, monitor the vapor levels and apply vapor-freeing techniques as applicable.

21. Once sludge removal and vapor-freeing is accomplished, commence steam cleaning operation.

22. Inspect tank for completion of cleaning in accordance with approved, specified standards.

23. Reballast tanks in accordance with Alternative 2B - Fill with Water, or Alternative 3A - Inert Material (sand).

24. Implement 2 year groundwater monitoring, with sampling and analyses performed semi-annually.

25. Conclude contract operations, determine that closure is complete.

26. Certify completion of closure.

TABLES

TABLE 1

GROUNDWATER ANALYSES FOR VOLATILE ORGANIC COMPOUNDS

| SAMPLE LOCATION | MW 53E | | MW 53W | | MW 56E | | MW 56W | |
|---|---|---|---|---|---|---|---|---|
| SAMPLE DATE | 10-22-85 | 11-26-86 | 10-22-85 | 10-26-86 | 10-22-85 | 10-26-86 | 10-22-85 | 10-26-86 |
| methylene chloride | 178 | ND | 54 | ND | ND | ND | 304 | ND |
| trans-1,2-dichloroethylene | 166 | 1100 | 46 | 400 | ND | ND | ND | ND |
| chloroform | 401 | ND | 353 | ND | 12 | ND | 18 | ND |
| 1,2-dichloroethane | 211 | ND | 229 | ND | ND | ND | ND | ND |
| 1,1,1-trichloroethane | 4400 | 930 | 4400 | 330 | ND | ND | 17 | ND |
| trichloroethylene | 1400 | 800 | 785 | 24 | ND | ND | ND | ND |
| tetrachloroethylene | 262 | 25 | 14 | 16 | ND | ND | ND | ND |
| benzene | 300 | 330 | 155 | ND | ND | ND | ND | ND |
| toluene | ND | 1400 | ND | ND | ND | ND | ND | ND |
| ethylbenzene | 374 | 150 | ND | ND | ND | ND | ND | ND |
| xylenes | 1620 | 600 | 140 | 65 | ND | ND | ND | ND |
| 1,1 dichloroethane | ND | 32 | ND | 14 | ND | ND | ND | ND |
| 1,1 dichloroethylene | ND | 170 | ND | 57 | ND | ND | ND | ND |
| trichlorofluoromethane | ND | ND | ND | ND | ND | ND | ND | ND |
| bromodichloromethane | ND | 470 | ND | 49 | ND | ND | ND | ND |

Concentrations are reported in parts per billion, (ppb).

ND indicates that trace amounts, below reportable detection limits or no amounts were found.

TABLE 2

GROUNDWATER ANALYSES FOR TOXIC METALS

| PARAMETER | MW 53E | MW 53W | MW 56E | MW 56W |
|---|---|---|---|---|
| Arsenic | <0.01 | <0.01 | <0.01 | <0.01 |
| Barium | <0.5 | <0.5 | <0.5 | <0.5 |
| Cadmium | 0.007 | <0.005 | <0.005 | <0.005 |
| Chromium | <0.05 | <0.05 | <0.05 | <0.05 |
| Lead | <0.05 | <0.05 | <0.05 | <0.05 |
| Mercury | <0.0005 | 0.0014 | 0.0012 | 0.0008 |
| Selenium | <0.01 | <0.01 | <0.01 | <0.01 |
| Silver | <0.01 | <0.01 | <0.01 | <0.01 |

Concentrations are reported in mg/l

Samples taken 10-22-85

TABLE 3

SAMPLE ANALYSES

| SAMPLE LOCATION | ERA 86-1 | ERA 86-2 | ERA 86-3D | ERA 86-3S | ERA 86-4 | ERA 86-5 |
|---|---|---|---|---|---|---|
| SAMPLE DATE | 10-01-86 | 10-01-86 | 10-06-86 | 10-01-86 | 10-01-86 | 12-06-86 |
| methylene chloride | ND | ND | ND | ND | ND | ND |
| trans-1,2-dichlorcethylene | ND | 3 | 26 | 1 | ND | ND |
| chloroform | ND | 10 | ND | 3 | 12 | ND |
| 1,2-dichloroethane | ND | ND | 18 | ND | ND | ND |
| 1,1,1-trichloroethane | ND | 5 | 101 | 5 | ND | ND |
| trichloroethylene | ND | 1 | 35 | 2 | ND | ND |
| tetrachloroethylene | ND | ND | 2 | ND | ND | ND |
| benzene | ND | ND | ND | ND | ND | ND |
| toluene | ND | ND | 2 | ND | ND | ND |
| ethylbenzene | ND | ND | 3 | ND | ND | ND |
| xylenes | ND | ND | 39 | ND | ND | ND |
| 1,1 dichloroethane | ND | 2 | 2 | 4 | ND | ND |
| trichlorofluoromethane | ND | ND | 1 | ND | ND | ND |

Concentrations are reported in parts per billion, (ppb).

ND indicates that trace amounts, below reportable detection limits or no amounts were found.

TABLE 4

ESTIMATED LIQUID VOLUMES IN TANKS

In Gallons

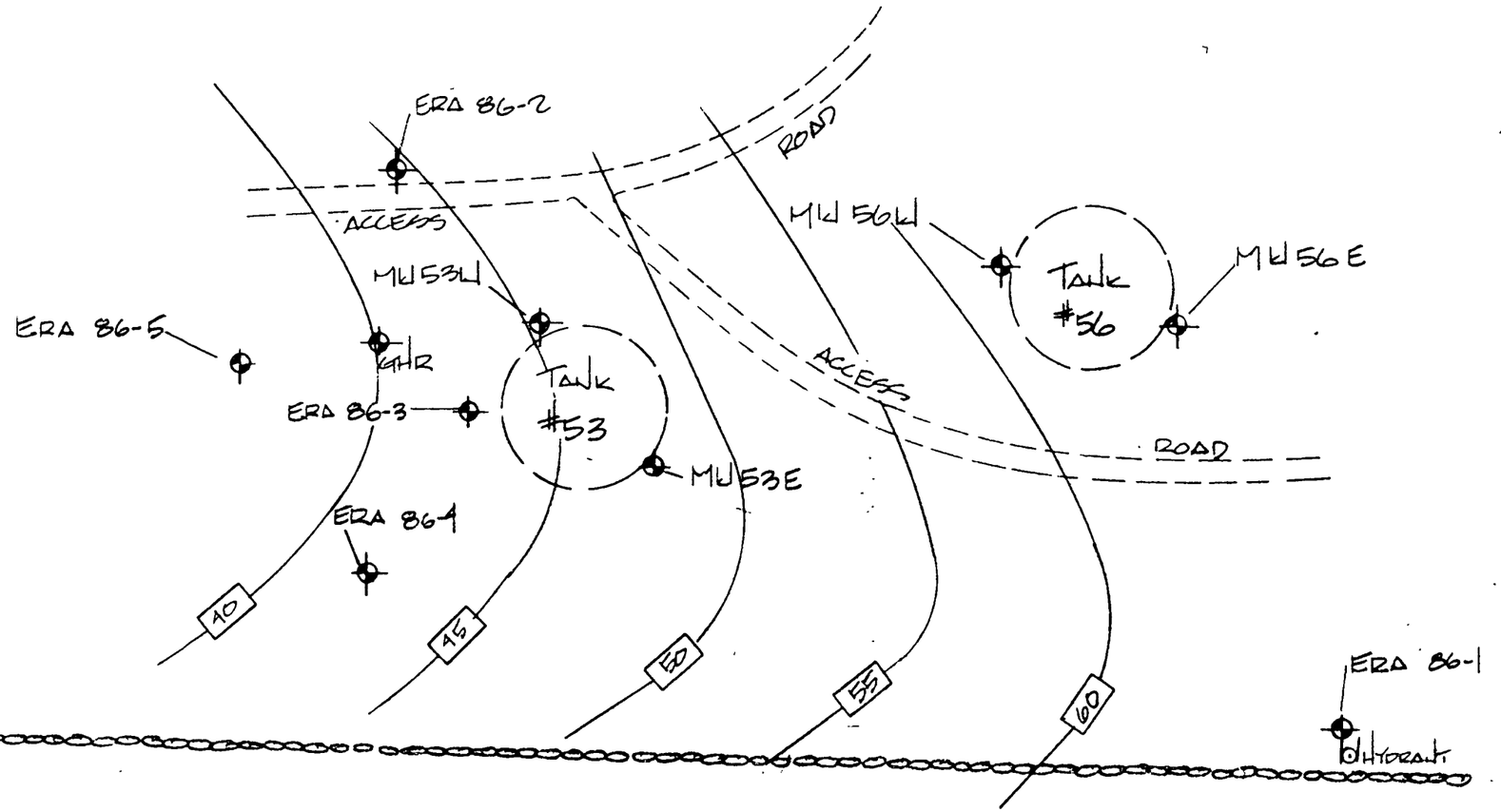
| Tank | Oil Vol | Water Vol | Sludge Vol | Total Vol |
|---|---|---|---|---|
| 53 | 45,730 | 2,367,870 | 117,445 | 2,531,045 |
| 56 | 35,983 | 1,144,446 | 79,500 | 1,259,929 |

82,000 gal

By Inches

| Tank | Oil | Water Vol | Sludge Vol | Total Vol |
|---|---|---|---|---|
| 53 | 7" | 30' 2" | 18" | 32' 3" |
| 56 | 5-1/2" | 14' 7" | 1' 3/8 | 16' 7/8" |

FIGURES




ENVIRONMENTAL RESOURCE ASSOCIATES, INC.
WARWICK, R.I. (401) 781-7422

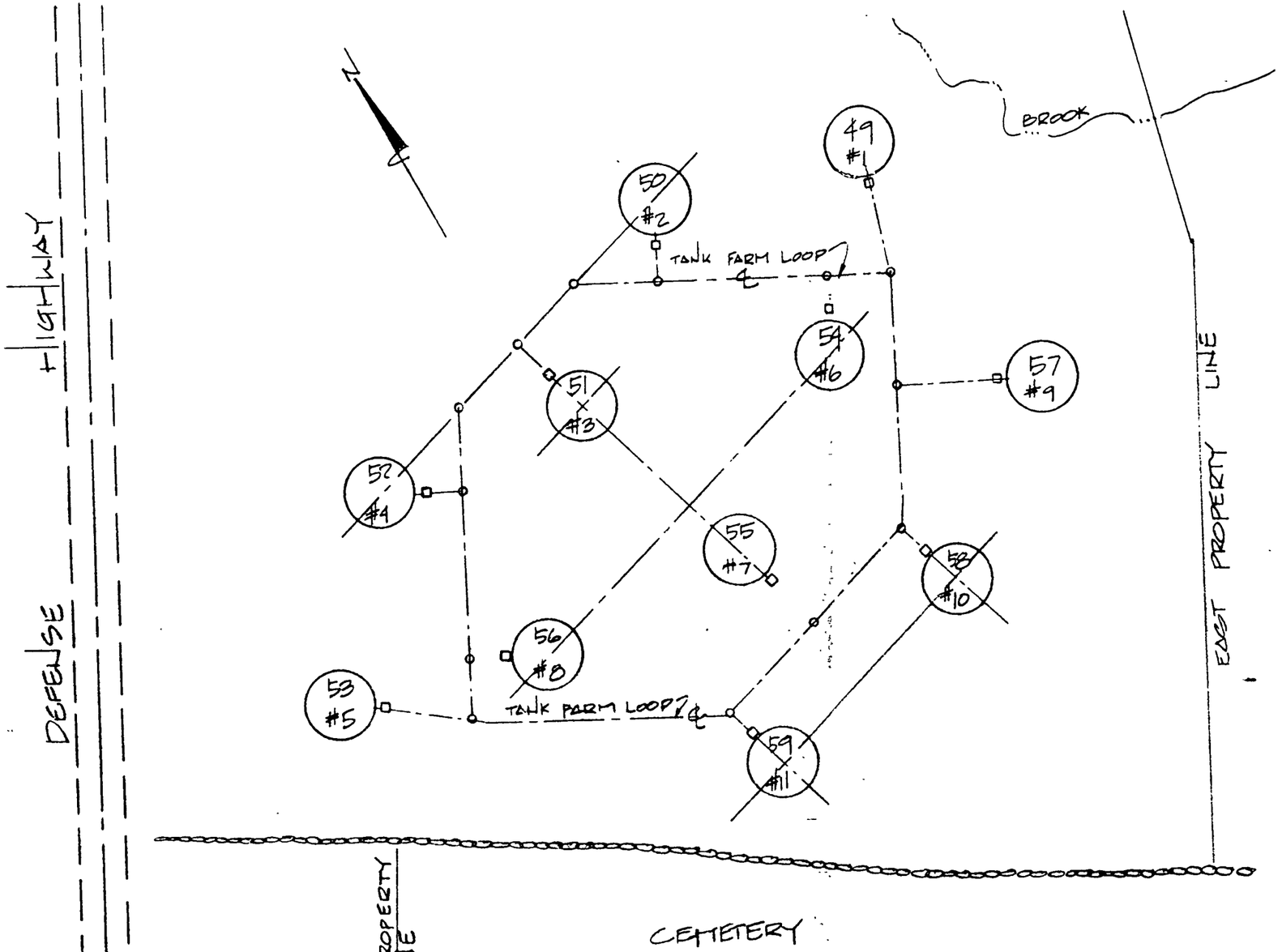
| | | |
|---|---|---|
| SCALE: 1"=100' | APPROVED BY CONTRACT PART "D" | DRAWN BY MKL |
| DATE: APR. 88 | | |

MONITORING WELL LOCATIONS & GROUNDWATER CONTOURS

FIGURE 1

DRAWING NUMBER 5290

TELEDYNE POST 18AB-08 – 11 x 17




ENVIRONMENTAL RESOURCE ASSOCIATES, INC.
WARWICK, R.I. (401) 781-7422

| | | |
|---|---|---|
| SCALE: 1" = 200' | APPROVED BY | DRAWN BY MKU |
| DATE: APR. 88 | | |

TANK FARM LOCATION PLAN
N.E.T.C. MIDDLETOWN, R.I.

FIGURE 1

DRAWING NUMBER 5200

APPENDIX A

tibbetts engineering corp.
210 DEANE STREET, NEW BEDFORD, MASSACHUSETTS 02746,
TELEPHONE (617) 996-5633

January 12, 1984

Engineering Division
Code 42P
Naval Education and Training Center
Newport, Rhode Island 02841

Attn: Mr. M. Dwyer

Re: Contract N2472-83-C-7940

Dear Mr. Dwyer:

Per the referenced contract, Tibbetts Engineering Corp. (TEC) [illegible] guaging information at the specified tanks at Tank Farm #5 at the NETC in Newport, Rhode Island, and collected and obtained analysis results on samples of the tank contents. As stated in the referenced contract, only tanks in which six (6) inches or more depth of oil was found were oil samples collected, except in the cases of the waste disposal tanks #53 and #56.

The results of this sampling and testing project are all included in the attached report, and a photograph of each collected "zone" sample from tanks numbered 53 and 56 is on file at TEC for reference.

We hope you are pleased with the quality services of TEC. Please contact me if you have questions or desire further services.

Very truly yours,
TIBBETTS ENGINEERING CORP.

FLT/ng

Fred E. Tibbetts, III, Ph.D., CPC
Director
Research & Environmental Affairs

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## APPENDIX

# CHAPTER 1

## Tank Sampling Description and Test Results Summary

## CHAPTER 1 TANK SAMPLING DESCRIPTION AND TEST RESULTS SUMMARY

Of the Nine (9) fuel oil storage tanks numbered 49, 50, 51, 52, 54, 55, 57, 58 and 59, a depth of oil of close to six (6) inches or more was found to exist only in tanks numbered 50 and 52. In the waste disposal tanks #53 and #56, only about one (1) to two (2) feet depth of oily material is believed to exist floating on top of the water layer in each tank, although "globs" or layers of oily material may be suspended in the water layer of each tank. In the bottom of each tank #53 and #56, a compacted layer of sediment of unknown depth is also believed to exist, and a sample of the surface layer of the bottom sediment in each tank was collected with a "Bacon" bottom sampler and analyzed for the Hazardous Waste Characterization Series of tests per the EPA's Resource Conservation and Recovery Act of 1976. The EP Toxicity Test and P.C.B.'s analysis could not be performed on the sediment samples because of an insufficient amounnt of each sample.

Most of the one foot "zone" samples collected from below the topmost oily layer in tanks #53 and #56 contained a small amount (five (5) to fifteen (15) percent) of oil floating on top of the water layer of each sample. This oil is believed by the sampling crew to have been obtained from the floating oily layer in each tank through which the "zone" sampler had to pass to obtain each zone sample at a lower level, and not from the tank contents at a deeper level. The oily layer floating on top of the water in tank #53 and #56 was of a somewhat thickened character, and passage of the zone sampler through the oily layer without collecting some oil thus seemed impossible.

However, comparison of the analytical test values obtained upon composite oil samples collected from the top and deeper parts of the tank contents in tank #53 and #56 shows that some test values are quite different.

First, the "Fuel Characteristic" tests for chlorides obtained upon composite oil samples from the top most "zones" and the deeper "zones" of either tank #53 or tank #56 were significantly different from each other. (See Chapter 4)

Second, the hazardous waste tests for volatile organic solvents obtained upon composite oil samples of the top most "zones" and of the deeper "zones" were very different when comparing samples from tank number 53, and also in the case of the solvent methylene chloride in the samples from tank #56. (See Chapter 3 and p. 12 of the Appendix)

The different concentrations of test substances that were found in different "zone" samples from each tank could indicate that stratified layers or "globs" of oil possibly exist at various levels within the water layer of each tank.

Thus, no conclusive statement about the possibility of oily layers or globs of oil existing in the water layer in either tank #53 or #56 can be made based upon the information that has been generated for this project per Contract N62472-83-C-7940. A photograph of each zone sample collected from tank #53 and #56 was taken and the photographs are being retained at TEC for reference.

At the TEC Laboratory, each zone sample was inspected and tested as is described in Chapter 2, and then groups of samples for each tank that were perceived to be similar were combined into one composite sample for analysis. The log describing which zone samples were combined into which composite samples, and the analytical test results obtained upon each sample are listed in the body of the report.

In general, no PCB's, chlorinated pesticides, or arsenic compounds were detected in the composite oil or water samples obtained from tanks #53 and #56, although some chlorinated volatile organic compounds and lead containing compounds were found in said samples. Regarding the fuel value characterization tests run upon all of the samples in which oil in more than six (6) inches depth was found to exist, no sulphur or percent chloride was found to be present in an amount greater than the limit set by the State of Rhode Island Division of Environmental Management for use of the oil as fuel.

All of the sample collection, sample compositing, and analytical test information is detailed in the following chapters and in the appendix.

