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NSTC GREAT LAKES, IL
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CORRECTIVE ACTION PLAN SUPPLEMENT BUILDING 1600A OLD GAS STATION NS GREAT LAKES IL
8/1/2000
TOLTEST, INC

577

Department of the Navy
Naval Training Center
Environmental Department
Great Lakes, Illinois

CORRECTIVE ACTION PLAN SUPPLEMENT
BUILDING 1600A (OLD GAS STATION)
GREAT LAKES, ILLINOIS

ENVIRONMENTAL JOB ORDER CONTRACT
CONTRACT NO. N68950-96-D-0052
DELIVERY ORDER NO. 0099

August 2000

TOLTEST, INC.

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BUILDING 1600A (OLD GAS STATION)
GREAT LAKES, ILLINOIS

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FOR

Department of the Navy
Naval Training Center (NTC) – Environmental Department
Building 1-A, 201 Decatur Avenue
Great Lakes, Illinois 60088-5600

SUBMITTED

AUGUST 2000
TOLTEST PROJECT NO. 37755.02

TOLTEST, INC.
1915 N. 12TH STREET
P.O. BOX 2186
TOLEDO, OHIO 43603
(419) 241-7175
FAX (419) 321-6259

TOLTEST, INC.

CORRECTIVE ACTION PLAN
BUILDING 1600A (OLD GAS STATION)
GREAT LAKES, ILLINOIS

ENVIRONMENTAL JOB ORDER CONTRACT (EJOC)
CONTRACT NO. N68950-96-D-0052
DELIVERY ORDER NO. 0054

FOR

Department of the Navy
Naval Training Center (NTC) – Environmental Department
Building 1-A, 201 Decatur Avenue
Great Lakes, Illinois 60088-5600

SUBMITTED

FEBRUARY 2000
TOLTEST PROJECT NO. 37755.01

TOLTEST, INC.
1915 N. 12TH STREET
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The Agency is authorized to require this information under Section 4 and Title XVI of the Environmental Protection Act (415 ILCS 5/4, 5/57 - 57.17). Failure to disclose this information may result in a civil penalty of not to exceed $50,000.00 for the violation and an additional civil penalty of not to exceed $10,000.00 for each day during which the violation continues (415 ILCS 5/42). Any person who knowingly makes a false material statement or representation in any label, manifest, record, report, permit, or license, or other document filed, maintained or used for the purpose of compliance with Title XVI commits a Class 4 felony. Any second or subsequent offense after conviction hereunder is a Class 3 felony (415 ILCS 5/57.17). This form has been approved by the Forms Management Center.

Underground Storage Tank Owner/Operator:

Please indicate below the type of plan/report that is being submitted to the Agency at this time. This form must be attached to all plans and reports submitted to the Agency pursuant to 35 Ill. Adm. Code 732 and 415 ILCS 5/57-57.17. Please check all that apply.

20 Day Certification	______	
45 Day Report	______	
Free Product Removal Report	______	

	Initial Submittal	Amended Submittal
Site Classification Plan	______	______
Site Classification Plan Budget	______	______
Site Classification Completion Report	______	______
Groundwater Monitoring Plan (Low Priority)	______	______
Groundwater Monitoring Plan Budget (Low Priority)	______	______
Groundwater Monitoring Results (Low Priority)	______	
Professional Engineer Certification (Low Priority)	______	______
Corrective Action Plan (High Priority)	X	______
Corrective Action Plan Budget (High Priority)	______	______
Corrective Action Completion Report (High Priority)	______	______
Professional Engineer Certification (High Priority)	______	______
Corrective Action Completion Report (35 IAC Section 732.300(b), 732.400(b) or (c)	______	______
Professional Engineer Certification (35 IAC Section 732.300(b), 732.400(b) or (c)	______	______

I certify under penalty of law that this document was prepared by me or under my direction or supervision. This information is to the best of my belief and knowledge, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine for knowing violations.

Owner Department of the Navy	**Operator** Same as Owner
Name: Mark Schultz	Name: ______
Title: Director, NTC, GL Env. Dept.	Title: ______
Signature: Mark Schultz	Signature: ______
Date: 2-18-00	Date: ______

Illinois Environmental Protection Agency

Leaking Underground Storage Tank Program

Corrective Action Plan

A. Site Identification

IEMA Incident # (6 digit): 971739 IEPA Generator # (10 digit): 0971255004

Site Name: United States Navy, Great Lakes Training Center

Site Address (Not a P.O. Box) : Building 1600A, Ray Street

City: Great Lakes County: Lake

B. Site Information

1. Will the owner/operator seek reimbursement from the Underground Storage Tank Fund? Yes___No X

2. If yes, is the budget attached? Yes___No X

3. Is this an amended plan? Yes___No X

4. Identify the material released: gasoline and diesel fuel

5. This Corrective Action Plan is being submitted pursuant to:

   a. 35 Ill. Adm. Code 731.166:

      i. A release of petroleum from a UST was reported to IEMA prior to September 13, 1993 and the owner/operator has NOT elected to Proceed under Title XVI of the Environmental Protection Act. ______

      ii. The material released was not petroleum. ______

   b. 35 Ill. Adm. Code 732.404:

      i. A groundwater quality standard or objective for any applicable indicator contaminant has been exceeded at the property boundary line or 200 feet from the leaking UST. X

      ii. The leaking UST system is within the setback zone or regulated Recharge area of a potable water supply well. ______

iii. There is evidence that migration of petroleum or petroleum vapors may threaten human health or human safety. ______

iv. Class III Special Resource Groundwater exists within 200 feet of the site. ______

v. A surface body of water has been adversely affected by the presence of a visible sheen or free product layer. ______

c. 35 Illinois Administrative Code Section 732.312 ______

C. Proposed Methods of Remediation

1. **Soil** - Heritage Environmental Services, Inc. (HES) removed impacted soil from the leak source in 1998. Subsurface soils within the identified plume are impacted due to the migration of dissolved gasoline and diesel constituents. An in-situ biosparge technique has been designated for this site which will remediate soils and groundwater concurrently. In-situ treatment allows soil to be treated without being excavated or transported, which results in significant cost savings. Due to the logistics of this site and the extent of contamination, excavation is not a feasible option for soil remediation.

2. **Groundwater** - The impacted groundwater will be treated in situ utilizing two directionally-drilled horizontal wells to deliver oxygen to the subsurface to enhance naturally-occurring bioactivity. Injecting air into the groundwater at fairly low rates can dramatically increase biological activity associated with the natural degradation of organic compounds. Biosparging through horizontal wells into the saturated zone is an efficient process that is typically more economical than SVE or conventional air sparging.

D. Soil and Groundwater Investigation Results

1. **Description of investigation activities performed to define the extent of soil and/or groundwater contamination**

HES submitted a LUST 45-Day/Site Classification Completion Report and LUST Investigation/Remediation Report to IEPA dated May 8, 1998. The HES report includes UST closure activities, piping removal, impacted soils removal, and soil boring activities. On September 17, 1997, RW Collins removed three USTs in September 1997. Two (2) 10,000-gallon gasoline tanks and one (1) 6,000 gallon diesel tank were removed. HES mobilized to the site on September 25, 1997 to remove the distribution piping and to excavate the petroleum contaminated soils within the immediate area of the former USTs. Approximately 800 cubic yards of impacted soil from the former UST excavation and dispenser pipeline area were transported to the Navy Fire Fighting Training Area for bioremediation.

Following the over-excavation efforts, a total of 35 Geoprobe® soil borings were advanced at the site to collect soil samples. In addition, four piezometers were installed for the collection of groundwater samples. The soil and groundwater plumes were defined using analytical results from a mobile field laboratory and a conventional analytical laboratory. A correlation between the results was not performed, as soil samples from the same horizon were not typically analyzed by both techniques, and the field lab did not test for polynuclear aromatics (PNAs). The site was designated as high priority because the plumes extend to adjacent properties and the soil is impacted at approximately 250 feet from the source. HES determined that the soil plume is larger than the groundwater plume; this was confirmed by subsequent sampling activities performed by TolTest. Appendix A contains figures from the HES report.[i]

Benzene is the indicator contaminant. It was detected offsite in soil borings within the Elgin Joliet and Eastern (EJ&E) Railway property, directly to the east of the subject property, and further to the east at (Navy-owned) Spaulding Street industrial facilities. With the exception of benzene, the soil and groundwater laboratory analytical results from the HES investigation indicate petroleum constituents are below the IEPA Tier 1 Site Remediation Objectives for the ingestion, inhalation and migration to groundwater routes of exposure for Residential property use.

The mobile field gas chromatograph (GC) analysis conducted by HES on soil samples did indicate exceedences of Tier 1 levels for ingestion/migration to Class I Groundwater remediation objectives as follows: at IPS 7 (for toluene, ethylbenzene & xylenes), IPS 8 (toluene) IPS 14 (ethylbenzene) and nine other locations (for benzene only). The plume as defined by HES was further investigated prior to the development of this CAP.

TolTest developed a Work Plan to confirm plume dimensions and to obtain hydrogeological information to develop a design for this CAP. The Work Plan, dated June 1999 was discussed with the IEPA with the objectives of the investigation clearly defined. TolTest mobilized to the site in October 1999. Drilling activities consisted of installing 11 soil borings and six monitoring wells at locations around the perimeter and within the identified subsurface plume. A Geoprobe® rig was used to install four small-diameter soil borings (one-inch diameter) approximately 15 to 20 feet west of the railroad tracks in the vicinity of HES soil boring B17. Direct push samplers with sample liners were used to collect samples for visual inspections and soil classification, with attention to the possible occurrence of free product. Total depth of the Geoprobe® soil borings is estimated to be approximately 12 to 15 feet. A temporary one-inch diameter PVC screen was placed in the Geoprobe® borings and visually inspected for any accumulation of free product with a small diameter Teflon bailer. Upon completion of sampling and inspections, the small diameter soil borings were backfilled with bentonite. Since no free product was encountered, no recovery well was installed.

A truck-mounted drill rig was utilized to advance the six large diameter soil borings. Figure 1 (Appendix H) depicts the locations of the soil borings/monitoring wells. The borings were advanced at least five feet into the apparent water table. Total depth is estimated to be approximately 12 to 15 feet. Soil samples were obtained continuously in soil borings utilizing 4¼" inside diameter (ID) hollow-stem auger methods. Standard penetration tests

(ASTM D1586) were performed utilizing 2" outside diameter split spoon sampler driven by a 140-pound drop hammer. The soils were classified on boring logs indicating lithologic descriptions and Unified Soil Classified System descriptions, degree of sorting, sedimentary contacts, PID readings, etc. All soil cuttings were placed in 55-gallon drums for disposal.

Monitoring wells were constructed of 2-inch ID, schedule 40 flush joint PVC risers and screens. Ten feet of 0.010 slot screen and a sufficient length of riser were placed in each boring. The screened interval was installed as to intersect the apparent water table and to allow for potential seasonal fluctuations. Each well screen was surrounded by a quartz sand filter pack with a bentonite seal, the remainder of the annulus was back-filled with a cement/bentonite slurry. Well covers were flush-mounted and cemented in place over the well casing.

To help assess the apparent groundwater gradient, exact water level measurements were made. Each monitoring well was surveyed by a registered land surveyor to a United States Geological Survey (USGS) common site datum to a reference mark on the top of casing to the nearest 0.01 foot to determine relative elevations of the groundwater. After the wells were developed and allowed to reach static equilibrium, water levels were taken with an electric water level indicator to an accuracy of 0.01 feet. From these measurements, groundwater contour map (see Figure 4, Appendix H) was constructed and the groundwater gradient and flow direction was assessed. The direction of groundwater flow as documented by TolTest, to the east, with a gradient of approximately 0.01, is generally consistent with the gradient described in the HES report of 1998. Table 1 summarizes groundwater measurements. Appendix B contains the survey data.

Table 1
Groundwater Measurements
Building 1600A, GLNTC, Illinois
(measurements obtained 12/16/99)

Well No.	TOC Elevation (NGVD 1929)	Depth to Water (ft)	Static Water Elevation (NGVD 1929)
MW-1	663.22	4.61	658.61
MW-2	663.33	6.08	657.25
MW-3	662.80	6.11	656.69
MW-4	660.73	5.38	655.35
MW-5	659.51	4.91	654.60
MW-6	658.73	4.14	654.59

Slug tests were conducted on the six monitoring wells to calculate the hydraulic conductivity of the uppermost water-bearing zone. This test entailed rapidly displacing a volume of water with a PVC bailer and measuring the rate of recharge towards static levels. Changes in water levels were measured by a pressure transducer and recorded by a programmable hydraulic monitor. The method developed by Bouwer and Rice (1976) was used for calculating the hydraulic conductivity. Table 2 is a summary of the hydraulic conductivities from the slug test results. Appendix C contains plots and data of the slug tests using the computer program *Aquifer Test for Windows, version 2.55*, developed by Waterloo Hydrogeologic, Inc.