# CHAPTER 2

## Hazardous Waste Tanks No. 53 and No. 56 Sampling Data Log and Zone Sample Description

## SAMPLING LOG TANK NO. 53

| TANK NO. | SAMP. NO. ASSIGNED | FT. FROM BOTTOM OF TANK | WATER LAYER pH | SP. COND. μmho/cm | VISUAL |
|---|---|---|---|---|---|
| 53 | S3313A2 | 32(Top) | | | Oil |
| " | " 3 | 31 | | | Oil |
| " | " 4 | 30 | | | Oil & Water |
| " | " 5 | 29 | 6.5 | 5,100 | Mostly all Water |
| " | " 6 | 28 | 6.5 | 5,100 | " |
| " | " 7 | 27 | 6.5 | 5,100 | " |
| " | " 8 | 26 | 6.5 | 5,100 | " |
| " | " 9 | 25 | 6.5 | 5,100 | " |
| " | " 10 | 24 | 6.5 | 5,100 | " |
| " | " 11 | 23 | 6.5 | 5,100 | " |
| " | " 12 | 22 | 6.5 | 5,100 | " |
| " | " 13 | 21 | 6.5 | 5,000 | " |
| " | " 14 | 20 | 6.5 | 5,100 | " |
| " | " 15 | 19 | 6.5 | 5,100 | " |
| " | " 16 | 18 | 6.5 | 5,100 | " |
| " | " 17 | 17 | 6.5 | 5,000 | " |
| " | " 18 | 16 | 6.5 | 5,000 | " |
| " | " 19 | 15 | 6.5 | 5,000 | " |
| " | " 20 | 14 | 6.5 | 5,000 | " |
| " | " 21 | 13 | 6.4 | 4,900 | " |
| " | " 22 | 12 | 6.5 | 5,100 | " |
| " | " 23 | 11 | 6.5 | 5,000 | " |
| " | " 24 | 10 | 6.5 | 5,100 | " |
| " | " 25 | 9 | 6.4 | 5,100 | " |
| " | " 26 | 8 | 6.4 | 5,300 | " |
| " | " 27 | 7 | 6.5 | 5,250 | " |
| " | " 28 | 6 | 6.6 | 5,300 | " |
| " | " 29 | 5 | 6.6 | 5,250 | " |
| " | " 30 | 4 | 6.6 | 5,750 | " |
| " | " 31 | 3 | 6.5 | 6,000 | " |
| " | " 32 | 2 | 6.6 | 6,000 | " |
| " | " 33 | 1 | 6.5 | 6,000 | " |
| " | " 1 | Bottom Sludge(0) | 6.5 | 6,000 | Sludge & Water |

## SAMPLE COMPOSITING DATA TANK NO. 53

| WATER COMPOSITE SAMPLE CONTAINING | CHLORIDES IN WATER COMP. | OIL COMPOSITE SAMPLE CONTAINING |
|---|---|---|
| 53-W-A Contains water layers from S3313A1, S3313A32 and S3313A33 | 1,750 ppm | 53-O-A Contains oil composite from Samples S3313A2, S3313A3 and S3313A4 |
| 53-W-B Contains water layers from S313A5 through S3313A31 | 1,430 ppm | 53-O-B Contains composited thin oil layers from samples S3313A5 through S3313A33 |

(53) 30 ft water
2.4 million gal

(56) 12
144 .96 mi

## SAMPLING LOG TANK NO. 56

| TANK NO. | SAMP. NO. ASSIGNED | FT. FROM BOTTOM OF TANK. | WATER LAYER pH | SP. COND. μσ/cm | VISUAL |
|---|---|---|---|---|---|
| 56 | S3313B4 | 15(Top) | | | Oil |
| " | " 5 | 14 | 7.1 | 8,200 | Oil & Water |
| " | " 6 | 13 | 7.2 | 4,800 | Mostly all Water |
| " | " 7 | 12 | 7.3 | 5,000 | " |
| " | " 8 | 11 | 7.2 | 5,250 | " |
| " | " 9 | 10 | 7.3 | 5,300 | " |
| " | " 10 | 9 | 7.4 | 5,500 | " |
| " | " 11 | 8 | 7.5 | 5,700 | " |
| " | " 12 | 7 | 7.4 | 5,750 | " |
| " | " 13 | 6 | 7.4 | 6,000 | " |
| " | " 14 | 5 | 7.6 | 6,200 | " |
| " | " 15 | 4 | 7.7 | 6,200 | " |
| " | " 16 | 3 | 7.6 | 6,500 | " |
| " | " 3 | 2 | 7.5 | 6,250 | Water |
| " | " 2 | 1 | 7.2 | 9,000 | Water |
| " | S3313B1 | Bottom Sludge(0) | 7.2 | 7,200 | Sludge & Water |

## SAMPLE COMPOSITING DATA TANK NO. 56

| WATER COMPOSITE SAMPLE CONTAINING | CHLORIDES IN WATER (ppm) | OIL COMPOSITE SAMPLE CONTAINING |
|---|---|---|
| 56-W-A Contains water layers from S3313B1 and S3313B2 | 2,390 | 56-O-A Contains oil composite from Samples S3313B4 and S3313B5 |
| 56-W-B Contains water layers from S3313B3 and S3313B5 through S3313B16 | 1,650 | 56-O-B Contains composited thin oil layers from samples S3313B1 through S3313B3 and S3313B6 through S3313B16 |

# CHAPTER 3

## Hazardous Waste Characterization Test Results
## Tank No. 53 and Tank No. 56

## Hazardous Waste Characteristics

(ppm)

| SAMPLE NUMBER | HEIGHT (Ft.) | HAZARDOUS WASTE * | VISUAL | BARIUM | CADMIUM | CHROMIUM | LEAD | MERCURY | SILVER |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Profile Tank No 53 | | | | | |
| 53-O-A | 30 to 32 | Yes | Oil | - | - | - | 53.0 | - | - |
| 53-O-B | 3 to 31 | Yes | Oil | - | - | - | 53.2 | - | - |
| 53-W-B | 3 to 31 | No | Water | - | - | - | 0.52 | - | - |
| 53-W-A | 1 to 2 | No | Water | - | - | - | 0.13 | - | - |
| 53-S | 0 to 1 | Yes | Sludge | 1,244 | 13.7 | 212 | 22,500 | 1.6 | 5.9 |
| | | | | Profile Tank No 56 | | | | | |
| 56-O-A | 13 to 14 | Yes | Oil | - | - | - | 44.9 | - | - |
| 56-O-B | 0 to 13 | Yes | Oil | - | - | - | 45.4 | - | - |
| 56-W-B | 2 to 13 | No | Water | - | - | - | 0.39 | - | - |
| 56-W-A | 0 to 1 | No | Water | - | - | - | 0.07 | - | - |
| 56-S | o to 1 | Yes | Sludge | 804 | 17.3 | 248 | 14,700 | 0.83 | 21.0 |
| STATE OF RHODE ISLAND HAZARDOUS WASTE LIMITS | | | | 100 | 1.0 | 5.0 | 5.0 | 0.2 | 5.0 |

O = Oil
W = Water
S = Sludge

* Identified as Hazardous per State of Rhode Island Hazardous Waste Limits (as listed)

# HAZARDOUS WASTE CHARACTERIZATION TEST RESULTS
## TANK NO. 53 AND TANK NO. 56

| | OILS | | | | WATERS | | | |
|---|---|---|---|---|---|---|---|---|
| TANK NO. | 53 | 53 | 56 | 56 | 53 | 53 | 56 | 56 |
| COMPOSITE SAMPLE NO. | 53-O-A | 53-O-B | 56-O-A | 56-O-B | 53-W-A | 53-W-B | 56-W-A | 56-W-B |
| VOLATILE ORGANIC COMPOUNDS (11 total) | 8 OF 11 FOUND | 7 OF 11 FOUND | 6 OF 11 FOUND | 8 OF 11 FOUND | 4 OF 11 FOUND | 7 OF 11 FOUND | 5 OF 11 FOUND | 3 OF 11 FOUND |
| P.C.B.'s and PESTICIDES (19 total) | NONE FOUND | NONE FOUND | NONE FOUND | NONE FOUND | NONE FOUND | NONE FOUND | NONE FOUND | NONE FOUND |
| ARSENIC (ppm) | N.D. | N.D. | N.D. | N.D. | N.D | N.D | N.D | N.D |
| LEAD (ppm) | 53.0 | 53.2 | 44.9 | 45.4 | 0.52 | 0.13 | 0.39 | 0.07 |

N.D. - NONE DETECTED DOWN TO THE TEST LIMIT (SEE APP. SEC. B(1) FOR LIMITS)

SEE APPENDIX SECTION B(1) FOR ANALYTICAL DATA ON ABOVE RESULTS

HAZARDOUS WASTE CHARACTERIZATION TEST RESULTS
TANK NO. 53 AND TANK NO. 56

BOTTOM SLUDGE

| TANK NO. | 53 | 56 |
|---|---|---|
| COMPOSITE SAMP. NO. | 53-S | 56-S |
| % SOLIDS (Total Wt. Basis) | 46.7 | 68.2 |
| % VOLATILE SOLIDS | 44.5 | 27.7 |
| % SILICA | 30.0 | 75.1 |
| ARSENIC | < 1.0 | < 2.5 |
| BARIUM | 1,244 | 804 |
| CADMIUM | 13.7 | 17.3 |
| CHROMIUM | 212 | 248 |
| LEAD | 22,500 | 14,700 |
| MERCURY | 1.6 | 0.83 |
| SELENIUM | < 0.5 | <1.0 |
| SILVER | 5.9 | 21.0 |

METALS RESULTS ARE IN p.p.m. DRY WEIGHT BASIS

# CHAPTER 4

## Fuel Characteristic Test Results on Oil Samples from Tanks No. 50, No. 52, No. 53 and No. 56

## FUEL CHARACTERISTICS TEST RESULTS

| TANK NO. | COMPOSITE SAMPLING NO. | DEPTH FROM TOP OF LIQUID | ASTM D287 GRAVITY, API @ 60°F | ASTM D240 BTU'S PER POUND | ASTM D240 BTU'S PER GALLON | ASTM D1552 % SULFUR | UOP 588 ORGANIC CHLORIDES (p.p.m.) | JOP 22 INORGANIC CHLORIDES (p.p.m.) |
|---|---|---|---|---|---|---|---|---|
| 53 | 53-0-A | 0to2½ft. | 28.5 | 19,224 | 141,566 | 0.70 | 2.4 | 6.8 |
| 53 | 53-0-B* | | | 18,749 | | 0.64 | 63** | 46.3 |
| 56 | 56-0-A | 0to1½ft. | 29.6 | 19,260 | 140,868 | 0.45 | 51.1 | 10.6 |
| 56 | 56-0-B* | | | 19,174 | | 0.54 | 532** | 75.3 |
| 50 | 50-0-A | 0to1½ft. | 24.5 | 18,797 | 141,974 | 0.95 | 49.6 | 23.9 |
| 52 | 52-0-A | 0to½ft. | 33.0 | 19,346 | 138,556 | 0.54 | 2.4 | 5.4 |



* - Composited Thin Oil Layers of Mostly Water Samples

** - Dohrman Mth. (Dohrmann DX-20 Analyzer, Xertex Co., Santa Clara, Cal.)

ASTM - American Society for Testing and Materials

UOP - Universal Oil Products

## APPENDIX

SECTION

A. Tank Guaging Data by E. W. Saybolt

B. (1) Hazardous Waste Tests by Rhode Island Analytical Laboratories
(2) Hazardous Waste Tests by Cambridge Analytical Associates
(3) Fuel Characteristics Tests by E. W. Saybolt

SECTION A

Tank Guaging Data
by
E. W. Saybolt Co., Inc.

E. W. GAYBOLT & CO., INC.

LICENSED INSPECTION
APPROVED GAUGERS BY U.S. CUSTOMS
INSPECTION OF PETROLEUM AND OTHER PRODUCTS

DOCKED
STARTED 0907 11-9-83
FINISHED 1408 "

LOCATION Middletown, R.I.

CARGO DESIGNATED AS Waste Oil

ORD. NO. EN 4640

| TANK | GAUGES FT. | INNAGE IN. | TEMP °F | GR | GROSS OUTAGE FT. | IN. | WATER measured Guage Height FT. | IN. | WATER, Guage Height FT. | IN. | GROSS LESS WATER | FACTORS | NET @ 60 °F | @ 60 °F DELIVERE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 53 | 32 | 2-1/2 | | | 1 | 9-5/8 | 34 | 0-1/8 | | | | | | |
| 56 | 15 | 5-1/2 | | | 19 | 5-3/8 | 34 | 11-3/8 | 35 | 3-7/8 | | | | |
| 59 | 9 | 2-1/4 | | | 26 | 1-3/8 | 35 | 3-7/8 | 35 | 3-7/8 | | | | |
| 55 | 12 | 3-5/8 | | | 23 | 0-11/16 | 35 | 4-3/8 | 35 | 4/15/16 | | | | |
| 58 | 31 | 7 | | | 3 | | 35 | 4 | 35 | 4 | | | | |
| 57 | 27 | 2-3/4 | | | 8 | 1-1/8 | 35 | 3-5/8 | 35 | 5-1/8 | | | | |
| 54 | 18 | 10-7/8 | | | 16 | 5-7/8 | 35 | 4-3/4 | 35 | 4-3/4 | | | | |
| 50 | 31 | 7-1/2 | | | 3 | 8-7/8 | 35 | 4-1/4 | (35 | 4-3/4) Full | | | | |
| 49 | 23 | 5-3/8 | | | 11 | 11-1/4 | 35 | 4-1/2 | 35 | 4-1/2 | | | | |
| 51 | 13 | 0-5/8 | | | 22 | 3-1/4 | 35 | 3-7/8 | 35 | 3-7/8 | | | | |
| | 12 | 9-1/8 | water | | | | | | | | | | | |
| 52 | 25 | 2-1/2 | | | 10 | 0 | 35 | 2-1/2 | 35 | 2-3/8 | | | | |
| | 24 | 9-5/8 | water | | | | | | | | | | | |

REVISED: 2-9-84 TO INCLUDE TANK 52 GAUGES.

Seal #85885 #85125
85809 85679

Measured Guage Heights

Guage Heights as painted on Bunkers

Where our opinion is based on information obtained from vessel's officer, ship's log or shore personnel, we cannot be responsible for incorrect facts supplied us.

| SUMMARY | Samples shall be retained for 45 days. | TEMP CORRECTION BASED ON ASTM D 1250 - 1P200 TABLE NO. |
|---|---|---|
| POUNDS | LAST 3 CARGOES | |
| GALS. @60°F | SHORE LINES BEFORE | DRAFT-FWD. AFT |
| BBLS. @60°F | SHORE LINES AFTER | DRAFT-FWD. AFT |
| TONS (2240 LBS) | INVOICE NUMBER | |
| POUNDS/GAL. | HOSES ON | HOSES OFF |

E. W. GAYBOLT & CO., INC.

BY

As ordered, we have visually inspected the above tanks, and found tanks (to be, not to be) in our opinion from visual inspection substantially clean for receipt of designated cargo. Where we are not specifically instructed to sample tanks for water and sediment and tilefing is not practical, water contamination is determined by an increase in gauged quantity. All test results obtained represent the material at the point of sampling. Test results are based on analysis made at the time samples are received in the laboratory.

SECTION B

(1)

Hazardous Waste Tests
by
Rhode Island Analytical Laboratories

R. I. Analytical Laboratories, Inc.

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK, R. I. 02888

PHONE. (401) 467-2452

# CERTIFICATE OF ANALYSIS

REPORT TO Tibbetts Engineering Corp.
20 Deane Street
New Bedford, MA 02746
Attn: Fred E. Tibbetts, III, Ph.D.

DATE RECEIVED 11/17/83 te
DATE REPORTED 12/22/83
PURCHASE ORDER NO
RIAL INV NO 9253

SAMPLE DESCRIPTION Twenty-two (22) water and oil samples

Subject samples have been analyzed by our laboratory with the attached results.

Methodology: Test Methods for Evaluating Solid Waste, Physical/ Chemical Methods, U.S. EPA, SW-846, 1980.

Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057, July 1982.

If you have any questions regarding this work or if we may be of further assistance, please contact us.

APPROVED BY Anthony F. Pennetti

Certificate of Analysis

Tibbetts Engineering Corp.
December 22, 1983
Inv.#9253
Page -2-

| PARAMETER | 53-A | 53-B | 56-A | 56-B | 53-0-A | 53-0-B | 56-0-A | 56-0-B |
|---|---|---|---|---|---|---|---|---|
| Aldrin | <0.98 | <1.60 | <2.35 | <1.00 | <1 | <1 | <1 | <1 |
| α BHC | <1.37 | <2.24 | <3.29 | <1.40 | <1 | <1 | <1 | <1 |
| β BHC | <1.37 | <2.24 | <3.29 | <1.40 | <1 | <1 | <1 | <1 |
| γ BHC | <1.37 | <2.24 | <3.29 | <1.40 | <1 | <1 | <1 | <1 |
| δ BHC | <1.37 | <2.24 | <3.29 | <1.40 | <1 | <1 | <1 | <1 |
| Chlordane | <4.5 | <7.4 | <10.9 | <4.6 | <5 | <5 | <5 | <5 |
| 4,4'-DDT | <1.25 | <2.05 | <3.01 | <1.28 | <1 | <1 | <1 | <1 |
| 4,4'-DDE | <1.25 | <2.05 | <3.01 | <1.28 | <1 | <1 | <1 | <1 |
| 4,4'-DDD | <1.25 | <2.05 | <3.01 | <1.28 | <1 | <1 | <1 | <1 |
| Dieldrin | <1.91 | <3.14 | <4.61 | <2.00 | <2 | <2 | <2 | <2 |
| α Endosulfan | <1.91 | <3.14 | <4.61 | <2.00 | <1 | <1 | <1 | <1 |
| β Endosulfan | <1.91 | <3.14 | <4.61 | <2.00 | <1 | <1 | <1 | <1 |
| Endosulfan Sulfate | <1.91 | <3.14 | <4.61 | <2.00 | <1 | <1 | <1 | <1 |
| Endrin | <1.91 | <3.14 | <5.08 | <2.00 | <2 | <2 | <2 | <2 |
| Endrin Aldelnyde | <1.91 | <3.14 | <5.08 | <2.00 | <2 | <2 | <2 | <2 |
| Heptachlor | <1.91 | <3.14 | <5.08 | <2.00 | <2 | <2 | <2 | <2 |
| Heptachlor epoxide | <1.91 | <3.14 | <5.08 | <2.00 | <2 | <2 | <2 | <2 |
| Toxaphene | <7.8 | <12.8 | <18.8 | <8 | <10 | <10 | <10 | <10 |
| PCB's (Arochlor 1254) | <3.9 | <6.4 | <9.4 | <4.0 | <5 | <5 | <5 | <5 |
| Sample Volume | 3.9 ml | 6.4 ml | 9.4 ml | 4.0 ml | --- | --- | --- | --- |

Note: Samples 53-A, 53-B, 56-A, 56-B reported in μg total weight

Samples 53-0-A, 53-0-B, 56-0-A, 56-0-B reported in ppm (wt/wgt)

R.I. Analytical Laboratories, Inc.

Certificate of Analysis

Tibbetts Engineering
December 22, 1983
Page -3-

| PARAMETER | 53-0-A | 53-0-B | 56-0-A | 56-0-B | 53-W-A | 53-W-B | 56-W-A | 56-W-B |
|---|---|---|---|---|---|---|---|---|
| Volatile Organics: (ppm) | | | | | | | | |
| vinly chloride | ND | ND | ND | ND | 0.071 | 0.194 | 0.440 | 0.187 |
| methylene chloride | 520 | 24 | 90 | 18 | 0.330 | 1.150 | 0.440 | 0.180 |
| trichlorofluormethane | 15 | ND | ND | ND | ND | ND | ND | ND |
| 1,1-dichloroethylene | 182 | 75 | 3 | 4 | 0.190 | 0.148 | ND | ND |
| 1,1-dichloroethane | ND | ND | ND | ND | ND | 0.134 | ND | ND |
| trans-1,2-dichloroethylene | 152 | 111 | ND | 36 | 3.025 | 2.530 | 0.630 | ND |
| chloroform | ND | ND | ND | 4 | ND | ND | 0.100 | ND |
| 1,2-dichloroethane | 51 | 11 | 6 | 5 | ND | ND | ND | ND |
| 1,1,1-trichloroethane | 1,230 | 344 | 24 | 30 | ND | 0.739 | ND | ND |
| trichloroethylene | 1,300 | 362 | 28 | 29 | ND | ND | ND | ND |
| tetrachloroethylene | 340 | 206 | 16 | 23 | ND | 0.072 | 0.110 | 0.540 |
| Metals: (mg/l) | | | | | | | | |
| Arsenic | <0.40 | <0.40 | <0.40 | <0.40 | <0.01 | <0.01 | <0.01 | <0.01 |
| Lead | 53.0 | 53.2 | 44.9 | 45.4 | 0.52 | 0.13 | 0.39 | 0.07 |

Note: A list of other volatile organic compounds tested for and their detection limits is attached.

Metals analyses reported on total basis (wet-ashing procedure)

R.I. Analytical Laboratories, Inc.