Table 2
Hydraulic Conductivity
Building 1600A, GLNTC, Illinois

Location	Hydraulic Conductivity	
	(cm/sec)	(ft/min)
MW-1	7.62×10^{-4}	1.50×10^{-3}
MW-2	4.21×10^{-4}	8.26×10^{-4}
MW-3	3.08×10^{-3}	6.06×10^{-3}
MW-4	5.39×10^{-3}	1.06×10^{-2}
MW-5	3.37×10^{-4}	6.63×10^{-4}
MW-6	4.80×10^{-4}	9.45×10^{-4}
Average	1.75×10^{-3}	3.43×10^{-3}

Based on the slug tests, the site's groundwater classification is a Class I per 35 IAC 620 since the hydraulic conductivity is greater than 1.00×10^{-4}. The average hydraulic conductivity measurements indicate the site is conducive to remediation by biosparge technology.

2. Analytical results and cleanup objectives in tabular format

Contaminants of concern, based on gasoline and diesel sources, are benzene, toluene, ethylbenzene, and xylenes (BTEX), methyl tertiary butyl ether (MTBE), PNAs, total lead and synthetic precipitate leaching procedure (SPLP) lead. IEPA has recently become concerned about MTBE contamination in groundwater at sites with gasoline releases because of recent case histories. Cleanup objectives for MTBE have not been set by USEPA or IEPA as the health risks have not been quantified. The USEPA has an advisory objective goal of 20 to 40 mg/L, but it is not enforceable at this time, as carcinogenic studies have not been performed.

The cleanup objectives for groundwater will be per 35 IAC part 742, Appendix B, Table E: Tier 1 Groundwater Remediation Objectives for the Groundwater Component of the Groundwater Ingestion Route for Class I Groundwater. The cleanup objectives for soil will be 35 IAC Part 742, Appendix B: Table A: Tier 1 Soil Remediation Objectives for Residential Properties, Soil Component of the Groundwater Ingestion Exposure Route Values for Class I Groundwater. It will be preferable to the Navy if Tier I residential objectives can be met through remediation of this site as no land use controls would be required. If the Tier I residential standards cannot be met, Industrial-Commercial standards would be acceptable to the Navy because these standards are consistent with the current land use. Any required land use controls would be established in cooperation between the Navy, IEPA, and the off site land owner.

The following Table 3 summarizes groundwater analytical results and Table 4 summarizes soil analytical results from TolTest's investigation. Appendix D contains summaries of the 1997 analytical results from the HES report. The TolTest results indicate the plumes have not changed in size. The fact that the soil plume is bigger than the groundwater plume is attributed to active microbial populations in the silty sands between the clay layers both above and below the groundwater plume.

Table 3
Groundwater Analyses
Building 1600A, GLNTC, Illinois

Target Analyte	"Groundwater Remediation Objective"	Analytical Results from Groundwater Samples					
	Class I (mg/L)	MW-1 (mg/L)	MW-2 (mg/L)	MW-3 (mg/L)	MW-4 (mg/L)	MW-5 (mg/L)	MW-6 (mg/L)
Benzene	0.005	<0.001	0.453	<0.001	0.691	0.0248	<0.001
Toluene	1.0	<0.001	0.407	<0.001	0.761	0.00779	<0.001
Ethylbenzene	0.7	<0.001	1.320	<0.001	0.243	<0.001	<0.001
Xylenes	10.0	<0.003	1.100	<0.003	1.680	0.00575	<0.003
MTBE	*	<0.001	<0.002	<0.001	<0.001	0.0192	<0.001
Acenaphthene	0.42	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Anthracene	2.1	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo(a)anthracene	0.00013	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo(b)fluoranthene	0.00018	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo(k)fluoranthene	0.00017	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo(a)pyrene	0.0002	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chrysene	0.0015	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Dibenzo(a,h)anthracene	0.0003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Fluoranthene	0.28	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Fluorene	0.28	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Indeno(1,2,3-c-d)pyrene	0.00043	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Naphthalene	0.025	<0.005	0.0562	<0.005	<0.005	<0.005	<0.005
Pyrene	0.21	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Lead	0.0075	0.020	<0.001	0.002	NA	NA	NA

Notes:
1. Shaded areas presents analyses greater than cleanup objectives as per 35 IAC Part 742, Appendix B: Table E: Tier 1 Groundwater Remediation Objectives for the Groundwater Component of the Groundwater Ingestion Route for Class I Groundwater.
2. Groundwater samples collected on October 28, 1999 (MW-1 thru MW-5) and December 16, 1999 (MW-6).
3. Samples were analyzed as follows: BTEX/MTBE (Method 5035/8021), PNAs (Method 8270), lead (Method 7421)

Table 4
Soil Analyses
Building 1600A, GLNTC, Illinois

Target Analyte	"Soil Component of the Ground water Ingestion Exposure Route Values" Class I	"Exposure Route Specific Values For Soil" Residential		Analytical Results from Soil Borings					
		Ingestion	Inhalation	**MW1-03 (4-6")**	**MW2-03 (4-6')**	**MW3-04 (6-8')**	**MW4-05 (8-10')**	**MW5-05 (8-10')**	**MW6-06 (10-12')**
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Benzene	0.03	22	0.8	<0.005	0.116	<0.005	0.023	0.039	<0.005
Toluene	12	16,000	650	<0.005	<0.005	<0.005	0.044	<0.005	0.031
Ethylbenzene	13	7,800	400	<0.005	<0.005	<0.005	0.031	<0.005	<0.005
Xylenes	150	160,000	410	<0.015	<0.015	<0.015	0.969	<0.015	<0.015
MTBE	*	*	*	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Acenaphthene	570	4,700	*	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300
Anthracene	12,000	23,000	*	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Benzo(a)anthracene	2	0.9	*	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150
Benzo(b)fluoranthene	5	0.9	*	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150
Benzo(k)fluoranthene	49	9	*	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300
Benzo(a)pyrene	8	0.9	*	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150
Chrysene	160	88	*	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Dibenzo(a,h)anthracene	2	0.9	*	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Fluoranthene	4,300	3,100	*	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300
Fluorene	560	3,100	*	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Indeno(1,2,3-c-d)pyrene	14	0.9	*	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Naphthalene	84	3,100	*	<0.300	6.990	<0.300	<0.300	<0.300	<0.300
Pyrene	4,200	2,300	*	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300
Lead (soil in mg/kg)	*	400	*	6.60	7.38	15.20	NA	NA	NA
Lead (SPLP in mg/l)	0.0075	*	*	0.020	0.038	0.027	NA	NA	NA

Notes:
1. Indicates no toxicity criteria available on 35 IAC Part 742, Appendix B: Table A: Tier 1 Soil Remediation Objectives for Residential Properties
2. Shaded areas present analyses greater than cleanup objectives.
3. NA – Location not analyzed for constituent.
4. Soil samples collected on October 19-20, 1999 (MW-1 thru MW-5) and December 7, 1999 (MW-6).
5. Samples were analyzed as follows: BTEX/MTBE (Method 5035/8021), PNAs (Method 8270), SPLP lead (Method 1312/7421)

3. **Laboratory reports.** Copies of the laboratory test reports are included in Appendix E.

4. **Boring logs.** Copies of the boring logs are included in Appendix F.

5. **Monitoring well logs.** Copies of the monitoring well logs are included in Appendix G.

6. **Site maps.** Figures of the following are presented in Appendix H:

   Figure 1 – Site Map
   Figure 2 – Estimated Extent of Groundwater Contamination
   Figure 3 – Estimated Extent of Soil Contamination
   Figure 4 – Groundwater Contour Map
   Figure 5 – Site Cross Sections
   Figure 6 – Proposed Well Locations
   Figure 7 – Proposed Horizontal Well (cross section)

E. Technical Information – Corrective Action Plan

1. A discussion of how the corrective action plan shall remediate each of the criteria which caused the site to be classified as High Priority

The site was classified as high priority in the HES report because contamination was detected off-site, beneath the EJ&E Railway property. In addition, the soil plume extends in excess of 200 feet from the source. Corrective actions will mitigate the migration and reduce concentration of the plume to less than action levels.

2. Engineering design specifications, diagrams, calculations, manufacturer's specifications, system analyses, site maps, etc.

Two parallel horizontal wells are proposed for the biosparge conceptual design to remediate this site to Tier 1 cleanup objectives. IEPA representatives met with TolTest and US Navy representatives on January 11, 2000 to discuss the feasibility of horizontal wells, and the necessity for extensive computer simulation prior to finalizing the screen size(s), screen length, compressed air injection rates, radii of influence and other engineering variables. Therefore, engineering design specifications, diagrams, calculations, manufacturer's specifications, system analyses, and site maps will be submitted after the IEPA and Navy approve the conceptual design as provided in this CAP.

Soils excavation is not feasible due to the extent of the plume, overhead and below ground utilities, and active rail freight line. Air sparging (AS) with soil vapor extraction (SVE) was considered early in the evaluation of in situ cleanup methods for the site but were rejected because of limitations on where vertical wells could be installed due to the presence of utilities and the rail lines on the site. Based on case histories of specifically designed horizontal well biosparge projects, SVE is not necessary or conducive to expediting clean up of this site.

Discussions on possible conventional and alternative technologies follow below. Most information pertaining to alternative technologies was obtained from the Technology Innovation Office of the U.S. Environmental Protection Agency web site at URL address http://clu-in.org/remed1.htm. This web site is an interactive document: *Federal Remediation, Technologies Roundtable, Remediation Technologies Screening Matrix and Reference Guide, Version 3.0.*

Conventional pumping - Groundwater pumping systems, consisting of appropriate recovery wells for groundwater extraction, remove contaminants that are dissolved in the water for treatment at the surface. One or more recovery wells are installed in a contaminated plume of groundwater. Water is pumped to the surface where it is treated by standard water treatment operations. The recovery well network is generally designed to capture water from the center (high concentration area) of the plume for rapid mass removal and from the leading edge of the plume to minimize plume spread. The design can be based on standard groundwater models. Simplicity of concept and flexibility in meeting various cleanup objectives (many different contaminant types, balanced optimization based on mass reduction and plume spread, etc.) are significant strengths of groundwater pump and treat, and this technology will continue to be an important tool in cleanup activities.

This technology is relatively mature with many years of operating experience and post operational evaluations complete. The treated water must be disposed to an outfall or to reinjection wells. This requires additional energy and expense. Long-term costs (labor, energy/consumables, and monitoring) are a substantial portion of this conventional technology.

Advantages

- This technology is simple to design and operate, uses standard equipment available from many sources, and treats all types of dissolved contamination.
- It allows flexibility in meeting various cleanup goals (e.g., mass reduction versus plume spread).
- It can be implemented quickly.

Disadvantages

- Treats "clean water" from the aquifer that is drawn into the cone of depression.
- Generation of substantial amounts of secondary waste water.
- High energy costs for pumping and moving large volumes of water.
- Indiscriminate removal of all ground water components.
- Slow progress toward terminal regulatory goals due to technical limitations typically lasting several years.

<u>Natural Attenuation</u> – Since target contaminants for natural attenuation are nonhalogenated VOCs, SVOCs, and fuel hydrocarbons, this site is a candidate for natural attenuation. For natural attenuation, natural subsurface processes -- such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials -- are allowed to reduce contaminant concentrations to acceptable levels. Natural attenuation is not a technology per se.

Consideration of this option requires modeling and evaluation of contaminant degradation rates and pathways. The primary objective of site modeling is to demonstrate that natural processes of contaminant degradation will reduce contaminant concentrations below regulatory standards before potential exposure pathways are completed. In addition, sampling and sample analysis must be conducted throughout the process to confirm that degradation is proceeding at rates consistent with meeting cleanup objectives. Where contaminants are expected to remain in place over long periods of time, waivers and institutional controls must be obtained.

Advantages

- Lower costs than most active remedial alternatives.
- Minimal disturbance to the site operations.