Benzyl chloride
Bromomethane
Bromoform
Carbon tetrachloride
Chloroacetaldehyde
Chlorobenzene
Chloroethane
Chloroform
Chloromethane
Dibromomethane
Dibromochloromethane
Dichlorobromomethane
1,1 Dichloroethane
1,2 Dichloroethane
1,1 Dichloroethylene (vinylidene chloride)
trans-1,2-Dichloroethylene
1,2 Dichloropropane
1,3 Dichloropropene (cis & trans)
Methylene chloride
1,1,2,2 Tetrachloroethane
Tetrachloroethylene
1,1,1 Trichloroethane
1,1,2 Trichloroethane
Trichloroethylene
Trichlorofluoromethane
Trichloropropane
Vinyl chloride

| Detection Limits: | | |
|---|---|---|
| | 53-W-A = 0.05 ppm | 53-O-A = 10 ppm |
| | 53-W-B = 0.05 ppm | 53-O-A = 10 ppm |
| | 56-W-A = 0.05 ppm | 56-O-A = 2 ppm |
| | 56-W-B = 0.05 ppm | 56-O-A = 2 ppm |

N.J. Analytical

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK, R.I. 02886

PHONE (401) 467-9700

# CERTIFICATE OF ANALYSIS

REPORT TO. Tibbetts Engineering Corp.
210 Deane Street
New Bedford, MA 02746
Attn: Dr. Fred Tibbetts, Ph.D.

DATE RECEIVED 12/13/83 te
DATE REPORTED 01/12/84
PURCHASE ORDER NO E-136-3
RIAL INV. NO. 9400

SAMPLE DESCRIPTION Two (2) sediment samples designated TK-53 and TK-56

Subject samples have been analyzed by our laboratory with the following results:

| PARAMETER | TK-53 | TK-56 |
|---|---|---|
| Arsenic | <1.0 ppm | <2.5 ppm |
| Mercury | 1.6 ppm | 0.83 ppm |
| Selenium | <0.5 ppm | <1.0 ppm |

Note: Lower detection limits could not be achieved due to a limited quantity of sample received.

Methodology: Analysis performed on total metal basis using samples as received in accordance with Test Methods for Evaluating Solid Waste, Physical/ Chemical Methods, U.S. EPA, SW-846, 1980.

If you have any questions regarding this work or if we may be of further assistance, please contact us.

APPROVED BY Anthony E. Perrotti

SECTION B

(2)

Hazardous Waste Tests
by
Cambridge Analytical Associates

Cambridge Analytical Associates
222 Arsenal Street / Watertown, Massachusetts 02172 / (617)923-9376

# FORMAL REPORT OF ANALYSIS

PREPARED FOR: Tibbetts Engineering Corporation
210 Deane Street
New Bedford, MA 02746

CUSTOMER ORDER NUMBER: E-123-3

CAMBRIDGE ANALYTICAL ASSOCIATES, INC.

REPORT NUMBER: 83-1021

DATE PREPARED: December 12, 1983

TABLE OF CONTENTS

## 1. INTRODUCTION

This report summarizes results of chemical analyses performed on samples received by CAA on November 18, 1983. Analytical methods employed for these analyses are described in Section 2 and results are presented in Section 3. The last section contains certifications supporting the analytical results.

## 2. ANALYTICAL METHODS

Analytical methods utilized for sample analysis are summarized in Table 1.

## 3. RESULTS

Results of analyses are presented in Table 2.

Table 1

SUMMARY OF ANALYTICAL METHODS

| Constituent | Method Reference | Method Description |
|---|---|---|
| As | Method 206.2 (1) | Graphite furnace atomic absorption |
| Se | Method 270.2 (1) | Graphite furnace atomic absorption |
| Pb | Method 239.1 (1) | Flame AAS |
| Ba | Method 200.7 (1) | ICP |
| Hg | Method 245.1 (1) | Cold-vapor AAS |

(1)U.S. EPA. 1979. Methods for Chemical Analysis of Water and Waste. EPA 600/4-79-020. EPA/EMSL, Cincinnati, Ohio.

Table 2

RESULTS OF CHEMICAL ANALYSES

| Client ID | CAA ID | Concentration (ppm) As | Ba | Pb | Hg | Se |
|---|---|---|---|---|---|---|
| 53319A | 8309333 | <0.05 | <0.050 | <0.005 | <0.0002 | <0.010 |
| 53-S | 8309336 | -- | 13 | 235 | -- | -- |
| 56-S | 8309337 | -- | 8.2 | 150 | -- | -- |
| Digest Blank | 8309338 | -- | 0.11 | 0.35 | -- | -- |

Note: Values for Barium and Lead in the sludge samples are stated in the report as mg/kg dry weight basis. These values were obtained by calculation using the above values for digested samples 53-S and 56-S, to relate back to a dry weight basis.

## 4. QUALITY ASSURANCE DOCUMENTATION

### Certification

This work has been checked for accuracy by the following staff personnel:

Director, Inorganic
Chemistry Laboratory

Keith A. Hausknecht

Keith A. Hausknecht

SECTION B

(3)

Fuel Characteristics Tests
by
E. W. Saybolt Co., Inc.

, SEATTLE, PORTLAND, ORE.,
D MEA, CHICAGO, BOSTON,
EST HAVEN, CONN.

CTION OF BULK CARGOES,
LEUM AND OTHER LIQUIDS,
NSCO WEIGHERS AND SAMP-
OF VEGETABLE OILS, WAXES
TS

ISTS IN TANK CALIBRATING
(201) 245-3100

ank Calibrators — Marine Oil Su ors

APPROVED GAUGERS BY U.S. CUSTOMS
GENERAL HEADQUARTERS
400 SWENSON DRIVE
KENILWORTH, N.J; 07033

P. O. BOX 1146
PASADENA, TEXAS 77502
(713) 477-8171

WEST COAST HEADQUARTER
P. O. BOX 1146
WILMINGTON, CALIF. 90748
(213) 835-8383

EAST COAST HEADQUARTER
400 SWENSON DRIVE
KENILWORTH, N. J. 07033
(201) 245-3100

SERVING THE PETROLEUM INDUSTRY FOR OVER 70 YEARS
DEPENDABLE INSPECTION SERVICE AT ALL PORTS ON THE ATLANTIC, GULF AND PACIFIC COASTS

# LABORATORY ANALYSIS REPORT

MPLE DESIGNATED BY CLIENT AS Oil — So. Boston, Mass.

OM Submitted (50-0-A / 52-0-A / 56-0-A / 56-0-B / 53-0-B / 53-0-A)
Tibbetts Engineering
New Bedford, Mass.

12/21/83

O Tibbetts Engineering Corp.
210 Deane Street
New Bedford, Mas. 02746

Lab No. 60530,31,3
33,34,35



| TEST | RESULTS | | | | | |
|---|---|---|---|---|---|---|
| | 50-0-A | 52-0-A | 53-0-A | 56-0-A | 53-0-B | 56-0-B |
| Gravity, API at 60 F | 24.5 | 33.0 | 28.5 | 29.6 | | |
| Btu's per pound | 18,797 | 19,346 | 19,224 | 19,260 | 18,749 | 19,174 |
| Btu's per gallon | 141,974 | 138,556 | 141,566 | 140,863 | | |
| Sulphur, ASTM:D1552 | 0.95% | 0.54% | 0.70% | 0.45% | 0.64% | 0.54% |
| Organic Chlorides PPM | 49.6 | 2.4 | 2.4 | 51.1 | 63 | 532 |
| Inorganil Chlorides PPM | 23.9 | 5.4 | 6.8 | 10.6 | 46.3 | 75.3 |

E. W. SAYBOLT & CO., INC.

BY

APPENDIX B

# GROUNDWATER STUDY

FOR

TANKS 53 AND 56
TANK FARM 5

NAVAL EDUCATION AND TRAINING CENTER

NEWPORT, RHODE ISLAND

PREPARED BY:

Environmental Resource Associates, Inc.
Warwick, Rhode Island

December 12, 1987

TABLE OF CONTENTS

# GROUNDWATER MONITORING

## SUMMARY

Monitoring of groundwater in the ring drains of Tanks 53 and 56 was accomplished by placement and sampling of four observation wells during October 1985. Results of chemical analyses indicated the groundwater around tank 53 to have elevated levels of organic compounds. At the request of Rhode Island Department of Environmental Management, an additional six monitoring wells were installed to intercept groundwater flow upgradient and downgradient of Tanks 53 and 56. Subsurface analyses indicate that the strata is composed of soft shale and fragmented schistose sandstone. Groundwater levels were measured and the groundwater flow was determined to be in a northwesterly direction.

Additional samples were drawn from the six monitoring wells and from the four observation wells previously installed in the ringwall perimeter of the two subject tanks. Analyses performed on the samples indicate contamination in the groundwater is most likely due to the leaking of product contained in tank 53. Tank 56 is not suspected to be a source of contamination.

## SUBSURFACE EXPLORATIONS AND INSTALLATIONS

On October 15 and 16, 1985, East Coast Drilling, Inc. of Wallingford, Connecticut, completed installation of four monitoring wells ERA-56E, 56W, 53E and 53W. Each of these wells were located approximately 2 to 3 feet from the respective west and east perimeter of two underground fuel storage Tanks numbers 53 and 56. An engineer from Goldberg-Zoino Associates Inc. (GZA) was present to observe and log the drilling procedures, soil conditions as encountered, and subsequent well installation procedures. All soil samples were screened for the presence of volatile organic compounds. Each test boring was advanced using hollow stem auger and wash boring techniques. Standard penetration tests were performed at five foot intervals. The borings were advanced to depths of 37 to 40 feet, and were terminated in or just below the depth at which the perimeter drain materials were encountered.

Construction drawings provided by NETC indicate the tanks were constructed with a perimeter or ring drain around the base of each tank at a depth of 35 to 40 feet. The tanks were subsequently backfilled with available soils and excavated rock spoil. The fill encountered at each borehole varied from a medium sand with some shaley gravel and trace amounts of silt to a fine sandy silt with trace shaley gravel content. The fill was typically loose. Boring 56E was terminated in granular perimeter drain material at a depth of 39.5 feet. Boring 53W penetrated a drain pipe at 36 feet. Boring 53E and 56W penetrated soft friable shale bedrock at depths of 40.5 and 36.5 feet, respectively.

Split spoon sample recoveries at 53E and 53W exhibited fuel oil staining and distinct fuel oil odors at depths from 5 feet to the bottom of the borehole. No staining or odors were noticed at the locations adjacent to tank 56. Data from these borings are contained in the boring logs attached in the appendix of this report.

Between September 12 and 23, 1986, the Guild Drilling Company of East Providence, Rhode Island, completed the installation of six additional monitoring wells (designated ERA86-1, -2, -3A, -3B, -4 and -5).

Proposed exploration locations were as follows: Well ERA86-1 upgradient to the south of Tank 53, wells ERA86-2 and ERA86-4 downgradient and, respectively to the north and south of Tank 53, wells ERA86-3A and ERA86-3B immediately southwest of Tank 53, and well ERA86-5 to the west and downgradient to Tank 53. These locations were staked by representatives of Environmental Resource Associates, Inc. (ERA).

A representative from GZA was present to observe and log the drilling procedures, subsurface materials, and well installations, and to perform pressure tests in order to evaluate bedrock hydraulic conductivity. GZA additionally monitored the breathing zone for the presence of volatile organic compounds. Copies of the drilling logs are included in the appendix.

Each test boring was cased and advanced to bedrock using drive and wash boring techniques from a truck mounted hydraulic drill rig. No soil sampling was performed. A minimum of 10 feet of rock core was drilled at locations ERA86-1, -2, -4 and -5. Coring was advanced to penetrate 25 feet of bedrock at ERA86-3. Drilling water introduced down the hole during the soil and rock drilling was drawn from local Navy supplies. Refer to the attached drilling logs for documentation of each exploration.

The rock core zones in the explorations (ERA86-1 to -4) were pressure tested using a double level inflatable Packer assembly. Exploration ERA86-5 was not pressure tested due to repeated collapse of the rock core walls. The pressure test depths and results are presented in Table I.

Groundwater monitoring and sampling wells were installed in the exploration. Each well typically consisted of a 20-foot section of 1-1/2 inch (ID) PVC screen installed to the clear bottom of the borehole, and sufficient length of solid PVC riser pipe to provide an extension of pipe riser 2 feet above the ground surface. All sections were provided with threaded flush joints, and no solvents or cements were used in assembly. An Ottawa sand filter was placed in the borehole annulus to span the length of the well screen, followed by a one to two foot thick bentonite clay seal. The borehole was then grouted with a bentonite and cement mix to ground surface. Each installation was completed with the placement of a 5-foot long by 3-inch diameter steel guard pipe supplied with a cap and lock for security and protection.

In the interests of efficient completion of the field program, the shallow and deep wells ERA86-3A and ERA86-3B were constructed as a multi-level installation in a single borehole. Each well consisted of 1-1/4 inch (ID) PVC well screen and flush jointed riser pipe. Well ERA86-3B (the lower installation) was isolated to screen bedrock at depths of 39 to 49 feet. A bentonite clay soil seal 4-feet in thickness was placed from a depth of 39 feet up to 2 feet below the base of the upper installation. Well ERA86-3A, (the upper installation) consisting of a 20-foot section of well screen, was installed to span the upper 12 feet of bedrock and 8 feet of overlying soils. The borehole was then sealed with bentonite and grouted to ground surface. Well installation details are summarized in Table II.

At the completion of each exploration and installation, the drilling and sampling tools and equipment were steam cleaned to minimize potential cross contamination between boreholes.

## SUBSURFACE CONDITIONS

No soil sampling was performed during the subsurface explorations, however, an interpretation of soils encountered is presented on the logs based upon observations of wash water returns and upon the effort required to penetrate the soil column. The borings penetrated total soil thickness of 21.5 feet at ERA86-3 in the vicinity of Tank 53, 17 feet at ERA86-1 and ERA86-2 to the south and north, and 11 and 12 feet at ERA86-4 and ERA86-5 to the west and northwest. The logs reports penetrations of 5 feet to as much as 10 feet of sand and gravel fill underlain by 2 feet (ERA86-5) to as much as 12 feet (ERA86-3) of glacial till immediately overlying bedrock.

Bedrock lithologies encountered in the core recoveries consisted of soft to very soft, near horizontally bedded and stratified shales schist, schistose sandstone and vein quartz. These lithologies are consistent with that reported as comprising the metasedimentary Rhode Island formation rocks underlying the region and those observed in shoreline exposures to the west of the tank farm. The shales and fine-grained schists were typically very soft and erosive. They exhibited staining and a weathered and weakened fabric along discernible joint surfaces. The more coarse grained schistose sandstone was fragmental in recovery, and exhibited both oxidation staining and a pitted texture. The core recoveries were poor with results close to 60% at boreholes ERA86-1 and ERA86-2 to less than 40% at boreholes ERA86-3, -4, and -5. The rock quality designator (RQD) was low. The RQD is the relative degree of discernible natural fractures expressed as the total length of core pieces grater than 4 inches in length as percentage of the total cored length. The soft and erosive nature of the rock and the poor core recoveries indicate that the underlying bedrock is weathered, and has undergone a history of probable stress relief fracturing/jointing in response to erosional unloading.

Observed joint fracture orientation was generally parallel to sub-parallel to near horizontal bedding and schistosity. Although no vertical joint surfaces were reported, core recoveries were often too poor or fragmental to enable orientation of joint surfaces with any degree of confidence.

Groundwater levels were observed in the boreholes at depths of 23 feet (ERA 86-5) to 31 feet (ERA 86-3), corresponding to depths of 11 to 14.5 feet below reported bedrock surface. These observations were made in cased or completed explorations after stabilization periods of typically 12 to 16 hours, but may not represent fully stabilized water levels.

## GROUNDWATER ELEVATIONS AND FLOW DIRECTION

Groundwater levels in the six wells installed during September, 1986 and in the four wells installed around the immediate perimeter of Tanks 53 and 56 in October, 1985 were monitored in December 1986. The depth to the observed groundwater table varied from a minimum of 25.7 feet at ERA86-1 to 29.5 feet at ERA86-3B (isolated within the rock zone) below existing ground surface. Measurements at installations ERA86-5 and perimeter installation 53W indicated that groundwater occurred at depths below the well at these locations, respectively, 22.7 feet and 22.5 feet below ground surface. All measurements in completed observation wells were referenced to the tops of protective casings using conventional surveying and differential leveling techniques. (Benchmark elevation 68.00 feet was set at the top of Tank No. 53).

Figure No. 1 depicts contours of groundwater elevations as observed within the installations in December, 1986. The contours show that the highest elevations occur to the south and southeast of Tank No. 53 and that flow direction appears to be generally northwest from this point towards Narragansett Bay. The groundwater elevations used to develop the contours were interpreted irrespective of the geologic material in which the various wells were screened. It is recognized that locally the bedrock and fill materials may reflect different piezometric levels. However, based upon the observed fractured conditions of the bedrock cores, the lack of evidence for a confining layer across the site, and the large head drop across the site, it is anticipated that the data reasonably reflects groundwater heads at the time of measurement.

The data collected indicates a hydraulic gradient of 30 feet in 800 feet, which when expressed as a decimal is equal to 0.0375. The hydraulic gradient is the ratio of total head difference to the horizontal distance across which the head difference occurs. For a free

water aquifer, one which is not confined, the hydraulic gradient is the slope of the water table. The subsurface data, including the groundwater measurements and the highly fractured conditions in the upper bedrock zone indicates that there is a unconfined condition.

There is little data available as to the distribution of vertical hydraulic gradients across the tank farm site. The groundwater elevations survey at multi-level installation ERA86-3A/3B reported a difference of 9 feet across the two wells, indicating a strongly downward gradient in the bedrock. However, given the highly fractured condition and the fine grained texture of the soft bedrock, this extreme difference in water levels may be reflective of water trapped due to an accumulation of fine grained sediments. In any case, although local vertically downward gradients may be present, groundwater flow through the site is nevertheless to the northwest to discharge at Narragansett Bay.

## HYDROGEOLOGIC CONSIDERATIONS

Within the limits of the current study area, groundwater levels have been measured below bedrock surface to the southeast (upgradient) and southwest (downgradient) of Tank No. 53, and in unconsolidated fills at the ringwall perimeter installations. Groundwater flow in the near horizontally bedded sedimentary bedrock underlying the tank farm occurs in discrete, generally minute openings (fractures and across bedding planes) in contrast to flow through unconsolidated porous media. Analysis of groundwater flow conditions must therefore consider in addition to the location and slope of the piezometric surface, the hydraulic characteristics of the flow medium.

## HYDRAULIC CHARACTERISTICS OF BEDROCK

Data from the test borings and groundwater level measurements have suggested that with the exception of limited fills at the tank perimeters, unconsolidated deposits and fills generally lie above the saturated zone and that portions may be only seasonally saturated. Thus the predominant water bearing material underlying the tank farm site is soft, fractured sedimentary bedrock.

## HYDRAULIC CONDUCTIVITY

Bedrock hydraulic conductivity has been estimated using the Packer pressure test data which is summarized in Table I. Hydraulic conductivity of the bedrock is the measure of how easily a volume of water can pass through a cross-section of the material in question. The units of expression for hydraulic conductivity are given as a distance per unit of time. When hydraulic conductivity is multiplied by the cross-sectional area of the water bearing strata, the result is a volume per unit of time which is a more familiar "flow quantity."

Of the eleven pressure tests performed (approximately two per test boring), seven recorded "no flow." The results of the test could not detect a measurable amount with the equipment used. The "no flow" test results correspond to hydraulic conductivity estimates of less than 10 feet per year.

Measurable flow rates were observed in two wells. These results were observed at depths of 31 feet to 41 feet in test boring ERA86-3 resulting in a hydraulic conductivity estimate of 10 to 20 feet per year and at depths of 22 feet to 31 feet in test boring ERA86-4, corresponding to hydraulic conductivity estimates of 50 to 65 feet per year.