Disadvantages

- Some migration of constituents may occur; not suitable if receptors might be affected.
- Long period of time required to remediate heavier petroleum products.
- Longer period of time may be required to mitigate contamination than for active remedial measures.
- May not always achieve the desired cleanup levels within a reasonable length of time.

<u>Biosparging</u> - **The Proposed Technology for Building 1600A.** Injecting air into the groundwater at fairly low rates can dramatically increase biological activity associated with the natural degradation of organic compounds. This procedure, called biosparging in the saturated zone, is an efficient process that is typically more economical than SVE or conventional AS. Since flow rates are low, blowers and associated operating costs are less, and there is no need to treat collected contaminant-laden soil gas. In large plume areas, or in locations under buildings or pavements, horizontal wells are very cost effective and efficient for injecting air and controlling vapor migration.

Two basic criteria must be satisfied for successful biosparging. First, air must be able to pass through the soil in sufficient quantities to maintain aerobic conditions; second, natural hydrocarbon-degrading microorganisms must be present in concentrations large enough to obtain reasonable biodegradation rates. Results of the heterotrophic plate count, used to determine how many microorganisms are in a given sample, indicated the percentage of organisms exhibiting the ability to degrade BTEX and MTBE exceeds the minimum requirements for bioremediation. Once active biosparging is initiated, the number of microorganisms will increase many-fold.

Computer modeling, utilizing proprietary software SPARGE© by Integrity Engineering, Inc. is used to specify design parameters such as the number and density of the wells, sparging rate, well slot size and spacing, well diameter, equipment, and required operating conditions.

Construction of the entry and exit pits for the proposed two horizontal wells will begin immediately upon mobilization. Each pit location will be prepared by excavating approximately a four-foot by four-foot area to approximately one foot in depth. The pits will be subsequently finished with a concrete pad and manhole for access to the well on one end and finished with a concrete pad, blower, heat exchanger, control, and small shed to house the blower equipment on the opposite end.

Figure 6, Proposed Well Locations, and Figure 7, Proposed Horizontal Well (cross section) depicts where the wells will be installed. Horizontal wells are installed by pushing a drill string with the hydraulics of a horizontal drill rig. Electronics behind the head of the drill bit transmit its location to the surface, where a receiver picks up the signal. A plate on the drill bit is used to guide the path of the drill string to the desired depth (bottom of the sand layer). Once the drill string is guided down to the desired depth, horizontally under the plume, and back up to the surface at the exit pit, a reamer is attached to the drill string after the drill head is removed. Engineered well screen and casing (four-inch diameter HDPE piping) is attached to the reamer and the drill string is pulled back to the entry point. Once placed, the well is developed to remove fines. Development water will be containerized, sampled, and properly disposed. Appendix I contains a conceptual process design of a biosparge system.

Advantages

- Readily available equipment; easy installation.
- Implemented with minimal disturbance to site operations.
- Short treatment times, 6 months to 2 years under optimal conditions.
- Is cost competitive.
- Enhances the effectiveness of air sparging for treating a wider range of petroleum hydrocarbons.
- In large plume areas, or in locations under railroad tracks and/or pavements, horizontal vapor extraction wells are very cost effective and efficient for controlling vapor migration.
- Requires no removal, treatment, storage, or discharge of groundwater.
- Low air injection rates minimize potential need for vapor capture and treatment.
- This technology does not require expensive equipment and can be left unattended for long periods of time.
- Typically, only periodic maintenance monitoring is conducted.

Disadvantages

- Can only be used in environments where biosparging is suitable (*e.g.*, no nearby subsurface confined spaces).
- Some interactions among complex chemical, physical, and biological processes are not well understood.
- Monitoring of off-gases at the soil surface may be required.

3. A list of sampling parameters and corresponding cleanup objectives

Contaminants of concern include BTEX, MTBE, PNAs, lead and SPLP lead per 35 IAC Section 732.310 (b) and (c) since historically, the USTs contained leaded gasoline and diesel fuel. MTBE recently became a concern with the IEPA regarding groundwater contamination and will soon be added to the list of LUST regulations. Corresponding cleanup objectives are listed in Tables 3 and 4 for groundwater and soils respectively.

4. The basis for determining sampling parameters and cleanup objectives

The basis for determining sampling parameters and cleanup objectives is 35 IAC Part 740 and 35 IAC Part 620 since the site's groundwater classification is Class I.

5. Media sampling plan to verify completion of remediation

Groundwater will be sampled from monitoring wells to ascertain when cleanup objectives have been met. Samples will be collected quarterly or until cleanup objectives are met. Closure sampling will be conducted after the monitoring wells in the plume exhibit concentrations below detection levels for BTEX for two consecutive quarters. Closure sampling will consist of existing wells and from soil from three new Geoprobe® holes in the plume for the contaminants of concern.

6. A discussion of the proposed system(s) effectiveness in remediating the contaminated soil and/or groundwater

Biosparging technology stimulates the natural in situ biodegradation of petroleum hydrocarbons in soil by providing oxygen to existing soil microorganisms using low air flow rates to provide only enough oxygen to sustain microbial activity. Oxygen is commonly supplied through direct air injection into residual contamination. In addition to degradation of adsorbed fuel residuals, volatile compounds are biodegraded as vapors move slowly through biologically active soil. Biosparging differs from air sparging which achieves physical removal of contaminants by operating at a higher volumetric flow rate.

The use of horizontal wells is more efficient and effective than vertical wells. To ensure the effectiveness of the conceptual design, and prior to the development of specifications, modeling will be performed to determine the number of horizontal wells, sparge flow rates and blower size, and minimum time to clear the well of groundwater and achieve steady-state sparge injection conditions.

7. A description and results of bench/pilot studies

Soil samples from five borings (MW-1, MW-2, MW-3, MW-4, and MW-5) were submitted to BioRemedial Technologies, Inc., Hermitage, Pennsylvania. Aliquots of the samples were used in tests designed to determine the feasibility of utilizing a biologically based technology for remediation. The laboratory report is included as Appendix J. Results of the heterotrophic plate count indicated the following:

- The percentage of organisms exhibiting the ability to degrade BTEX and MTBE exceeds the minimum requirements for bioremediation.
- Some of the microorganisms prefer the contaminant as a food source.
- Microbial degradation of the contaminants of interest is a viable option for remediation at the site.