Although the bedrock core recoveries were generally low in comparison to the cored length and of poor quality, that is, highly fractured/fragmental, the predominant fracture orientation was subparallel to parallel to the horizontal. Groundwater flow through a fractured bedrock medium occurs essentially across fracture planes and is highly dependent upon the aperture opening across the fracture and the degree of interconnection of the fracture system. The core recoveries indicate that the principle fracture (joint) orientation is near horizontal. However, these fractures are believed to be relatively tight or closed due to normal stresses with overburden. Additionally, the soft erosive nature of the lithology would tend to promote fracture filling with fine-grained sediments derived from the local rock. Essentially, the numerous fractures are compressed by the overburden into tight openings which may then become clogged with very fine sediments from the weathered rock.

## GROUNDWATER TRANSPORT VELOCITY

The average velocity at which groundwater moves between two points may be estimated by a form of Darcy's Equation as shown below:

$V=(K*i)/n$ Where:

- V = transport velocity
- K = hydraulic conductivity
- i = hydraulic gradient
- n = effective porosity of rock formation as a percentage of fracture volume/total volume

Substituting values described above, and adopting a bedrock porosity range of 0.1 to 1.0 percent ($10^{-2}$ to $10^{-3}$) expressed as a percent (from published data in the literature)* (Freeze & Cherry), groundwater transport velocities ranging from less than 0.5 to approximately 10 feet per day are calculated.

The concept of transport velocity differs from hydraulic conductivity in that the transport velocity is an actual travel rate for a given

increment of water, while hydraulic conductivity is a measure of volume rate of flow. Therefore a low hydraulic conductivity indicates that the quantity of water released through the rock for a given time period is small, yet the small water quantity must be rapidly dispersed through the extremely small "passage-way" available through the rock. When considering the concept of contaminant transport, the rate of pollutant movement is appropriately considered as concentration within the context of hydraulic conductivity. Volume rate multiplied by concentration of pollutant produces the effect of "mass balance", in contrast to a small volume moving a a high rate of speed.

## CHEMICAL ANALYSES

Monitoring wells ERA 86-1,-2,-3s,-4,-5 were sampled on October 1, 1986. Samples were drawn using specially prepared stainless steel bailers. Three volumes of standing water were evacuated from each well prior to drawing the sample. Samples were placed in clean 30 ml glass vials with septum covers and packed in ice for transportation. ERA 86-3B was found to have a bend in the casing apparently due to the expansion of the bentonite seal placed at the bottom of ERA 86-3A. This prevented passage of a standard length bailer. On October 6, 1986 sampling was attempted using a short (~18 in.) bailer. The bend did not allow passage of the shorter bailer therefore a septum vial was lowered into the groundwater and a sample drawn.

Samples were submitted to Rhode Island Analytical Laboratories (RIAL) and tested for volatile organic compounds (voc). The results of the analyses are presented in Table III. A copy of the certificate of analyses is included in the appendix.

Monitoring wells 56-E, 56-W, 53-E, 53-W were sampled on November 26, 1986 using the aforementioned procedure. MW 53-E and MW 53-W were found to have a floating oil layer. Because of this floating oil layer, these wells were not purged prior to sampling, so that the most representative sample could be obtained. Well samples are usually purged to ensure that a "fresh sample" of the ground water is taken. When the well contains an oil layer such as the one encountered in this case, the purging of the well is counter productive. The oils and related volatile compounds will not be recovered in a "fresh sample", and are consequently less valid results. Samples were submitted to RIAL for voc analyses. The results of the analyses are presented in Table IV. Included in the table are the results from a previous round of sampling performed on October 22, 1985.

On October 11, 1985 representatives of ERA drew samples from Tanks 53 and 56. Three samples were taken in each tank: one from the bottom (sludge layer), one from the top of the water layer and a third of the floating oil layer. Samples were submitted to RIAL and analyzed for volatile organic compounds. The results of the analyses are presented in Table V.

TABLE II

Summary of Well Installation Details

| Well no | Approx Grade El (ft) | Well head El (ft) | Wellscreen Depth Interval and Location in Geologic Column | Approx El top of Bedrock | GWT El (ft) |
|---|---|---|---|---|---|
| ERA 86-1 | 89.5 | 91.51 | 15 to 35 ft: 2 ft soil 18 ft rock | 72.5 | 65.81 |
| ERA 86-2 | 59.5 | 61.35 | 15 to 35 ft: 2.5 ft soil 17.5 ft rock | 42 | 42.35 |
| ERA 86-3A | 67 | 68.86 | 13 to 33 ft: 8 ft soil 12 ft rock | 45.5 | 48.86 |
| ERA 86-3B | 67 | 68.86 | 39 to 49 ft: sealed in rock | 45.5 | 39.36 |
| ERA 86-4 | 62 | 63.77 | 14 to 34 ft: rock | 51 | 41.97 |
| ERA 86-5 | 56.5 | 58.74 | 6 to 26 ft 6 ft soil 14 ft rock | 44.5 | 36.04 |
| MW 53 E | 70.5 | 72.7 | 4.5 to 39.5 ft: ringwall perimeter fill | 30 * | 48.7 |
| MW 53 W | 69 | 70.93 | 5 to 35 ft: ringwall perimeter fill | NE | 48.43 |
| MW 56 E | 89 | 91.13 | 8.5 to 38.5 ft: ringwall perimeter fill | NE | 62.63 |
| MW 56 W | 87 | 88.93 | 5 to 35 ft: ringwall perimeter fill | 50.5 | 62.83 |

TABLE III

SAMPLE ANALYSES

| SAMPLE LOCATION | ERA 86-1 | ERA 86-2 | ERA 86-3D | ERA 86-3S | ERA 86-4 | ERA 86-5 |
|---|---|---|---|---|---|---|
| SAMPLE DATE | 10-01-86 | 10-01-86 | 10-06-86 | 10-01-86 | 10-01-86 | 12-06-86 |
| methylene chloride | ND | ND | ND | ND | ND | ND |
| trans-1,2-dichloroethylene | ND | 3 | 26 | 1 | ND | ND |
| chloroform | ND | 10 | ND | 3 | 12 | ND |
| 1,2-dichloroethane | ND | ND | 18 | ND | ND | ND |
| 1,1,1-trichloroethane | ND | 5 | 101 | 5 | ND | ND |
| trichloroethylene | ND | 1 | 35 | 2 | ND | ND |
| tetrachloroethylene | ND | ND | 2 | ND | ND | ND |
| benzene | ND | ND | ND | ND | ND | ND |
| toluene | ND | ND | 2 | ND | ND | ND |
| ethylbenzene | ND | ND | 3 | ND | ND | ND |
| xylenes | ND | ND | 39 | ND | ND | ND |
| 1,1 dichloroethane | ND | 2 | 2 | 4 | ND | ND |
| trichlorofluoromethane | ND | ND | 1 | ND | ND | ND |

Concentrations are reported in parts per billion, (ppb).

ND indicates that trace amounts, below reportable detection limits or no amounts were found.

TABLE IV

SAMPLE ANALYSES

| SAMPLE LOCATION | MW 53E | | MW 53W | | MW 56E | | MW 56W | |
|---|---|---|---|---|---|---|---|---|
| SAMPLE DATE | 10-22-85 | 11-26-86 | 10-22-85 | 10-26-86 | 10-22-85 | 10-26-86 | 10-22-85 | 10-26-86 |
| methylene chloride | 178 | ND | 54 | ND | ND | ND | 304 | ND |
| trans-1,2-dichloroethylene | 166 | 1100 | 46 | 400 | ND | ND | ND | ND |
| chloroform | 401 | ND | 353 | ND | 12 | ND | 18 | ND |
| 1,2-dichloroethane | 211 | ND | 229 | ND | ND | ND | ND | ND |
| 1,1,1-trichloroethane | 4400 | 930 | 4400 | 330 | ND | ND | 17 | ND |
| trichloroethylene | 1400 | 800 | 785 | 24 | ND | ND | ND | ND |
| tetrachloroethylene | 262 | 25 | 14 | 16 | ND | ND | ND | ND |
| benzene | 300 | 330 | 155 | ND | ND | ND | ND | ND |
| toluene | ND | 1400 | ND | ND | ND | ND | ND | ND |
| ethylbenzene | 374 | 150 | ND | ND | ND | ND | ND | ND |
| xylenes | 1620 | 600 | 140 | 65 | ND | ND | ND | ND |
| 1,1 dichloroethane | ND | 32 | ND | 14 | ND | ND | ND | ND |
| 1,1 dichloroethylene | ND | 170 | ND | 57 | ND | ND | ND | ND |
| trichlorofluoromethane | ND | ND | ND | ND | ND | ND | ND | ND |
| bromodichloromethane | ND | 470 | ND | 49 | ND | ND | ND | ND |

Concentrations are reported in parts per billion, (ppb).

ND indicates that trace amounts, below reportable detection limits or no amounts were found.

TABLE V

SAMPLE ANALYSES

| SAMPLE LOCATION | Bottom Tank 56 | Top Tank 56 | Oil Tank 56 | Bottom Tank 53 | Top Tank 53 | Oil Tank 53 |
|---|---|---|---|---|---|---|
| vinyl chloride | ND | ND | ND | 1,300 | 216 | ND |
| methylene chloride | ND | ND | 178,000 | 82 | ND | 217,000 |
| chloroform | 146 | 649 | 166,000 | 261 | 524 | 47,000 |
| 1,2-dichloroethane | ND | ND | ND | 336 | ND | 143,000 |
| 1,1,1-trichloroethane | ND | ND | 2,600 | 253 | 130 | 75,000 |
| trichloroethylene | ND | ND | 606 | 13 | ND | 83,600 |
| tetrachloroethylene | ND | ND | 490 | ND | ND | 33,800 |
| benzene | ND | ND | 27,500 | 824 | 706 | 119,000 |
| toluene | ND | ND | 312,000 | 5,140 | 4,500 | 773,000 |
| ethylbenzene | ND | ND | 265,000 | 379 | 211 | 448,000 |
| xylenes | ND | ND | 875,000 | 1,000 | 813 | 1,600,000 |

Samples were taken 10-11-85

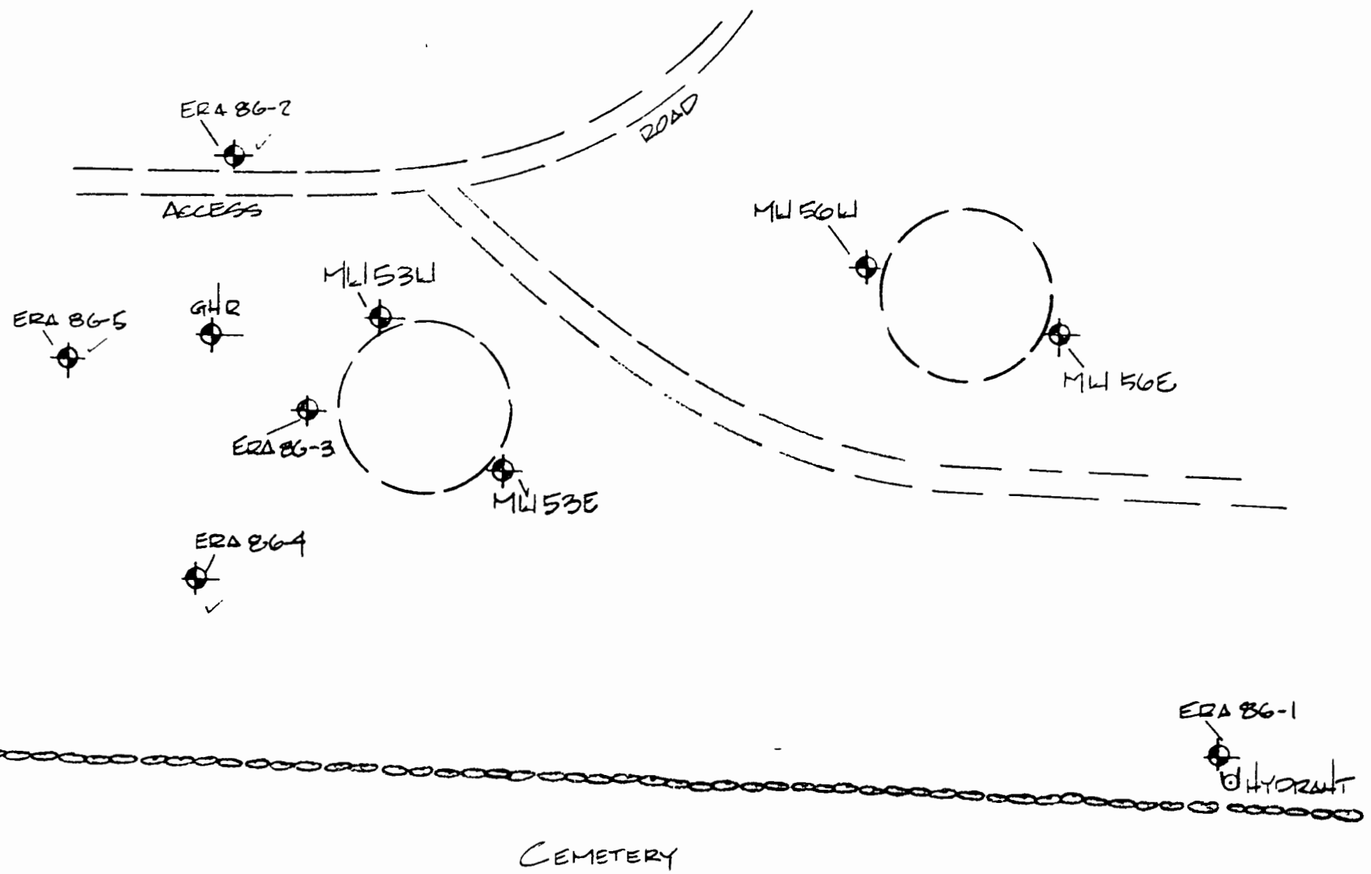
Concentrations are reported in parts per billion, (ppb).

ND indicates that trace amounts, below reportable detection limits or no amounts were found.

TABLE I

Summary of Bedrock Pressure Test Results

| Borehole | Drilling Data: Depth to Bedrock (ft) | Drilling Data: Core Interval (ft) | Drilling Data: Rock Quality RQD % | Pressure Test Data: Test Depth Interval (ft) | Pressure Test Data: Observed Flow (gpm) | Pressure Test Data: Calculated Hydraulic Cond. (ft/yr) | Remarks: |
|---|---|---|---|---|---|---|---|
| ERA 86-1 | 17<br>80 % total core rec. | 20-25<br>25-30<br>30-35 | 22<br>25<br>29 | 23-28<br>28-33 | 0.4 gal/15 min<br>0 | < 10 ft/yr<br>< 10 ft/yr | Recovery of 60 to 80 % with depth: soft, erodable shale to 27 ft; schist to 30 ft, soft shale 30 to 35 ft. |
| ERA 86-2 | 17.5<br>58 % total core rec. | 20-25<br>25-30<br>30-35 | 0<br>19<br>0 | 22-27<br>25-30<br>30-35 | 0.5 gal/15 min<br>0<br>0 | < 10 ft/yr<br>< 10 ft/yr<br>< 10 ft/yr | Recovery of 30 t0 70 % of soft to very soft shale. Rock easily eroded 30-35'. |
| ERA 86-3 | 21.5<br>28 % total core recovery | 24-29<br>29-34<br>34-39<br>39-44<br>44-49 | 0<br>0<br>0<br>0 | 26-31<br>31-36<br>36-41<br>41-46 | 0<br>2.5 gal/15 min<br>1.6 gal/15 min<br>0.4 gal/6 min | < 10 ft/yr<br>20 ft/yr<br>11 ft/yr<br>< 10 ft/yr | 10 to 40 % recovery of fractured schist to 39 ft. 20% recovery of fragmented schistose sandstone 39' to 49 ft. |
| ERA 86-4 | 11<br>40 % total core recovery | 19-24<br>24-29<br>29-34 | 0<br>0<br>0 | 22-27<br>27-31 | 6.7 gal/15 min<br>5 gal/15 min | 65 ft/yr<br>48 ft/yr | Recovery less than 50 %. Fragmented sandstone to 30 ft. Very soft shale with silt joint fillings 30-40' |
| ERA 86-5 | 12<br>37 % total recvovery | 16-21<br>21-26<br>26-30 | 0<br>0<br>roller bit | not tested | | | Less than 40 % recovery Fragmenteds, weathered schistose sandstone and schist. Continued sidewall collapse obstructed Packer assembly. Rock zone not tested. |




ENVIRONMENTAL RESOURCE ASSOCIATES, INC.
WARWICK, R.I. (401) 781-7422

| | | |
|---|---|---|
| SCALE: 1"=100' | APPROVED BY CONTRACT PART "D" | DRAWN BY |
| DATE: APR. 88 | | |

MONITORING WELL LOCATION PLAN
N.E.T.C. MIDDLETOWN, R.I.

FIGURE 2

DRAWING NUMBER 5200

TELEDYNE POST 18A8-08 – 11 x 17

## TABLE I

### SOIL SAMPLE SCREENING RESULTS

HNu READINGS, ppm. OF VOLATILE ORGANIC COMPOUNDS

| SAMPLE DEPTH | BOREHOLE LOCATION T53 W | T53 W | T56 E | T56 W |
|---|---|---|---|---|
| 0-2 | <1 | 1.8 | 7.8 | 7.8 |
| 5-7 | 11 | 60.0 | 0.2 | 13.8 |
| 10-12 | 40 | 34.0 | 0.6 | 17.2 |
| 15-17 | 50 | 52.0 | ND | 2.2 |
| 20-22 | 30 | 0.8 | 0.6 | 2.2 |
| 25-27 | 6 | 2.8 | 7.2 | ND |
| 30-32 | 7 | 6.0 | 9.8 | ND |
| 35-37 | 500 | 1.6 | 44.0 | ND |
| 40-42 | 50 | | 13.0 | |

Notes:

1. HNu readings represent total volatile organic compound concentrations registered in parts per million, ppm, as detected using an HNu photoionizaion detector model PI-101.

2. Ambient air readings varied from ND to 0.2 ppm.

3. ND indicates that volatile organic compounds, if present, were below the detection limits of the instrument.

GOLDBERG-ZOINO & ASSOCIATES, II
255 SOUTH MAIN ST, PROVIDENCE, RHODE ISLAND
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
USN Tank Farm Study
Middletown, RI

REPORT OF BORING No 753E
SHEET 1 OF 2
FILE No C-5527
CHKD BY

BORING Co East Coast Drilling, Inc.
FOREMAN Bill Kennedy
GZA ENGINEER Mike Sherrill

BORING LOCATION East Perimeter, Tank 53
GROUND SURFACE ELEVATION ____ DATUM ____
DATE START 10/16/85 DATE END 10/16/85

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb HAMMER FALLING 30 in.
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb HAMMER FALLING 24 in
CASING SIZE: OTHER: HS Auger

GROUNDWATER READINGS

| DATE | TIME | WATER AT | CASING AT | STABILIZATION TIME |
|---|---|---|---|---|
| 10/16/85 | 11:00 | 28 | 35 | 0 |
| | | | | |
| | | | | |

| DEPTH (ft) | CASING (blows/ft) | SAMPLE No. | SAMPLE PEN (in)/REC | SAMPLE DEPTH (ft) | SAMPLE BLOWS/6" | SAMPLE DESCRIPTION (Burmister CLASSIFICATION) | REMARKS | STRATUM DESCRIPTION (HNu) |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 24/14 | 0-2 | 4-7-9-11 | 1) Medium dense brown medium to fine SAND, little + coarse to fine Gravel, little Silt. FILL | 1. | <1ppm — Loose, very loose and medium dense FILL: Silty medium to fine SAND with fragmented SHALE |
| 5 | | 2 | 24/15 | 5-7 | 6-5-7-6 | 2) Medium dense, brown and grey medium to fine + SAND, some Silt, little coarse to fine grey SHaly Gravel Moist, FILL | | 11ppm |
| 10 | | 3 | 24/12 | 10-12 | 2-2-3-3 | 3) Loose, brown, medium to fine + SAND, Some Silt, trace fine Gravel; moist; organic solvent odor. | | 40 ppm |
| 15 | | 4 | 24/11 | 15-17 | 3-2-9-5 | 4) Medium dense to loose, brown, medium to fine SAND, little + Silt, trace fine Gravel, moist to wet; diesel fuel odor FILL | | 50 ppm |
| 20 | | 5 | 24/6 | 20-22 | 2-1-2-3 | 5) Very loose, brown, medium to fine SAND, some Silt, trace coarse to fine shaley Gravel; moist to wet; FILL | | 30 ppm |
| 25 | | 6 | 24/8 | 25-27 | 2-7-9-5 | 6) Medium dense, brown & grey medium to fine + SAND & SILT, little - shaley coarse to fine Gravel; moist to wet; slight plasticity; slight odor. FILL | | 0 ppm |
| 30 | | 7 | 24/7 | 30-32 | 2-2-4-5 | 7) Loose, brown Silt, some medium to fine SAND, trace shaley Gravel, moist to wet FILL | | 7 ppm |
| 35 | | | | | | | | |

| GRANULAR SOILS | | COHESIVE SOILS | |
|---|---|---|---|
| BLOWS/FT | DENSITY | BLOWS/FT | DENSITY |
| 0-4 | V LOOSE | <2 | V. SOFT |
| 4-10 | LOOSE | 2-4 | SOFT |
| 10-30 | M DENSE | 4-8 | M STIFF |
| 30-50 | DENSE | 8-15 | STIFF |
| >50 | V DENSE | 15-30 | V. STIFF |
| | | >30 | HARD |

REMARKS:
1) An HNu photoionization detector was used to screen samples for volatile organic compounds.
2) Ambient air HNu monitoring recorded 0 to 0.2 ppm.