A soil sample from MW-6 was not submitted since this soil boring was installed at a later date. It was determined after review of the microbial results that a sample from this location would not add to the general microbial assessment of the site.

8. Itemized cost estimates of alternative versus conventional technologies.

Itemized costs are not provided with this submittal because the Navy is not seeking state reimbursement from the Underground Storage Tank Fund. It is appropriate, however, to emphasize that the proposed innovative technology has been estimated to be 80% more cost effective than pump and treat technology with vertical wells, and 50% more cost effective than air sparge technology. These cost estimates were provided by a design professional, (Louis D. Fournier, Ph.D.) with horizontal well experience on 200 petroleum contamination sites over the past 10 years (where the lithology was conducive to horizontal well application).

9. For alternative technologies the following must be provided:

a. A demonstration that the proposed technology has a substantial likelihood of achieving compliance with all applicable regulations and all corrective action remediation objectives necessary to comply with the Environmental Protection Act and the regulations and to protect human health and the environment. Due to the complexity of the plume, (multiple property owners, active freight rail line, and overhead and below ground utilities) institutional controls are not desirable for this site. The Navy prefers to meet Tier I residential objectives. If the Tier I residential objectives cannot be met, Industrial-Commercial standards would be acceptable to the Navy because these standards are consistent with the current land use. The proposed biosparging alternative technology has been proven with over 200 case histories. It is cost effective as documented in the presentation to the IEPA and Navy on January 11, 2000 by Louis Fournier, Ph.D. Dr. Fournier is a member of the National Ground Water Association's Horizontal Well Technical Committee and the Editor of Horizontal Well News.

b. A demonstration that the proposed technology will not adversely affect human health or the environment. Biosparging introduces low air flow rates, typically 0.5 scfm per foot of well screen through a horizontal well. At such low flow rates, vapors have been shown not to be a problem at the surface, and the plume does not spread due to the injection of air into the subsurface. Monitoring points are already established to demonstrate that the plume remains contained during the biosparge treatment, which is expected to completely reduce contaminants of concern to concentrations below the Tier 1 levels within one to three years. Existing monitoring wells MW-1, MW-2, MW-3, MW-4, MW-5, and MW-6 will be used to measure system effectiveness. Two additional wells, approximately 50 feet north and south of MW-4, respectively, will be installed to more accurately measure system performance.

Additional evidence that the proposed technology will not adversely affect human health or the environment includes that the site is located in an urban environment surrounded by industrial property. Also, the site consists of an active freight rail line. There are no nearby residential structures, schools, or ecologically sensitive areas.

c. Copies of all Agency permits necessary to authorize the use of the alternative technology. No IEPA permits are necessary.

d. Results of the monitoring program implemented to determine whether the proposed technology will achieve compliance with the applicable regulations and remediation objectives. Results will be provided with periodic monitoring reports and in the Corrective Action Completion Report as per 35 IAC Part 732.

F. Signatures

I certify under penalty of law that this plan, supporting documents and all attachments were prepared under my direction or supervision. To the best of my knowledge and belief, this plan, supporting documents and all attachments are true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Owner

Name: Department of the Navy
Mark Shultz, by order of the Commanding Officer
Title: Director, NTC GL Env. Dept.
Address: Bldg 1-A, 201 Decatur Avenue
Great Lakes, IL 60088
Phone: (847) 688-5999 x 40
Signature: Mark Schultz
Date: 2-18-06

Operator

Name: Same as the Owner
Title:
Address:
Phone:
Signature:
Date:

Consultant

Firm: TolTest, Inc.
Contact: Robert R. Beckwith, CPG
Title: Principal Hydrogeologist
Address: 1915 N. 12th Street
Toledo, Ohio 43606
Phone: (419) 241-7175
Signature: Robert R Beckwith
Date: 2/16/00

APPENDIX A

STAR Environmental, Inc.
Layout and Design of a Two-Well Horizontal Well Remediation System

STAR Environmental, Inc.

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Layout and Design of a Two-Well Horizontal Well Remediation System for the Naval Training Center, Great Lakes, Illinois

(Delivery Order 0099)

Prepared For:

United States Navy

Great Lakes Naval Training Center
Great Lakes, Illinois

&

TolTest, Inc.

1915 North 12th Street
Toledo, OH 43624

Prepared By:

Louis B. Fournier, Ph.D.
Principal Scientist/President

June 19, 2000

"Strategies & Technologies for Assessment & Remediation"