GZA

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GOLDBERG-ZOINO & ASSOCIATES,
255 SOUTH MAIN ST, PROVIDENCE, RHODE ISLAND
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
USN Tank Farm Study
Middletown, RI

REPORT OF BORING No T53E
SHEET 2 OF 2
FILE No C-5527
CHKD. BY

| DEPTH (ft) | CASING (bl/ft) | SAMPLE No. | SAMPLE PEN (in)/REC | SAMPLE DEPTH (ft) | SAMPLE BLOWS/6" | SAMPLE DESCRIPTION (Burmister CLASSIFICATION) | REMARKS | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| 35 | | 8 | 18/9 | 35.5-37 | 2-1-2 | 8) Very loose, grey medium to fine SAND, trace + Silt, changing to grey fine Sand, some Silt, little - fine shaley Gravel; wet oily; FILL | 3. 4. | 500 ppm Very loose, medium to fine SAND FILL - Perimeter drain |
| 40 | | 9 | 7/7 | 40-40.7 | 18-50/2" | 9) Dense Brown coarse to medium SAND, trace Silt, changing to fine SAND & SILT, changing to grey, very soft, weathered shale at 40.5 | 5. | 50 ppm ------ 40.5 ---------- SHALE Boring Terminated at 40.7 ft. |

REMARKS:
3. Tool recovery - A rods wet to 28' depth with oil sheen and trace black/brown fuel product at top.
4. HNu offscale on 0-20 & 0-200 ppm.
5. Observation well installed consisting of 1.5-inch ID slotted PVC screen (0.01 - inch slot size) from 4.5 - 39.5 ft; Ottawa sand from 4- to 39.5 ft; Bentonite seal; steel guard casing and concrete surface seal.

GZA

BORING No T53E

GOLDBERG-ZOINO & ASSOCIATES, INC.
255 SOUTH MAIN ST, PROVIDENCE, RHODE ISLAND
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
USN Tank Farm Study
Middletown, RI

REPORT OF BORING No T53W
SHEET 1 OF 2
FILE No C-5527
CHKD BY

BORING Co East Coast Drilling Inc.
FOREMAN Bill Kennedy
GZA ENGINEER Michael Sherrill

BORING LOCATION 25' N of stake, 63'+ off center line
GROUND SURFACE ELEVATION _____ DATUM _____
DATE START 10/16/85 DATE END 10/16/85

SAMPLER UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb HAMMER FALLING 30 in
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb HAMMER FALLING 24 in.

CASING SIZE: OTHER: HS Auger

GROUNDWATER READINGS

| DATE | TIME | WATER AT | CASING AT | STABILIZATION TIME |
|---|---|---|---|---|
| 10/16 | 1500 | 25 | 30 | 0 |
| | | | | |
| | | | | |

| DEPTH (ft) | CASING (ft/ft) | SAMPLE No. | SAMPLE PEN/REC | SAMPLE DEPTH (ft) | SAMPLE BLOWS/6" | SAMPLE DESCRIPTION (Burmister CLASSIFICATION) | REMARKS | STRATUM DESCRIPTION (HNu) |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 24/17 | 0-2 | 4-5-15-15 | 1) Loose fine SAND & SILT, topsoil to 0.5 to Brown, medium fine + SAND, some - Silt, little coarse to fine shaley Gravel; FILL | 2. | 1.8 ppm Loose Fill: Gravelly medium to fine SAND to medium to fine SAND & SILT with shale fragments |
| 5 | | 2 | 24/14 | 5-7 | 11-4-5-5 | 2) Loose, brown & grey medium to fine + SAND, some shaley Gravel to coarse Sand, little - Silt; moist ; odor; FILL | | 60 ppm |
| 10 | | 3 | 24/15 | 10-12 | 14-4-3-3 | 3) Loose, brown medium to fine + SAND, little + coarse to fine Shaley Gravel, little + Silt; fuel on spoon, odor. | | 34 ppm |
| 15 | | 4 | 24/8 | 15-17 | 2-2-3-3 | 4) Very loose, to loose, brown medium to fine SAND & SILT, little Shaley Gravel odor; moist. | | 52 ppm |
| 20 | | 5 | 24/11 | 20-22 | 6-3-5-2 | 5) Loose, brown & gray fine SAND & SILT, little Shaley Gravel; moist; slight odor. | | 0.8 ppm |
| 25 | | 6 | 24/10 | 25-27 | 2-3-2-3 | 6) Loose, brown, medium to fine SAND & SILT, little grey Shaley Gravel, moist to wet; slight odor. | 3. | 2.8 ppm |
| 30 | | 7 | 18/6 | 30.5-32 | 3-3-3 | 7) Loose, brown fine SAND, some Silt, little shaley Gravel; wet; oily sheen & odor. Brown fuel staining. | | 6 ppm |
| 35 | | 8 | | | | | | |

| GRANULAR SOILS | | COHESIVE SOILS | |
|---|---|---|---|
| BLOWS/FT | DENSITY | BLOWS/FT. | DENSITY |
| 0-4 | V. LOOSE | < 2 | V. SOFT |
| 4-10 | LOOSE | 2-4 | SOFT |
| 10-30 | M. DENSE | 4-8 | M STIFF |
| 30-50 | DENSE | 8-15 | STIFF |
| >50 | V. DENSE | 15-30 | V. STIFF |
| | | >30 | HARD |

REMARKS:
1) An HNu photoionization detector was used to screen samples for volatile organic compound content. Ambient air readings varied from 0 to 0.2 ppm.
2) Driller reports odor in auger return from 0-5 ft.
3) A-rods wet at 25 ft when pulled to sample S-7 at 30 ft.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

BORING No. T53W

GOLDBERG-ZOINO & ASSOCIATES, INC.
255 SOUTH MAIN ST, PROVIDENCE, RHODE ISLAND
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
USN Tank Farm Study
Middletown, RI

REPORT OF BORING No T53W
SHEET 2 OF 2
FILE No C-5527
CHKD. BY

| DEPTH (ft) | CASING (bl/ft) | SAMPLE No. | SAMPLE PEN (in)/REC | SAMPLE DEPTH (ft) | SAMPLE BLOWS/6" | SAMPLE DESCRIPTION Burmister CLASSIFICATION | REMARKS | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| 35 | | 8 | 21/8 | 35-36.8' | 9-19-20/0" | 8) Medium dense, brown & grey coarse to fine SAND, little - coarse Gravel, trace Silt | 4. | 1.6 ppm COARSE TO FINE SAND FILL 36.8' Boring Terminated |
| | | | | | -1/9" | | | |
| 40 | | | | | | | | |

REMARKS:
4) Sample spoon free fall from 36 to 36.8 ft. Probably penetrated drain pipe.
5) Observation well installed consisting of 1.5-inch ID slotted PVC screen (0.01-inch slot size) from 5 ft. to 35 ft; Ottawa sand from 3.5 ft. to 35 ft. Bentonite seal 3- to 3.5 ft; steel guard casing and concrete surface seal.

GZA

BORING No T53W

GOLDBERG-ZOINO & ASSOCIATES, INC.
255 SOUTH MAIN ST, PROVIDENCE, RHODE ISLAND
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
USN Tank Farm Study
Middletown, RI

REPORT OF BORING No T56E
SHEET 1 OF 2
FILE No C-5527
CHKD BY

BORING Co East Coast Drilling
FOREMAN Bill Kennedy
GZA ENGINEER Michael Sherrill

BORING LOCATION East perimeter, Tank 56
GROUND SURFACE ELEVATION _____ DATUM _____
DATE START 10/15/85 DATE END 10/15/85

SAMPLER UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb HAMMER FALLING 30 in.
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb HAMMER FALLING 24 in

CASING SIZE: OTHER: HS Auger

GROUNDWATER READINGS

| DATE | TIME | WATER AT | CASING AT | STABILIZATION TIME |
|---|---|---|---|---|
| 10/15 | 1130 | 24-25 | 25 | 0 |
| | | | | |
| | | | | |

| DEPTH (ft) | CASING (b/ft) | SAMPLE No | SAMPLE PEN (in) / REC | SAMPLE DEPTH (ft) | SAMPLE BLOWS/6" | SAMPLE DESCRIPTION (Burmister CLASSIFICATION) | REMARKS | STRATUM DESCRIPTION (HNu) |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 24/18 | 0-2 | 3-6-5-4 | 1) Dark brown fine SAND, some Silt, trace roots - topsoil; Change at 0.5 ft. to: Brown, medium to fine + SAND, little fine shaley Gravel, little Silt | 1. | 7.8 ppm — Medium dense to loose FILL: Silty medium to fine SAND to SANDY SILT with Shale Fragments |
| 5 | | 2 | 24/14 | 5-7 | 5-8-8-8 | 2) Medium dense, grey fine SAND & coarse to fine shaley Gravel, little + Silt | | 0.2 ppm |
| 10 | | 3 | 24/14 | 10-12 | 10-7-11-10 | 3) Medium dense, grey Silt, and fine Shaley Gravel, little medium to fine sand; moist; FILL | | 0.6 ppm |
| 15 | | 4 | 24/8 | 15-17 | 2-3-4-4 | 4) Loose, greyfine SAND, some - Silt, little fine Shaley Gravel; moist; FILL | | ND |
| 20 | | 5 | 24/16 | 20-22 | 7-7-6-6 | 5) Medium dense, grey and brown fine SAND & SILT, little - fine Shaley Gravel, moist | | 0.6 ppm |
| 25 | | 6 | 24/11 | 25-27 | 5-2-3-2 | 6) Loose, grey fine SAND, some Silt, little - fine Shaley Gravel; moist to wet. | 2. | 7.2 ppm |
| 30 | | 7 | 24/10 | 30-32 | 3-2-3-3 | 7) Loose, brown to grey medium to fine SAND, little Silt; to fine SAND, some + Silt, trace fine Gravel; trace medium Sand; wet. | | 9.8 ppm |

| GRANULAR SOILS | | COHESIVE SOILS | |
|---|---|---|---|
| BLOWS/FT | DENSITY | BLOWS/FT. | DENSITY |
| 0-4 | V LOOSE | <2 | V. SOFT |
| 4-10 | LOOSE | 2-4 | SOFT |
| 10-30 | M DENSE | 4-8 | M STIFF |
| 30-50 | DENSE | 8-15 | STIFF |
| >50 | V DENSE | 15-30 | V. STIFF |
| | | >30 | HARD |

REMARKS:
1. An HNu photoionization detector was used to screen samples for volatile organic compound content.
2. Water encountered in 25- to 30-ft. zone - Spoon sample No. 6 indicated water at 24 ft.

GZA

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

BORING No T5EE

GOLDBERG-ZOINO & ASSOCIATES, I.
255 SOUTH MAIN ST, PROVIDENCE, RHODE ISLAND
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
USN Tank Farm Study
Middletown, RI

REPORT OF BORING No T56W
SHEET 1 OF 2
FILE No C-5527
CHKD BY

BORING Co East Coast Drilling Inc.
FOREMAN Bill Kennedy
GZA ENGINEER Michael Sherrill

BORING LOCATION West perimeter of Tank 56
GROUND SURFACE ELEVATION _____ DATUM _____
DATE START 10/15/85 DATE END 10/15/85

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb HAMMER FALLING 30 in
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb HAMMER FALLING 24 in
CASING SIZE:
OTHER: HS Auger

GROUNDWATER READINGS

| DATE | TIME | WATER AT | CASING AT | STABILIZATION TIME |
|---|---|---|---|---|
| 10/15 | 1400 | 26 | 25 | 0 |
| | | | | |
| | | | | |

| DEPTH (ft) | CASING (blows/ft) | SAMPLE No | SAMPLE PEN./REC | SAMPLE DEPTH (ft) | SAMPLE BLOWS/6" | SAMPLE DESCRIPTION (Boring Log CLASSIFICATION) | REMARKS | STRATUM DESCRIPTION (HNu) |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 24/11 | 0-2 | 6-7-10-9 | 1) Medium dense, brown medium to fine SAND, some coarse to fine shaley Gravel, little Silt; dry; FILL | 1. | 7.8 ppm |
| | | | | | | | 2. | |
| 5 | | 2 | 24/14 | 5-7 | 5-6-5-6 | 2) Medium dense brown and grey, fine SAND, some + Silt, little coarse to fine shaley Gravel, moist. FILL | | 13.8 ppm Loose and medium dense Silty SAND and Shaley Gravel FILL |
| 10 | | 3 | 24/10 | 10-12 | 3-2-3-6 | 3) Loose, grey medium to fine + SAND, and SILT, little coarse to fine shaley Gravel, moist FILL | | 17.2 ppm |
| 15 | | 4 | 24/12 | 15-17 | 2-4-4-5 | 4) Loose, grey coarse to fine Shaley GRAVEL, little + medium to fine SAND, little Silt; moist. FILL | | 2.2 ppm |
| 20 | | 5 | 18/15 | 20.5-22 | 9-4-5 | 5) Loose, brown and grey medium to fine SAND, little + Silt, trace fine Gravel, moist FILL | | 2.2 ppm |
| 25 | | 6 | 24/13 | 25-27 | 3-4-14-13 | 6) Medium dense, brown medium to fine SAND, some Silt, little - grey coarse to fine shaley Gravel; moist to wet FILL | 3. | ND |
| 30 | | 7 | 18/8 | 30-31.5 | 5-6-6 | 7) Medium dense, brown medium to fine SAND, some + Silt, little + grey coarse to fine shaley Gravel; wet. FILL | 4. | ND |
| 35 | | | | | | | | |

| GRANULAR SOILS | | COHESIVE SOILS | |
|---|---|---|---|
| BLOWS/FT | DENSITY | BLOWS/FT | DENSITY |
| 0-4 | V LOOSE | <2 | V SOFT |
| 4-10 | LOOSE | 2-4 | SOFT |
| 10-30 | M DENSE | 4-8 | M STIFF |
| 30-50 | DENSE | 8-15 | STIFF |
| >50 | V DENSE | 15-30 | V. STIFF |
| | | >30 | HARD |

REMARKS:
1) Located boring 1 ft. west of stake
2) An HNu photoionization detector was used to screen soil samples for volatile organic compounds.
3) Wet sample tip of recovery S-6 26. ft.
4) Two feet of material in augers when sample S-8 at 35 ft. attempted. Will wash out and attempt sample.

GZA

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

BORING No. T5EW

GOLDBERG-ZOINO & ASSOCIATES, Inc.
255 SOUTH MAIN ST, PROVIDENCE, RHODE ISLAND
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
USN Tank Farm Study
Middletown, RI

REPORT OF BORING No T56E
SHEET 2 OF 2
FILE No C-5507
CHKD BY

| DEPTH (ft) | CASING (blows/ft) | SAMPLE No. | SAMPLE PEN (in)/REC | SAMPLE DEPTH (ft) | SAMPLE BLOWS/6" | SAMPLE DESCRIPTION (Burmister CLASSIFICATION) | REMARKS | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| 35 | | 8 | 18/6 | 35.5-37 | 3-4-5 | 8) Loose, brown and grey medium to fine + SAND, and SILT, little fine shaley Gravel; wet; FILL | | 44 ppm |
| | | | | | | | 3. | 36± |
| | | 9 | 24/11 | 37.5-39.5 | 15-14-31-5 | 9) Dense brown coarse to fine GRAVEL, little fine Sand, trace Silt | | Sandy GRAVEL FILL Perimeter drain |
| | | | | | | | | 13 ppm |
| 40 | | | | | | | | 39.5 ft |
| | | | | | | | | Borehole Terminated |

REMARKS: 3) Observation well installed consisting of 1.5 inch ID slotted PVC screen (0.01 inch slot size) from 8.5 ft. to 38.5 ft. depths; Ottowa sand from 3 ft. to 38.5 ft; Bentonite seal from 2.5- to 3 ft; steel guard casing and concrete surface seal.

GZA

BORING No. T56E

GOLDBERG-ZOINO & ASSOCIATES, IN
255 SOUTH MAIN ST, PROVIDENCE, RHODE ISLAND
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
USN Tank Farm Study
Middletown, RI

REPORT OF BORING No TS6N
SHEET 2 OF 2
FILE No C-5527
CHKD BY

| DEPTH (ft) | CASING (bl/ft) | SAMPLE No. | SAMPLE PEN (in)/REC | SAMPLE DEPTH (ft) | SAMPLE BLOWS/6" | SAMPLE DESCRIPTION Burmister CLASSIFICATION | REMARKS | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| 35 | | 8 | 24/19 | 35-37 | 13-11-12-13 | 8) Medium dense grey coarse to fine SAND, little Silt change to weathered shale at 36.5 ft. | 5. | ND Coarse to fine SAND<br>FILL<br>Shale<br>Borehole terrinated at 37 ft. |

REMARKS: 5) Observation well installed consisting of 1.5-inch ID slotted PVC screen (0.01 inch slot size) from 5- to 35-ft.; Ottowa sand from 4.5- to 35-ft; Bentonite seal from 3.5- to 4.5 ft; steel guard casing and concrete surface seal.

GZA

BORING No. TS6N

# GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R I

TO Goldberg-Zoino & Assoc., Inc. | ADDRESS Providence, R.I.

PROJECT NAME USN Fuel Storage Area | LOCATION Middletown, R.I.

REPORT SENT TO above | PROJ NO.

SAMPLES SENT TO " | OUR JOB NO. 87-185

SHEET ___ OF ___

DATE

HOLE NO. W 86-1

LINE & STA.

OFFSET

SURF. ELEV.

GROUND WATER OBSERVATIONS

At 26' after 16 Hours

At ___ after ___ Hours

| | CASING | SAMPLER | CORE BAR |
|---|---|---|---|
| Type | HW-NW | | NVD |
| Size I D | 4" 3" | | |
| Hammer Wt | 300# | | BIT |
| Hammer Fall | 24" | | Dia. |

| | Date | Time |
|---|---|---|
| START | 9/16/86 | am |
| COMPLETE | 9/16/86 | pm |

TOTAL HRS.

BORING FOREMAN D. Green

INSPECTOR

SOILS ENGR.

LOCATION OF BORING

| DEPTH | Casing Blows per foot | Sample Depths From - To | Type of Sample | Blows per 6" on Sampler From 0-6 | To 6-12 | To 12-18 | Moisture Density or Consist. | Strata Change Elev | SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc. | SAMPLE No | Pen | Rec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Brown Sand & Gravel | | | |
| | | | | | | | | 7' | | | | |
| | | | | | | | | | Black to Gray Glacial TILL | | | |
| | | | | | | | | 15' | | | | |
| | | | | | | | | 16'6" | Boulder (Granite) | | | |
| | | | | | | | | 17' | Glacial TILL | | | |
| | | | | | | | Min/Ft | | | | | |
| | | 20'-25' | C | | | | 2 | | Gray Graphitic SHALE, very weathered | C1 | 60" | 36" |
| | | | | | | | 2 | | | | | |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | | | | | |
| | | 25'-30' | C | | | | 2 | | | C2 | 60" | 48" |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | | | | | |
| | | | | | | | 2 | | | | | |
| | | | | | | | 1 | | | | | |
| | | 30'-35' | C | | | | 1 | | | C3 | 60" | 48" |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | 35' | | | | |
| | | | | | | | | | Bottom of Boring 35' | | | |
| | | | | | | | | | Installed Observation Well at 35' | | | |
| | | | | | | | | | 20' of 1½" Sch. 80 Screen | | | |
| | | | | | | | | | 17' of 1½" Sch. 80 Solid | | | |
| | | | | | | | | | One Bag of Ottawa Sand | | | |
| | | | | | | | | | ½ Pail of Bentonite Balls | | | |
| | | | | | | | | | One 3"x5' Guard Pipe | | | |
| | | | | | | | | | One Bag of Cement | | | |
| | | | | | | | | | 0' to 11' - Grouted Hole | | | |
| | | | | | | | | | Pressure Tested Hole | | | |
| | | | | | | | | | Two Tests | | | |

GROUND SURFACE TO 9' USED HW "CASING: THEN NW to 19'

Sample Type
D = Dry C = Cored W = Washed
UP = Undisturbed Piston
TP = Test Pit A = Auger V = Vane Test
UT = Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt. x 30" fall on 2" O.D. Sampler

| Cohesionless Density | | Cohesive Consistency | | |
|---|---|---|---|---|
| 0-10 | Loose | 0-4 | Soft | 30 + Hard |
| 10-30 | Med. Dense | 4-8 | M/Stiff | |
| 30-50 | Dense | 8-15 | Stiff | |
| 50 + | Very Dense | 15-30 | V-Stiff | |

SUMMARY
Earth Boring 20'
Rock Coring 15'
Samples 0

HOLE NO W 86-1

TOWN PRESS - EAST PROV.

# GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R I

SHEET ____ OF ____

TO Goldberg-Zoino & Assoc., Inc. | ADDRESS Providence, R.I.

PROJECT NAME USN Fuel Storage Area | LOCATION Middletown, R.I.

REPORT SENT TO above | PROJ. NO. ____

SAMPLES SENT TO " | OUR JOB NO. 87-185

DATE ____

HOLE NO. W 86-2

LINE & STA. ____

OFFSET ____

SURF. ELEV. ____

GROUND WATER OBSERVATIONS

At 28' after 56 Hours

At ____ after ____ Hours

| | CASING | SAMPLER | CORE BAR |
|---|---|---|---|
| Type | HW-NW | | NVD |
| Size I D | 4" 3" | | |
| Hammer Wt. | 300# | | BIT Dia. |
| Hammer Fall | 24" | | |

| | Date | Time |
|---|---|---|
| START | 9/12/86 | ____ a m |
| COMPLETE | 9/15/86 | ____ p m |
| TOTAL HRS. | | |

BORING FOREMAN D. Green

INSPECTOR ____

SOILS ENGR. ____

LOCATION OF BORING Bunker Oil Storage Area

| DEPTH | Casing Blows per foot | Sample Depths From - To | Type of Sample | Blows per 6" on Sampler From 0-6 | To 6-12 | To 12-18 | Moisture Density or Consist | Strata Change Elev. | SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc. | SAMPLE No | Pen | Rec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Brown Sand & Gravel | | | |
| | | | | | | | | 9' | | | | |
| | | | | | | | | | Gray to Black Goacial TILL | | | |
| | | | | | | | | 17'6" | | | | |
| | | | | | | | Min/Ft | | | | | |
| | | 20'-25' | C | | | | 1 | | Gray Graphitic SHALE very weathered | C1 | 60" | 21" |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1½ | | | | | |
| | | | | | | | 2 | | | | | |
| | | | | | | | 1 | | | | | |
| | | 25'-30' | C | | | | 1 | | | C2 | 60" | 43" |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | | | | | |
| | | | | | | | 2 | | | | | |
| | | | | | | | 2 | | | | | |
| | | 30'-35' | C | | | | 2 | | | C3 | 60" | 40" |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1½ | | | | | |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | 35' | | | | |
| | | | | | | | | | Bottom of Boring 35' | | | |
| | | | | | | | | | Installed Observation Well at 35' | | | |
| | | | | | | | | | 20' of 1½" Sch. 80 Screen | | | |
| | | | | | | | | | 17' of 1½" Sch. 80 Solid | | | |
| | | | | | | | | | One Bag of Ottawa Sand | | | |
| | | | | | | | | | ½ Pail of Bentonite Balls | | | |
| | | | | | | | | | One 3"x5' Guard Pipe | | | |
| | | | | | | | | | One Bag of Cement | | | |
| | | | | | | | | | Grouted Hole 0' to 15' | | | |
| | | | | | | | | | Pressure Tested Hole | | | |
| | | | | | | | | | 3 Tests in Hole | | | |

GROUND SURFACE TO 15' USED HW "CASING: THEN NW to 20' then Cored

Sample Type
D: Dry C: Cored W: Washed
UP: Undisturbed Piston
TP: Test Pit A: Auger V: Vane Test
UT: Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt. x 30" fall on 2" O D. Sampler

Cohesionless Density
0-10 Loose
10-30 Med. Dense
30-50 Dense
50 + Very Dense

Cohesive Consistency
0-4 Soft
4-8 M/Stiff
8-15 Stiff
15-30 V-Stiff
30 + Hard

SUMMARY
Earth Boring 20'
Rock Coring 15'
Samples 0

HOLE NOW 86-2

TOWN PRESS - EAST PROV.

100 WATER STREET EAST PROVIDENCE, R I

TO Goldberg-Zoino & Assoc., Inc. | ADDRESS Providence, R.I.
PROJECT NAME USN Fuel Storage Area | LOCATION Middletown, R.I.
REPORT SENT TO above | PROJ. NO.
SAMPLES SENT TO " | OUR JOB NO. 87-185

DATE
HOLE NO. W 86-3
LINE & STA.
OFFSET
SURF. ELEV.

GROUND WATER OBSERVATIONS
At 31' after Hours
At after Hours

| | CASING | SAMPLER | CORE BAR |
|---|---|---|---|
| Type | HW-NW | | NVD |
| Size I D | 4" 3" | | |
| Hammer Wt | 300# | | BIT |
| Hammer Fall | 24" | | Dia. |

| | Date | Time |
|---|---|---|
| START | 9/22/86 | a m p m |
| COMPLETE | 9/23/86 | a m p m |
| TOTAL HRS. | | |
| BORING FOREMAN | D. Green | |
| INSPECTOR | | |
| SOILS ENGR. | | |

LOCATION OF BORING Edge of Fuel Tank

| DEPTH | Casing Blows per foot | Sample Depths From - To | Type of Sample | Blows per 6" on Sampler From 0-6 | To 6-12 | To 12-18 | Moisture Density or Consist. | Strata Change Elev. | SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc. | SAMPLE No | Pen | Rec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Brown Sand & Gravel (Fill) | | | |
| | | | | | | | | 9' | | | | |
| | | | | | | | | | Brown to Black Glacial Till | | | |
| | | | | | | | | 21'6" | | | | |
| | | 24'-29' | C | | | | | | Gray SCHIST, very weathered | C1 | 60" | 6" |
| | | | | | | | | 29' | | | | |
| | | 29'-34' | C | | | | | | Dark Gray SHALE weathered | C2 | 60" | 36" |
| | | | | | | | | 34' | | | | |
| | | 34'-39' | C | | | | | | Gray SCHIST & Quartz very weathered | C3 | 60" | 18" |
| | | 39'-44' | C | | | | | | | C4 | 60" | 12" |
| | | 44'-49' | C | | | | | | | C5 | 60" | 12" |
| | | | | | | | | 49' | | | | |
| | | | | | | | | | Bottom of Boring 49' | | | |
| | | | | | | | 2 Wells | | | | | |
| | | Installed Observation Well at 49' | | | | | | | Installed Observation Well at 33' | | | |
| | | 10' of 1½" Sch. 40 Screen | | | | | | | 20' of 1½" Sch. 40 Screen | | | |
| | | 40' of 1½" Sch. 40 Solid | | | | | | | 15' of 1½" Sch. 40 Solid | | | |
| | | One Bag of Ottawa Sand | | | | | | | 3 Bags of Ottawa Sand | | | |
| | | ½ Pail of Bentonite Balls | | | | | | | ½ Pail of Bentonite Balls | | | |
| | | | | | | | | | One 5'x4" Guard Pipe | | | |
| | | Pressure Tested Hole -- | | | | | 4 Tests | | One Bag of Cement | | | |

GROUND SURFACE TO 24' USED HW "CASING: THEN NW to 24' then Cored

Sample Type
D: Dry C: Cored W: Washed
UP: Undisturbed Piston
TP: Test Pit A: Auger V: Vane Test
UT: Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt. x 30" fall on 2" O D. Sampler
Cohesionless Density: 0-10 Loose; 10-30 Med. Dense; 30-50 Dense; 50 + Very Dense
Cohesive Consistency: 0-4 Soft; 4-8 M/Stiff; 8-15 Stiff; 15-30 V-Stiff; 30 + Hard

SUMMARY
Earth Boring 24'
Rock Coring 25'
Samples 0

HOLE NO. W 86-3

TOWN PRESS - EAST PROV.

# GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R I

TO Goldberg-Zoino & Assoc., Inc. | ADDRESS Providence, R.I.
PROJECT NAME USN Fuel Storage Area | LOCATION Middletown, R.I.
REPORT SENT TO above | PROJ. NO.
SAMPLES SENT TO " | OUR JOB NO. 87-185

DATE
HOLE NO. W 86-4
LINE & STA.
OFFSET
SURF. ELEV.

GROUND WATER OBSERVATIONS
At 25.5' after 16 Hours
At ____ after ____ Hours

| | CASING | SAMPLER | CORE BAR |
|---|---|---|---|
| Type | HW-NW | | NVD |
| Size I.D. | 4" 3" | | |
| Hammer Wt | 300# | | BIT |
| Hammer Fall | 24" | | Dia. |

| | Date | Time |
|---|---|---|
| START | 9/17/86 | |
| COMPLETE | 9/18/86 | |
| TOTAL HRS. | | |

BORING FOREMAN D. Green
INSPECTOR
SOILS ENGR.

LOCATION OF BORING:

| DEPTH | Casing Blows per foot | Sample Depths From - To | Type of Sample | Blows per 6" on Sampler From 0-6 | To 6-12 | To 12-18 | Moisture Density or Consist. | Strata Change Elev. | SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc Rock-color, type, condition, hardness, Drilling time, seams and etc. | SAMPLE No | Pen | Rec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Brown Sand & Gravel | | | |
| | | | | | | | | 5' | | | | |
| | | | | | | | | | Black to Brown Glacial TILL | | | |
| | | | | | | | | 11' | | | | |
| | | | | | | | Min/Ft | | | | | |
| | | 19'-24' | C | | | | 1 | | Gray Graphitic SHALE very weathered | C1 | 60' | 27" |
| | | | | | | | ½ | | | | | |
| | | | | | | | ½ | | | | | |
| | | | | | | | 1 | | | | | |
| | | | | | | | ½ | | | | | |
| | | 24'-29' | C | | | | 1 | | | C2 | 60' | 36" |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | | | | | |
| | | | | | | | ½ | | | | | |
| | | | | | | | ½ | | | | | |
| | | 29'-34' | C | | | | ½ | | | C3 | 60' | 24" |
| | | | | | | | ½ | | | | | |
| | | | | | | | ½ | | | | | |
| | | | | | | | ½ | | | | | |
| | | | | | | | 1 | 34' | | | | |
| | | | | | | | | | Bottom of Boring 34' | | | |
| | | | | | | | | | Installed Observation Well at 34' | | | |
| | | | | | | | | | 20' of 1½" Sch. 80 Screen | | | |
| | | | | | | | | | 16' of 1½" Sch. 80 Solid | | | |
| | | | | | | | | | One Bag of Ottawa Sand | | | |
| | | | | | | | | | ½ Pail of Bentonite Balls | | | |
| | | | | | | | | | One 3"x5' Guard Pipe | | | |
| | | | | | | | | | One Bag of Cement | | | |
| | | | | | | | | | Grouted Hole | | | |
| | | | | | | | | | Pressure Tested Hole | | | |
| | | | | | | | | | 2 Tests | | | |

GROUND SURFACE TO 9' USED HW "CASING: THEN NW to 19' then Cored

Sample Type
D: Dry C: Cored W: Washed
UP: Undisturbed Piston
TP: Test Pit A: Auger V: Vane Test
UT: Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140lb Wt. x 30" fall on 2" O.D. Sampler

| Cohesionless Density | | Cohesive Consistency | |
|---|---|---|---|
| 0-10 | Loose | 0-4 | Soft |
| 10-30 | Med. Dense | 4-8 | M/Stiff |
| 30-50 | Dense | 8-15 | Stiff |
| 50 + | Very Dense | 15-30 | V-Stiff |
| | | 30 + | Hard |

SUMMARY
Earth Boring 19'
Rock Coring 15'
Samples 0

HOLE NO. W 86-4

# GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R. I.

SHEET 1 OF 1

TO Goldberg-Zoino & Assoc., Inc. | ADDRESS Providence, R.I.

PROJECT NAME USN Fuel Storage Area | LOCATION Middletown, R.I.

REPORT SENT TO above | PROJ. NO.

SAMPLES SENT TO " | OUR JOB NO. 87-185

DATE

HOLE NO. W 86-5

LINE & STA.

OFFSET

SURF. ELEV.

GROUND WATER OBSERVATIONS

At 23' after Comp. Hours

At ____ after ____ Hours

| | CASING | SAMPLER | CORE BAR |
|---|---|---|---|
| Type | HW-NW | | NVD |
| Size I.D. | 4" 3" | | |
| Hammer Wt | 300# | | BIT Dia. |
| Hammer Fall | 24" | | |

| | Date | Time |
|---|---|---|
| START | 9/18/86 | a.m. p.m. |
| COMPLETE | 9/19/86 | a.m. p.m. |

TOTAL HRS.

BORING FOREMAN D. Green

INSPECTOR

SOILS ENGR.

LOCATION OF BORING:

| DEPTH | Casing Blows per foot | Sample Depths From - To | Type of Sample | Blows per 6" on Sampler From 0-6 | To 6-12 | To 12-18 | Moisture Density or Consist. | Strata Change Elev. | SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc. | SAMPLE No | Pen | Rec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Brown Sand & Gravel | | | |
| | | | | | | | | 10' | | | | |
| | | | | | | | | | Brown to Black Glacial TILL | | | |
| | | | | | | | | 12' | | | | |
| | | | | | | | Min/Ft | | | | | |
| | | 16'-21' | C | | | | 1 | | Gray SCHIST with Quartz Seams, very weathered & broken (@ 18' - lost water) | C1 | 60" | 24" |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | | | | | |
| | | 21'-26' | C | | | | 1 | | | C2 | 60" | 20" |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | | | | | |
| | | | | | | | 1 | 24' | | | | |
| | | | | | | | 1 | | Gray SCHIST & Shale very weathered | | | |
| | | | | | | | 1 | 26' | | | | |
| | | | | | | | | | Very weathered Rock (Ran Button Bit from 26' to 30') | | | |
| | | | | | | | | 30' | | | | |
| | | | | | | | | | Bottom of Boring 30' | | | |
| | | | | | | | | | Installed Observation Well at 26' | | | |
| | | | | | | | | | 20' of 1½" Sch. 80 Screen | | | |
| | | | | | | | | | 8' of 1½" Sch. 80 Solid | | | |
| | | | | | | | | | 2 Bags of Ottawa Sand | | | |
| | | | | | | | | | ½ Pail of Bentonite Balls | | | |
| | | | | | | | | | One 3"x5' Guard Pipe | | | |
| | | | | | | | | | One Bag of Cement | | | |
| | | | | | | | | | Try to Pressure Test Hole but rock kept falling back in hole. Didn't want to lose packer. | | | |

GROUND SURFACE TO 9' USED HW "CASING: THEN NW to 16' then Cored

Sample Type
D: Dry C: Cored W: Washed
UP: Undisturbed Piston
TP: Test Pit A: Auger V: Vane Test
UT: Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt. x 30" fall on 2" O.D. Sampler

| Cohesionless Density | | Cohesive Consistency | | |
|---|---|---|---|---|
| 0-10 | Loose | 0-4 | Soft | 30 + Hard |
| 10-30 | Med. Dense | 4-8 | M/Stiff | |
| 30-50 | Dense | 8-15 | Stiff | |
| 50 + | Very Dense | 15-30 | V-Stiff | |

SUMMARY
Earth Boring 20'
Rock Coring 10'
Samples 0

HOLE NO. W 86-5

TOWN PRESS - EAST PROV.

R.I. Analytical Laboratories, Inc.

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK R I 02888

PHONE (401) 467-2452

# CERTIFICATE OF ANALYSIS

REPORT TO Environmental Resource Associates
150 Lavan Street
Warwick, RI 02888
Attn: Mr. Robert Hoffman

SAMPLE DESCRIPTION Six (6) liquid samples

DATE RECEIVED 10/11/85
DATE REPORTED 11/09/85
PURCHASE ORDER NO
RIAL INV NO E3393

Subject samples have been analyzed by our laboratory with the attached results.

Methodology: Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-202, revised March 1983.

Methods for Organic Chemical Analysis of Municipal and Industrial wastewater, EPA-600/4-82-057, July 1982.

If you have any questions regarding this work or if we may be of further assistance, please contact us.

APPROVED BY

Anthony F. Perrotti

Certificate of Analysis

Environmental Resource Associates
Number E3393
November 9, 1985


water + oil

| PARAMETER | BOTTOM TANK 56 | TOP TANK 56 | OIL TANK 56 | BOTTOM TANK 53 | TOP TANK 53 | OIL TANK 53 |
|---|---|---|---|---|---|---|
| Cyanide (total) | <0.03 mg/l | <0.03 mg/l | <0.03 ppm | <0.03 mg/l | <0.03 mg/l | <0.03 ppm |
| $BOD_5$ | 40 " | 40 " | --- | 300 " | 390 " | --- |
| Phenol (total) | 0.40 " | 0.74 " | 4.3 ppm | 2.1 " | 2.1 " | 1.9 ppm |
| Total Kjeldhl Nitrogen | 3.3 " | 3.3 " | --- | 8.9 " | 5.4 " | --- |
| Sulfide (as $S^{=}$) | 1.1 " | 0.03 " | --- | 0.02 " | 0.02 " | --- |
| Metals (total): | | | | | | |
| Antimony | <0.2 mg/l | <0.2 mg/l | <15 ppm | <0.2 mg/l | <0.2 mg/l | <15 ppm |
| Arsenic | <0.01 " | <0.01 " | <2 " | <0.01 " | <0.01 " | <1 |
| Beryllium | <0.01 " | <0.01 " | <0.8 " | <0.01 " | <0.01 " | <0.8 " |
| Cadmium | 0.007 " | 0.007 " | <0.4 " | 0.008 " | 0.005 " | <0.4 " |
| Chromium | <0.05 " | <0.05 " | <4 " | <0.05 " | <0.05 " | <4 " |
| Copper | 0.04 " | 0.06 " | 21 " | <0.02 " | 0.03 " | 4.5 " |
| Lead | 0.06 " | 0.07 " | 54 " | 0.05 " | 0.06 " | 104 " |
| Mercury | <0.001 " | <0.001 " | 0.18 " | <0.001 " | <0.001 " | 0.45 " |
| Nickel | 0.07 " | 0.05 " | 33 " | <0.04 " | <0.04 " | 9.8 " |
| Selenium | <0.01 " | <0.01 " | <2 " | <0.01 " | <0.01 " | <1 " |
| Silver | <0.01 " | <0.01 " | <1 " | <0.01 " | <0.01 " | 6 " |
| Thallium | <0.1 " | <0.1 " | <8 " | <0.1 " | <0.1 " | <8 " |
| Zinc | 0.10 " | 0.12 " | 128 " | 0.01 " | 0.01 " | 42.8 " |

R.I. ANALYTICAL LABORATORIES, INC.