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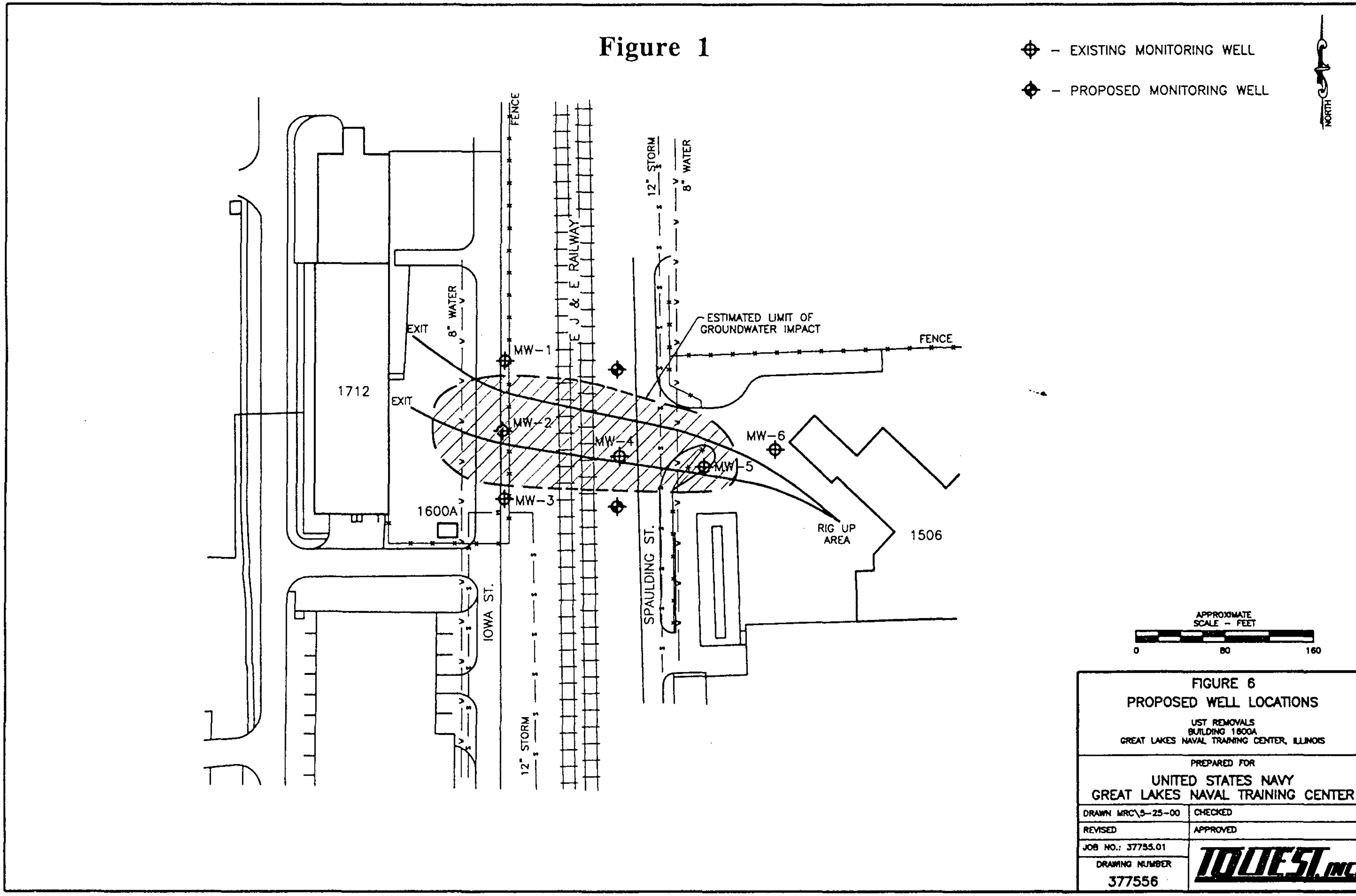
INTRODUCTION

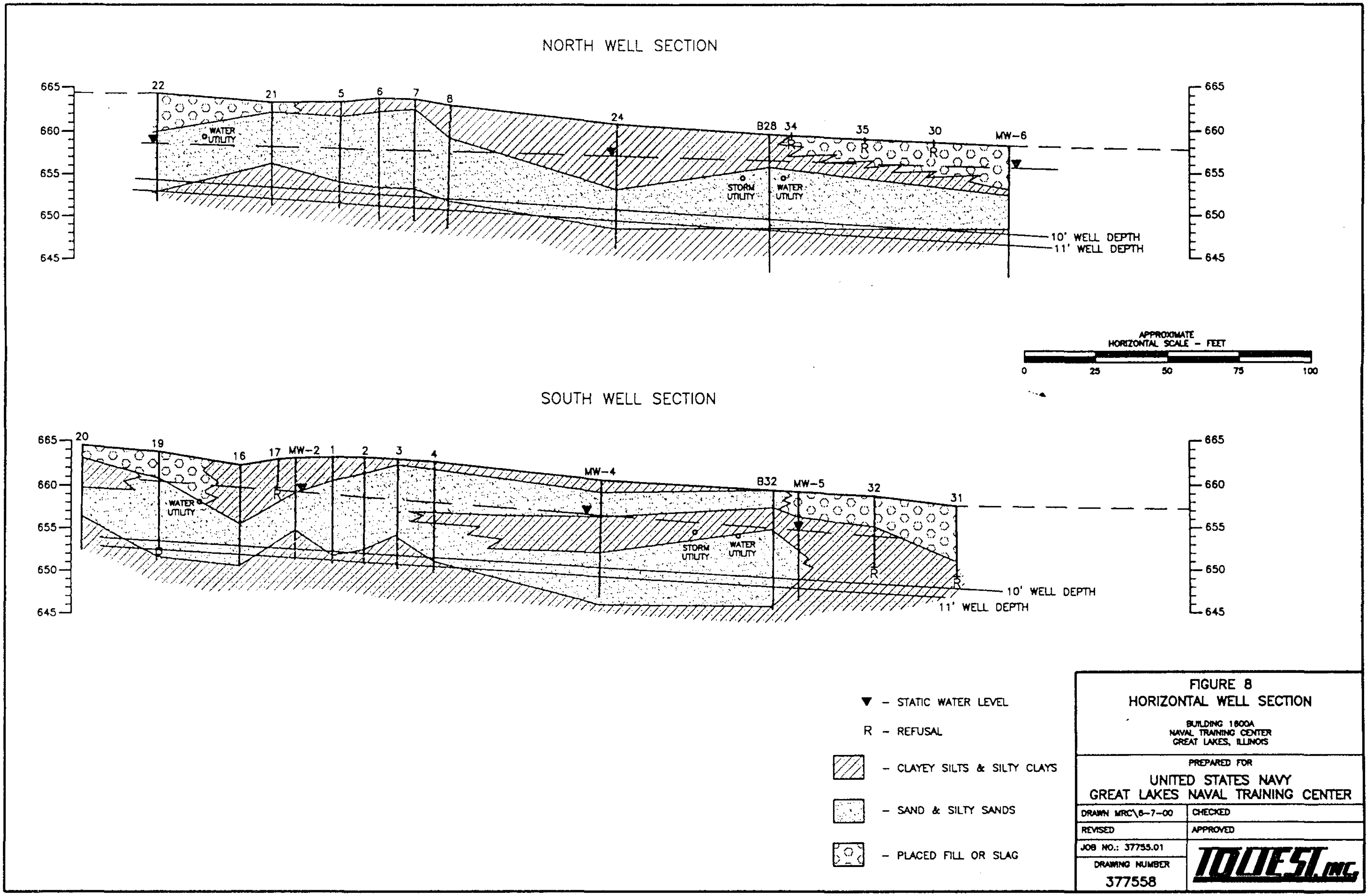
TolTest, Inc. ("TolTest" herein) and STAR Environmental, Inc. ("STAR" herein) are working together to design and install two identical directionally-drilled biosparge wells to remediate petroleum hydrocarbon contamination at a site at the United States Navy Great Lakes Naval Training Center (Great Lakes, Illinois). The plume runs between Buildings 1506 and 1712 as shown in Figure 1 and is generally contained within a sandy zone between a lower confining clay layer and an upper clayey fill layer as shown in Figure 2. Two identically-designed biosparge wells will be installed at 10 feet below grade as illustrated in these figures. The exact length of these wells has yet to be determined, but will be approximately 430' long with 230' of screen, 100' of header (i.e., the distance from the equipment compound to the screen) and 100' of tail (i.e., the distance from the screen to the distal end of the well.) Drilling of these wells has been contracted to Longbore, Inc. of Houston, Texas, a firm which specializes in the installation of directionally-drilled horizontal wells. TolTest will provide over-all project management, civil engineering support, electrical engineering and installation for power drops to blower compounds, and on-going project operation and maintenance support (O&M). STAR will provide the design of the horizontal wells, custom-slotted well materials, conceptual design of blower equipment, oversight of well installation, assistance with system start-up, and on-going project consulting. The purpose of the present report is to provide required well designs.