Certificate of Analysis

Environmental Resource Associates
Number E3393
November 9, 1985


| PARAMETER | BOTTOM TANK 56 | TOP TANK 56 | OIL TANK 56 | BOTTOM TANK 53 | TOP TANK 53 | OIL TANK 53 |
|---|---|---|---|---|---|---|
| Volatile Organic Compounds: | | | | | | |
| vinyl chloride | ND | ND | ND | 1,300 µg/l | 216 µg/l | ND |
| methylene chloride | ND | ND | 178,000 ppb | 82 " | ND | 217,000 ppb |
| chloroform | 146 µg/l | 649 µg/l | 166,000 " | 261 " | 524 µg/l | 47,000 " |
| 1,2-dichloroethane | ND | ND | ND | 336 " | ND | 148,000 " |
| 1,1,1-trichloroethane | ND | ND | 2,600 ppb | 253 " | 130 µg/l | 75,000 " |
| trichloroethylene | ND | ND | 606 " | 13 " | ND | 88,600 " |
| tetrachloroethylene | ND | ND | 490 " | ND | ND | 33,800 " |
| benzene | ND | ND | 27,500 " | 824 µg/l | 706 µg/l | 119,000 " |
| toluene | ND | ND | 312,000 " | 5,140 " | 4,500 " | 378,000 " |
| ethylbenzene | ND | ND | 265,000 " | 379 " | 211 " | 448,000 " |
| xylenes | ND | ND | 875,000 " | 1,000 " | 813 " | 1,600,000 " |
| Semi-volatile Organic Compounds: | | | | | | |
| Base/neutral Extractable Compounds: | | | | | | |
| naphthalene | ND | ND | 880,000 ppb | 10 µg/l | 38 µg/l | 550,000 ppb |
| isophorone | ND | ND | ND | ND | 19 " | ND |
| Acid Extractable Compounds: | | | | | | |
| 2,4-dimethyphenol | 14 µg/l | 55 µg/l | ND | 60 µg/l | 70 µg/l | ND |
| Pesticides | ND | ND | ND | ND | ND | ND |
| Polychlorinated Biphenyls | ND | ND | ND | ND | ND | ND |

Note: A list of other volatile and semi-volatile organic compounds tested for and their detection limits is attached.

R.I. ANLYTICAL LABORATORIES, INC.

R.I. Analytical Laboratories, Inc.

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK, R I 02888

PHONE (401) 467-2452

## CERTIFICATE OF ANALYSIS

REPORT TO Environmental Resource Associates
150 Lavan Street
Warwick, RI 02888
Attn: Mr. Robert Hoffman

DATE RECEIVED 10/11/85
DATE REPORTED 11/09/85
PURCHASE ORDER NO
RIAL INV NO E3394

SAMPLE DESCRIPTION Eight (8) liquid samples (water phase)

Subject samples have been analyzed by our laboratory with the attached results.

Methodology: Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-202, revised March 1983.

Methods for Organic Chemical Analysis of Municipal and Industrial wastewater, EPA-600/4-82-057, July 1982.

If you have any questions regarding this work or if we may be of further assistance, please contact us.

APPROVED BY

Anthony E. Perrotti

Certificate of Analysis

Environmental Resource Associates
Number E3394
November 9, 1985


| PARAMETER | TANK 49 | TANK 50 | TANK 51 | TANK 52 | TANK 54 | TANK 55 | TANK 58 | TANK 59 |
|---|---|---|---|---|---|---|---|---|
| pH | 7.4 SU | 6.5 SU | 5.6 SU | 8.1 SU | 7.1 SU | 7.7 SU | 6.9 SU | 6.9 SU |
| Total Suspended Solids | 15.9 mg/l | 17.9 mg/l | 16.8 mg/l | 16.1 mg/l | 13.7 mg/l | 14.0 mg/l | 12.2 mg/l | 14.8 mg/l |
| Cyanide (total) | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " |
| $BOD_5$ | 16 " | 8 " | 400 " | 75 " | <2 " | 5 " | <2 " | 4 " |
| Nitrate | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | 0.11 " | <0.01 " | 0.10 " |
| Oil & Grease | 1.5 " | 9.1 " | 2.0 " | 2.8 " | 1.7 " | 3.9 " | 0.7 " | 2.0 " |
| Phenol (total) | 0.04 " | 0.17 " | 3.5 " | 0.50 " | 0.05 " | 0.10 " | 0.03 " | 0.07 " |
| Ammonia (as N) | 0.06 " | 0.63 " | 0.76 " | 2.8 " | 0.10 " | 0.27 " | 0.16 " | 0.04 " |
| Sulfate | 4.9 " | 61.3 " | 6.6 " | <4.0 " | 14.5 " | <4.0 " | 11.9 " | 14.5 " |
| Metals (total): | | | | | | | | |
| Antimony | <0.2 mg/l | <0.2 mg/l | <0.2 mg/l | <0.2 mg/l | <0.2 mg/l | <0.2 mg/l | <0.2 mg/l | <0.2 mg/l |
| Arsenic | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " |
| Beryllium | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " |
| Cadmium | <0.005 " | <0.005 " | 0.005 " | <0.005 " | <0.005 " | <0.005 " | <0.005 " | <0.005 " |
| Chromium | <0.05 " | <0.05 " | <0.05 " | <0.05 " | <0.05 " | <0.05 " | <0.05 " | <0.05 " |
| Copper | 0.05 " | 0.06 " | 0.07 " | 0.03 " | 0.03 " | 0.03 " | 0.02 " | 0.05 " |
| Lead | <0.05 " | <0.05 " | 0.06 " | <0.05 " | <0.05 " | <0.05 " | <0.05 " | <0.05 " |
| Mercury | <0.001 " | <0.0005 " | <0.0005 " | <0.001 " | <0.0005 " | <0.0005 " | <0.0005 " | 0.0006 " |
| Nickel | <0.04 " | <0.04 " | <0.04 " | <0.04 " | <0.04 " | <0.04 " | <0.04 " | <0.04 " |
| Selenium | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " |
| Silver | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 " | <0.01 |
| Thallium | <0.1 " | <0.1 " | <0.1 " | <0.1 " | <0.1 " | <0.1 " | <0.1 " | <0.1 " |
| Zinc | 0.01 " | 0.02 " | 0.09 " | 0.02 " | 0.02 " | 0.01 " | 0.02 " | 0.01 " |

R.I. ANALYTICAL LABORATORIES, INC.

Certificate of Analysis

Environmental Resource Associates
Number E3394
November 9, 1985


| PARAMETER | TANK 49 | TANK 50 | TANK 51 | TANK 52 | TANK 54 | TANK 55 | TANK 58 | TANK 59 |
|---|---|---|---|---|---|---|---|---|
| Volatile Organic Compounds: | | | | | | | | |
| methylene chloride | ND | 113 ppb | 70 ppb | 613 ppb | 15 ppb | 651 ppb | ND | ND |
| 1,1-dichloroethylene | ND | ND | ND | 71 " | ND | ND | ND | ND |
| 1,1-dichloroethane | ND | 12 " | ND | 28 " | ND | ND | ND | ND |
| trans-1,2-dichloroethylene | ND | 11 " | ND | 124 " | ND | ND | ND | ND |
| chloroform | ND | 10 " | 1,400 ppb | 6 " | 4 ppb | 24 ppb | ND | ND |
| 1,2-dichloroethane | ND | 14 " | 702 " | 134 " | 23 " | 187 " | ND | ND |
| 1,1,1-trichloroethane | ND | ND | 309 " | 9 " | ND | ND | ND | ND |
| trichloroethylene | ND | ND | 13 " | 36 " | ND | ND | ND | ND |
| benzene | ND | 42 ppb | 33 " | 74 " | ND | 7 ppb | ND | ND |
| toluene | ND | 86 " | 97 " | 35 " | ND | 10 " | ND | ND |
| ethylbenzene | ND | 48 " | 49 " | 59 " | ND | ND | ND | ND |
| xylenes | ND | 152 " | 287 " | 71 " | ND | ND | ND | ND |

Note: A list of other volatile organic compounds tested for and their detection limits is attached.

R. I. Analytical Laboratories, Inc.

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK, R I 02888

PHONE (401) 467-2452

## CERTIFICATE OF ANALYSIS

REPORT TO Environmental Resource Associates

150 Lavan Street

Warwick, RI 02888

Attn: Mr. Robert Hoffman

DATE RECEIVED 10/22/85

DATE REPORTED 11/09/85

PURCHASE ORDER NO

RIAL INV NO E3483-B

SAMPLE DESCRIPTION Four (4) liquid samples from Navy Tank Farm 5

Subject samples have been analyzed by our laboratory with the attached results.

Methodology: Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-202, revised March 1983.

Test Methods for Evaluating Solid Waste, Physical/ Chemical Methods, U.S. EPA, SW-846, July 1982, 2nd ed.

If you have any questions regarding this work or if we may be of further assistance, please contact us.

APPROVED BY

Anthony E. Perrotti

Certificate of Analysis

Environmental Resource Associates
November 9, 1985
Number E3483-B


| PARAMETER | MW 53W | MW 56W | MW 53E | MW 56E |
|---|---|---|---|---|
| Metals (soluble): | | | | |
| Arsenic | <0.01 mg/l | <0.01 mg/l | <0.01 mg/l | <0.01 mg/l |
| Barium | <0.5 " | <0.5 " | <0.5 " | <0.5 " |
| Cadmium | 0.007 " | <0.005 " | <0.005 " | <0.005 " |
| Chromium | <0.05 " | <0.05 " | <0.05 " | <0.05 " |
| Lead | <0.05 " | <0.05 " | <0.05 " | <0.05 " |
| Mercury | <0.0005 " | 0.0014 " | 0.0012 " | 0.0008 " |
| Selenium | <0.01 " | <0.01 " | <0.01 " | <0.01 " |
| Silver | <0.01 " | <0.01 " | <0.01 " | <0.01 " |
| Volatile Organic Compounds: | | | | |
| methylene chloride | 54 ppb | 304 ppb | 178 ppb | ND |
| trans-1,2-dichloroethylene | 46 " | ND | 166 " | ND |
| chloroform | 353 " | 18 ppb | 401 " | 12 ppb |
| 1,2-dichloroethane | 229 " | ND | 211 " | ND |
| 1,1,1-trichloroethane | 4,400 " | 17 ppb | 4,400 " | ND |
| trichloroethylene | 785 " | ND | 1,400 " | ND |
| tetrachloroethylene | 14 " | ND | 262 " | ND |
| benzene | 155 " | ND | 300 " | ND |
| toluene | 341 " | ND | 1,100 " | ND |
| ethylbenzene | 21 " | ND | 374 " | ND |
| xylenes | 140 " | ND | 1,620 " | ND |

Note: A list of other volatile organic compounds tested for and their detection limits is attached.

R.I. ANALYTICAL LABORATORIES, INC.

Air Strip

# R.I. Analytical Laboratories, Inc.

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK R I 02888

PHONE (401) 467-2452

## CERTIFICATE OF ANALYSIS

REPORT TO Environmental Resource Assoc.
150 Lavan Street
Warwick, RI 02888
Attn: Mr. Robert Hoffman

DATE RECEIVED 12/04/85 era
DATE REPORTED 1/03/86
PURCHASE ORDER NO
RIAL INV NO E3601

SAMPLE DESCRIPTION Nine (9) liquid samples labelled ERA #5200

Subject samples have been analyzed by our laboratory with the attached results.

Methodology: Methods for Organic Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised March 1983.

If you have any questions regarding this work or if we may be of further assistance, please contact us.

APPROVED BY

Certificate of Analysis

Environmental Resource Assoc., Inc.
January 2, 1986
Number E3601


| PARAMETER | #4 | #5 | #6 | #7 | #8 |
|---|---|---|---|---|---|
| Volatile Oganic Compounds: | | | | | |
| vinyl chloride | 2,000 ppb | 2,000 ppb | 518 ppb | 2,400 ppb | 908 ppb |
| 1,1-dichloroethane | 1,300 " | 1,200 " | 328 " | 1,300 " | 551 " |
| 1,2-dichloroethane | ND | 83 " | ND | 70 " | 34 " |
| 1,1,1-trichloroethane | 1,200 ppb | 1,300 " | 264 ppb | 1,500 " | 612 " |
| trichloroethylene | ND | ND | ND | ND | ND |
| benzene | 806 ppb | 824 ppb | 388 ppb | 872 ppb | 508 ppb |
| toluene | 1,700 " | 1,940 " | 1,400 " | 1,971 " | 1,000 " |
| ethylbenzene | 88 " | 306 " | 156 " | 306 " | 138 " |
| xylenes | 1,100 " | 1,100 " | 608 " | 1,200 " | 740 " |

R.I. ANALYTICAL LABORATORIES, INC.

Certificate of Analysis

Environmental Resource Assoc., Inc.
Janaury 3, 1986
Number E3601


| PARAMETER | #9 | #10 | #11 | #12 |
|---|---|---|---|---|
| Volatile Oganic Compounds: | | | | |
| vinyl chloride | 533 ppb | 2,800 ppb | 1,600 ppb | 281 ppb |
| 1,1-dichloroethane | 245 " | 1,300 " | 1,000 " | 262 " |
| 1,2-dichloroethane | 1 " | 24 " | 38 " | ND |
| 1,1,1-trichloroethane | 280 " | 1,300 " | 913 " | 224 ppb |
| trichloroethylene | ND | 14 " | ND | ND |
| benzene | 340 ppb | 806 " | 657 ppb | 358 ppb |
| toluene | 1,400 " | 1,900 " | 1,800 " | 1,400 " |
| ethylbenzene | 144 " | 356 " | 231 " | 144 " |
| xylenes | 592 " | 1,100 " | 920 " | 538 " |

R.I. ANALYTICAL LABORATORIES, INC.

# R. I. Analytical Laboratories, Inc.

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK, R I 02888

PHONE (401) 467-2452

## CERTIFICATE OF ANALYSIS

REPORT TO Environmental Resource Assoc.
150 Lavan Street
Warwick, RI
Attn: Mr. Robert Hoffman

DATE RECEIVED 12/20/85
DATE REPORTED 1/09/86
PURCHASE ORDER NO
RIAL INV NO E4062

SAMPLE DESCRIPTION One (1) wastewater sample (MW#1, Tank Farm #5-NETC)

Subject sample has been analyzed by our laboratory with the following results:

| PARAMETER | RESULTS |
|---|---|
| Volatile Organic Compounds: | |
| methylene chloride | 240 ppb |
| trans-1,2-dichloroethylene | 9 " |
| chloroform | 5 " |
| 1,1,1-trichloroethane | 18 " |
| trichloroethylene | 5 " |
| tetrachloroethylene | 9 " |
| benzene | 4 " |
| toluene | 14 " |
| xylenes | 52 " |

Methodology: Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057, July 1982.

Note: A list of other volatile organic compounds tested for and their detection limit.

If you have any questions regarding this work or if we may be of further assistance, please contact us.

APPROVED BY

R.I. Analytical Laboratories, Inc.

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK, R I 02888

PHONE. (401) 467-2452

# CERTIFICATE OF ANALYSIS

REPORT TO Environmental Resource Associates
150 Lavan Street
Warwick. RI 02888
Attn: Mike Clark. Project Manager

DATE RECEIVED 10/01/86
DATE REPORTED 11/04/86
PURCHASE ORDER NO
RIAL INV NO F4363

SAMPLE DESCRIPTION Four (4) GWT Water Samples

Subject samples have been analyzed by our laboratory with the attached results.

Methodology: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057. July 1982.

If you have any questions regarding this work or if we may be of further assistance, please contact us.

APPROVED BY
Anthony E. Perrotti

Certificate of Analysis

Environmental Resource Associates
November 4, 1986
Invoice #F4363


| PARAMETER | ERA-86-1 | ERA-86-2 | ERA-86-3S* | ERA-86-4 |
|---|---|---|---|---|
| Volatile Organic Compounds: | | | | |
| 1,1 dichloroethane | ND | 2 ppb | 4 ppb | ND |
| trans-1,2-dichloroethylene | " | 3 " | 1 " | " |
| chloroform | " | 10 " | 3 " | 12 ppb |
| 1,1,1 trichloroethane | " | 5 " | 5 " | ND |
| trichloroethylene | " | 1 " | 2 " | " |

Note: A list of other volatile organic compounds tested for and their limits of detection is attached.

S → Shallow

R.I. ANALYTICAL LABORATORIES, INC.

R. I. Analytical Laboratories, Inc.

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK, R. I. 02888

PHONE (401) 467-2452

# CERTIFICATE OF ANALYSIS

REPORT TO Environmental Resource Associates

150 Lavan Street

Warwick, RI 02888

Attn: Mike Clark, Project Manager

DATE RECEIVED 10/06/86

DATE REPORTED 11/04/86

PURCHASE ORDER NO

RIAL INV NO F4418

SAMPLE DESCRIPTION One (1) water/sediment sample

ERA-86-3D (WAS NOT PURGED - JUST TAKEN FROM CASING)

2ND DEEP

Subject sample has been analyzed by our laboratory with the following results:

| PARAMETER | RESULTS |
|---|---|
| Volatile Organic Compounds: | |
| trichlorofluoromethane | 1 ppb |
| 1,1 dichloroethylene | 2 " |
| 1,1 dichloroethane | 18 " |
| trans-1,2-dichloroethylene | 26 " |
| 1,1,1 trichloroethane | 101 " |
| trichloroethylene | 35 " |
| tetrachloroethylene | 2 " |
| toluene | 2 " |
| ethylbenzene | 3 " |
| xylenes | 39 " |

Methodology: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057, July 1982.

If you have any questions regarding this work or if we may be of further assistance, please contact us.

Note: A list of other volatile organic compounds tested for and their limits of detection is attached.

APPROVED BY

Anthony E. Perrotti

R. I. Analytical Laboratories, Inc.

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK, R. I. 02888

PHONE (401) 467-2452

# CERTIFICATE OF ANALYSIS

REPORT TO: Environmental Resource Associates
150 Lavan Street
Warwick, RI 02888
Attn: Mike Clark

DATE RECEIVED 11/26/86
DATE REPORTED 12/24/86
PURCHASE ORDER NO
RIAL INV NO F5245

SAMPLE DESCRIPTION Four (4) liquid samples

Subject samples have been analyzed by our laboratory with the attached results.

Methodology: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057, July 1982.

If you have any questions regarding this work or if we may be of further assistance, please contact us.

APPROVED BY Robert L. Hoffman

Robert L. Hoffman, PE

Certificate of Analysis

Environmental Resource Associates
December 24, 1986
Invoice #F5245


| PARAMETER | 5200-53E | 5200-53W | 5200-56E | 5200-56W |
|---|---|---|---|---|
| Volatile Organic Compounds: | | | | |
| 1,1 dichloroethylene | 170 ppb | 57 ppb | ND | ND |
| 1,1 dichloroethane | 32 " | 14 " | " | " |
| trans-1,2-dichloroethylene | 1,100 " | 400 " | " | " |
| 1,1,1 trichloroethane | 930 " | 330 " | " | " |
| bromodichloromethane | 470 " | 49 " | " | " |
| trichloroethylene | 800 " | 24 " | " | " |
| tetrachloroethylene | 25 " | 16 " | " | " |
| benzene | 330 " | ND | " | " |
| toluene | 1,400 " | " | " | " |
| ethylbenzene | 150 " | " | " | " |
| xylenes | 600 " | 65 ppb | " | " |

Note: A list of other volatile organic compounds tested for and their limits of detection is attached.

R.I. ANALYTICAL LABORATORIES, INC.

# VOLATILE ORGANIC PRIORITY POLLUTANTS COMPOUNDS

benzene
bromoform
carbon tetrachloride
chlorobenzene
chlorodibromomethane
chloroethane
2-chloroethylvinyl ether
chloroform
dichlorobromomethane
1,1-dichloroethane
1,2-dichloroethane
1.2-dichloropropane
1,2-dichloropropene (cis & trans)
ethylbenzene
methyl bromide
methyl chloride
methylene chloride
1,1,2,2-tetrachloroethane
tetrachloroethylene
toluene
trans-1,2-dichloroethylene
1,1,1-trichloroethane
1.1.2-trichloroethane
trichloroethylene
trichlorofluoromethane
vinyl chloride
xylenes

Detection Limit: 10 ppb

RI ANALYTICAL LABORATORIES, INC.

R. I. Analytical Laboratories, Inc.

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK, R. I. 02888

PHONE (401) 467-2452

# CERTIFICATE OF ANALYSIS

REPORT TO Lindsay Liebig Roche Architects
861 Hartford Road
Waterford, CT 06385
Attn: Mr. David G. Halloway

DATE RECEIVED 7/09/85
DATE REPORTED 8/07/85
PURCHASE ORDER NO 1057
RIAL INV NO E2585

SAMPLE DESCRIPTION One (1) oil and water composite sample from tank no. 58, Naval Education and Training Center, Newport, RI

Subject sample, collected by RIAL personnel, has been analyzed by our laboratory with the attached result.

Methodology: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, U.S. EPA, SW-846, July 1982, 2nd ed.

# VOLATILE ORGANIC PRIORITY POLLUTANTS

## COMPOUNDS

benzene
carbon tetrachloride
chlorobenzene
1,1-dichloroethane
1,2-dichloroethane
1,1,1-trichloroethane
1,1,2-trichloroethane
1,1,2,2-tetrachloroethane
chloroethane
2-chloroethylvinyl ether
chloroform
1,1-dichloroethylene
trans-1,2-dichloroethylene
1,2-dichloropropane
1,3-dichloropropene (cis & trans)
ethylbenzene
methylene chloride
methyl chloride
methyl bromide
bromoform
dichlorobromomethane
trichlorofluoromethane
chlorodibromomethane
tetrachloroethylene
toluene
trichloroethylene
vinyl chloride
xylene

R. I. Analytical Laboratories, Inc.

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK, R I 02888

PHONE (401) 467-2452

# CERTIFICATE OF ANALYSIS

REPORT TO Lindsay Liebig Roche Architects
861 Hartford Road
Waterford, CT 06385
Attn: Mr. David G. Halloway

DATE RECEIVED 4/24/85
DATE REPORTED 8/07/85
PURCHASE ORDER NO 1057
RIAL INV NO E1940

SAMPLE DESCRIPTION One (1) oil and water composite sample from tank no. 57, Naval Education and Training Center, Newport, RI

Subject sample, collected by RIAL personnel, has been analyzed by our laboratory with the attached result.

Methodology: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, U.S. EPA, SW-846, July 1982, 2nd ed.

Certificate of Analysis

Lindsay Liebig Roche Architects
August 8, 1985
Number E1940


| PARAMETER | OIL PHASE | WATER PHASE |
|---|---|---|
| pH | 5.6 SU | 6.7 SU |
| Flash Point (c/c) | >200°F | --- |
| Total Chlorination | 1.54% | --- |
| Total Suspended Solids | --- | 4.8 mg/l |
| Total Cyanide | --- | <0.01 " |
| Ammonia (as N) | --- | 0.6 " |
| Nitrate (as N) | --- | <0.1 " |
| Phenols | 1.8 ppm | 0.06 " |
| Sulfate | --- | 23.0 " |
| Oil & Grease | --- | <0.5 " |
| $BOD_5$ | --- | <2 " |
| Metals (total): | | |
| Antimony | <50 ppm | <0.2 mg/l |
| Arsenic | <1 " | <0.01 " |
| Beryllium | <1 " | <0.01 " |
| Cadmium | 6 " | <0.005 " |
| Chromium | <3 " | <0.05 " |
| Copper | <3 " | <0.02 " |
| Lead | <4 " | <0.05 " |
| Mercury | 0.82 " | <0.0005 " |
| Nickel | 22 " | <0.04 " |
| Selenium | <1 " | <0.01 " |
| Silver | <2 " | <0.01 " |
| Thallium | <50 " | <0.04 " |
| Zinc | 9 " | 0.02 " |
| Volatile Organic Compounds | ND | ND |
| Polychlorinated Biphenyls | ND | --- |
| Detection limit = 10 ppm | | |

# VOLATILE ORGANIC PRIORITY POLLUTANTS

## COMPOUNDS

benzene
carbon tetrachloride
chlorobenzene
1,1-dichloroethane
1,2-dichloroethane
1,1,1-trichloroethane
1,1,2-trichloroethane
1,1,2,2-tetrachloroethane
chloroethane
2-chloroethylvinyl ether
chloroform
1,1-dichloroethylene
trans-1,2-dichloroethylene
1,2-dichloropropane
1,3-dichloropropene (cis & trans)
ethylbenzene
methylene chloride
methyl chloride
methyl bromide
bromoform
dichlorobromomethane
trichlorofluoromethane
chlorodibromomethane
tetrachloroethylene
toluene
trichloroethylene
vinyl chloride
xylene

APPENDIX C

# AIR STRIPPER PILOT STUDY

FOR

TANK 53

TANK FARM 5

NAVAL EDUCATION AND TRAINING CENTER

NEWPORT, RHODE ISLAND

Prepared by:

Environmental Resource Associates, Inc.

Warwick, Rhode Island

September 9, 1987

# AIR STRIPPING SYSTEM

## Pilot Plant Results and Preliminary Design

## I. INTRODUCTION

During the closure of the tank farm, it is expected that a relatively large quantity of water containing trace amounts of solvents will require treatment before disposal. Two disposal options include discharge into the municipal sewage treatment system or through a permitted discharge at Melville into Narragansett Bay. ERA conducted a pilot study to assess the expected performance of an air stripper to reduce the concentrations of solvents in this water. Using the pilot data, a preliminary design of a full scale system including several options for treatment was made. A summary of the pilot data, conclusions and full scale equipment needed for implementation is discussed below.

## II. DESCRIPTION OF PILOT PLANT TEST

### Equipment

A small scale stripper column was erected at the site of Tank # 53 for testing. The stripper column was constructed of an 8" diameter PVC shell with packing support at the bottom and an orifice distributor at the top (see Figure 1). The column was filled with No. 1/2 Tripack polypropylene packing giving a packed bed height of 91". Liquid sampling ports were located on the side of the column to allow convenient sampling of the incoming feed water and the partially treated water at various points down the column. Sampling ports were available at the following heights above the packing support: 4.5", 53", and 94".

A positive displacement blower was used to inject a measured amount of air into the bottom of the column below the support plate. A portable gasoline powered pump withdrew water from below the oil interphase in Tank No. 53 and pumped to the distributor at the top of the column. The water trickled down the packing, exited the bottom of the column, and returned by gravity to the storage tank. The injected air forced its way up the packing and vented to the atmosphere at the top of the column.

### Operating Conditions

The stripping column was operated at three conditions during the course of the test. These conditions spanned the range of conditions which could be reasonably expected for a full scale air stripper. A summary of the operating conditions according to decreasing air/water ratios is given below:

Summary of Pilot Plant Operating Conditions

| | Run 1 | Run 2 | Run 3 |
|---|---|---|---|
| Air flowrate (scfm) | 54 | 45 | 39 |
| Water flowrate (gpm) | 5.4 | 7.4 | 9.9 |
| Water temperature (C) | 14 | 14 | 14 |
| Gas/liquid ratio (cf/cf) | 74 | 45 | 29 |

The pilot plant was operated at each condition for a period of time sufficient to reach stable operation and equilibrium before samples of the water were drawn for analysis. Each water sample was analyzed according to standard EPA methods for volatile priority pollutants.

## Pilot Plant Results

As expected, the pilot plant demonstrated the relative ease of reducing the concentrations of volatile organics by aeration in a packed tower. A summary of the average composition of the feed water and the overall percent removals attained by 86.5 inches of packing in the column is given below:

Summary of Pilot Plant Results

| Compound ID | Feed Compos. (ug/l) | Percent Removal Run 1 | Run 2 | Run 3 |
|---|---|---|---|---|
| vinyl chloride | 2390 | 77 | 90 | 74 |
| 1,1,1 trichloroethane | 1310 | 81 | 82 | 80 |
| 1,1 dichloroethane | 1300 | 82 | 80 | 74 |
| 1,2 dichloroethane | 70 | -- | -- | -- |
| benzene | 830 | 61 | 56 | 54 |
| xylene | 1130 | 55 | 51 | 45 |
| ethylbenzene | 280 | 53 | 44 | 47 |
| toluene | 1870 | 28 | 27 | 30 |
| trichloroethylene | 14 | -- | -- | -- |
| gas/liquid ratio (cf/cf) | | 74 | 45 | 29 |

Note: average feed compositions, detectability limit 10 ug/l for all volatile priority pollutants, blanks indicate insufficient data

Reviewing the above results, it is readily apparent that most of the volatiles experience higher percent removals as the gas/liquid volume ratio (G/L) increases. This agrees with expected performance for this type of process. Interestingly, toluene was not easily removed and its percent removal was not affected by increasing G/L. This may be due to analytical error, or the existence of free-phase toluene in the feed waste.

The percent removal for any volatile compound increases with increasing height of packing. Since the packing height of the pilot stripper (7.2 ft) is less than that normally used for a full scale stripper (at least 12 ft), greater percent removals can be expected for a full scale system. The expected performance for a full scale stripper can be derived using chemical engineering relations and the pilot plant performance data.

## Preliminary Design - Full Scale

Several scenarios are available for ultimate disposal of the treated water from the tank farm, and are discussed elsewhere in the closure plan. The degree of treatment will vary depending upon the scenario selected for closure, and must be determined at a later date before the design of a full scale treatment system can begin. A preliminary design of a treatment system was made by ERA and is presented below. It consists of several treatment units in series, each improving on the percent removal from the previous unit.

A block flow diagram of a treatment system is given in Figure 2. The treatment system consists of two air stripping towers connected in series followed by activated carbon canisters for polishing. Each stripping tower will be 3' in diameter by 14' high, and operate at approximately 100 gpm. Air will be blown into the bottom of each stripper at a rate of about 1100 scfm and exhausted at the top to the atmosphere. The partially treated water from the first stripper will be captured in a sump and repumped into the second stripper, if desired. The water emitting from the second stripper will be captured in another sump and pumped through several 1000 pound prepackaged carbon canisters before ultimate disposal. The carbon canisters will require replacement and disposal at a frequency dependent upon the amount of contamination to be removed. The depicted treatment system assumes that oil and solids are not present in the water.

The level of performance expected from the stripper units has been estimated based upon the pilot plant data and normal scale-up procedures. The percent removals for the volatile organics are estimated below.

Estimated Performance for Full Scale Treatment System

| Compound ID | Feed Compos. (ug/l) | Effluent Quality (ug/l) Stripper 1 | Stripper 2 | Carbon Column |
|---|---|---|---|---|
| vinyl chloride | 2390 | 360 | 60 | * |
| 1,1,1 trichloroethane | 1310 | 200 | 30 | |
| 1,1 dichloroethane | 1300 | 200 | 30 | |
| 1,2 dichloroethane | 70 | -- | -- | |
| benzene | 830 | 250 | 75 | |
| xylene | 1130 | 400 | 140 | |
| ethylbenzene | 280 | 100 | 40 | |
| toluene | 1870 | 1200 | 800 | |
| trichloroethylene | 14 | -- | -- | |

*Potentially non detectable for most volatiles if replaced frequently enough

The above projected effluent qualities reflect the essentially constant percent removal expected to occur for each stripper for a given compound and operating conditions. The actual effluent quality from each unit will vary directly with the feed composition. Higher feed concentrations will result in higher effluent concentrations.

The performance of the activated carbon column is highly dependent upon the amount of organics entering the column, the size of the column, water flowrate through the column, and the frequency of replacement. Activated carbon is commonly used to remove trace amounts of solvents that remain from previous treatment processes. Its capacity for these solvents is relatively low. The spent activated carbon must be regularly replaced with virgin carbon. The frequency of replacement may be estimated; however, only by experience or a separate study can the frequency be determined with accuracy.

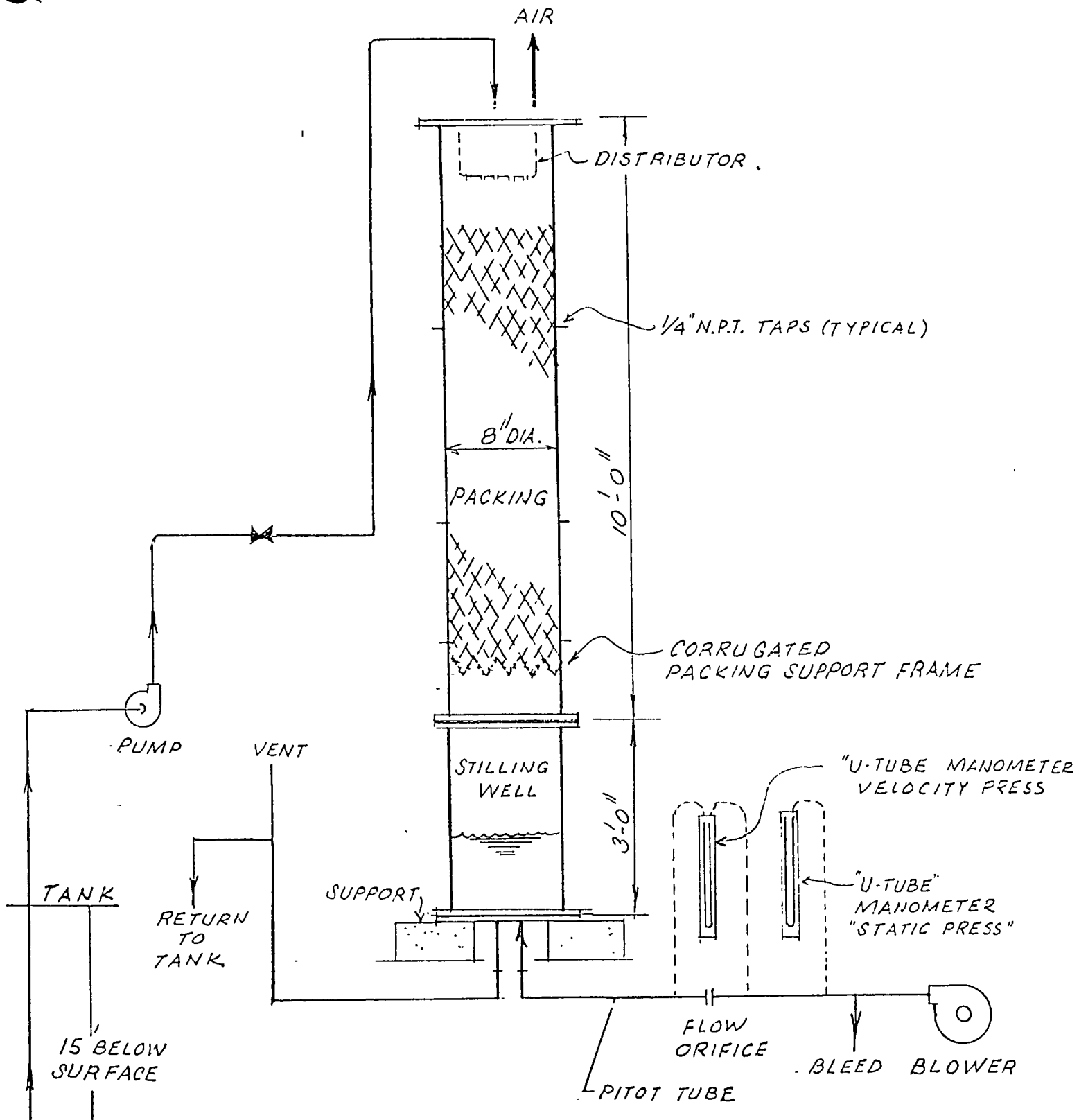



FIGURE-1

TANK 53 AIR STRIPPING PILOT PLANT

N.E.T.C.

Nov. 6, 1985

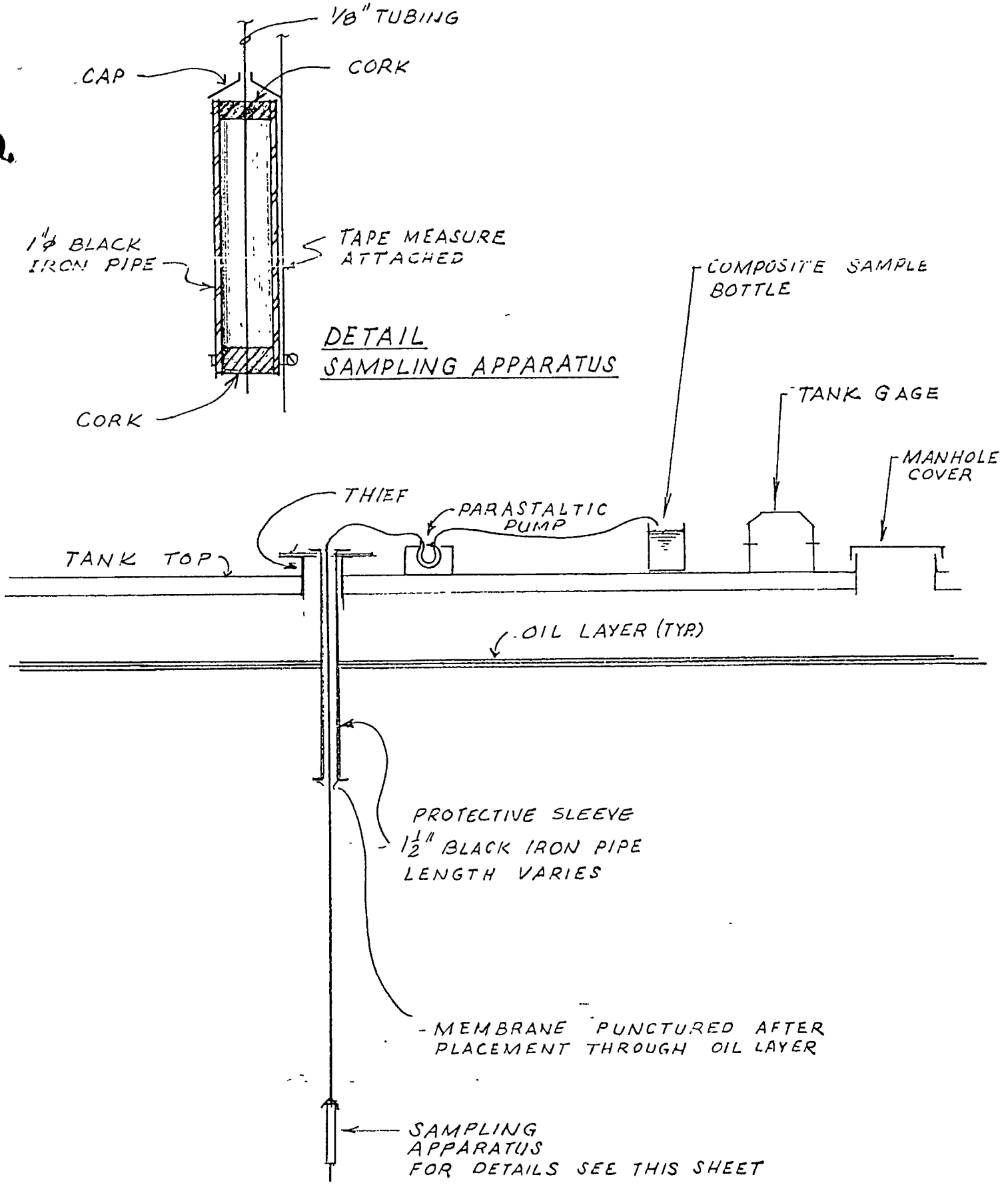



FIGURE-2.

AQUEOUS PHASE SAMPLE COLLECTION APPARATUS

N.E.T.C.

Nov. 6, 1985