Figure 1



– EXISTING MONITORING WELL
– PROPOSED MONITORING WELL
NORTH
FENCE
1712
EXIT
EXIT
8" WATER
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
1600A
E J & E RAILWAY
12" STORM
8" WATER
ESTIMATED LIMIT OF GROUNDWATER IMPACT
FENCE
RIG UP AREA
1506
SPAULDING ST.
IOWA ST.
12" STORM
APPROXIMATE SCALE – FEET
0
80
160
FIGURE 6
PROPOSED WELL LOCATIONS
UST REMOVALS
BUILDING 1600A
GREAT LAKES NAVAL TRAINING CENTER, ILLINOIS
PREPARED FOR
UNITED STATES NAVY
GREAT LAKES NAVAL TRAINING CENTER
DRAWN MRC\5-25-00
CHECKED
REVISED
APPROVED
JOB NO.: 37755.01
DRAWING NUMBER
377556

Figure 2


NORTH WELL SECTION
SOUTH WELL SECTION
WATER UTILITY
STORM UTILITY
10' WELL DEPTH
11' WELL DEPTH
APPROXIMATE HORIZONTAL SCALE - FEET
0 25 50 75 100
▼ - STATIC WATER LEVEL
R - REFUSAL
- CLAYEY SILTS & SILTY CLAYS
- SAND & SILTY SANDS
- PLACED FILL OR SLAG
FIGURE 8
HORIZONTAL WELL SECTION
BUILDING 1600A
NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS
PREPARED FOR
UNITED STATES NAVY
GREAT LAKES NAVAL TRAINING CENTER
DRAWN MRC\6-7-00
CHECKED
REVISED
APPROVED
JOB NO.: 37755.01
DRAWING NUMBER
377558

DISCUSSION

The principals at STAR were the first persons to install and utilize directionally-drilled horizontal wells for subsurface remediation and have conceptualized, designed, installed, and/or operated over 200 horizontal well systems since 1989. In addition, the company has developed over a dozen highly specialized, fluid-mechanics-based computer programs for the design of air sparge, biosparge, groundwater withdrawal, steam injection, water injection, and related purposes. These computer programs are reiterative, based on the laws of conservation of mass and energy, and have been field-proven in dozens of projects. These programs provide highly-accurate information on the slot size and spacing, well diameter, operational requirements, and other parameters required to achieve desired performance with any horizontal (or vertical) well in any formation, with any contaminant distribution, and regardless of stratigraphy.

In addition, STAR provides a variety of services related to horizontal wells and horizontal well remediation including:

- Preparation of well and motive equipment specifications and designs.
- Turn-key well installation, drilling oversight, and performance verification.
- Custom-slotted well materials (STAR-Well®) to meet computer-determined requirements.
- Cetco biodegradable and specialty drilling fluids.
- Drilling rigs and crews.
- Equipment fabrication and installation.
- Well maintenance.
- Post-installation consulting.

For the present effort, STAR was asked to assist in the conceptual design, engineering design, associated modeling, and preparation of design specifications for contracting for two horizontal biosparge remediation wells by performing the following:

- Review of existing supplied project documents as required to develop conceptual design parameters for sparge wells.

- Provide conceptual design and modify based on discussion with TolTest project management.
- Perform required modeling using Sparger® software, modifying conceptual design of the wells based on modeling results (both location and well design specifications).
- Assist in the review and edit of technical specifications for drilling contractor bid documents.
- Provide technical support during well installation.
- Assist with development and oversight of startup and pilot testing procedures.

To determine the correct well orientation at the site, TolTest performed a GeoProbe® study of the two proposed drill paths. The results of that study are illustrated in Figure 2. An evaluation of this information concluded that the wells could be installed at either 10' or 11' below grade. Of these two, the 10' depth appeared to offer the greatest interaction with the sandy saturated zone.

With wells 10' below grade, it is expected from historic records and site survey(s) that there will be nominally 8' of groundwater on top of the screened intervals. However, there may be times that the more water is present, representing a greater hydraustatic head, and times that the zone may be virtually dry. It was concluded that the wells would be designed to perform with a nominal head of 8' of water but with capabilities of operating with 10' of water or more. Conversely, it was decided that if the sand zone should run dry during periods of draught, the use of the wells will be discontinued. At other times, blower equipment should be fitted with either manual or automatic (or semi-automatic) capability to adjust operation to reflect site conditions.

Normally, as part of the Conceptual Design Report, STAR provides engineering operating specifications for the horizontal well system. For the present effort, it has been determined that others will provide engineering support for equipment design and procurement. Hence, the current report is limited to providing information related to the design of the horizontal wells proper including slot size and spacing, required well diameter, suggested materials-of-construction, pressure requirements, and flow requirements.

Modeling Results

Sparger® is the newest computer software modeling program developed by STAR. It, like previous proprietary programs, is based on fluid dynamics equations pertinent to the flow of air and other gases through conduit and into porous media. Each of these programs are based on the conservation of mass and energy as a primary requirement. Programs are available for all remediation technologies including air sparging, biosparging, groundwater pump-and-treat, water injection, soil vapor extraction, and steam injection. These are the first such programs known to be available within the environmental industry.

Figures 3, 4, 5, 6, 7 and 8 summarize the best well design for this project as determined using the Sparger® computer program. From these figures and the data used to generate them, the following comments can be offered:

- Based on a specified screen length of 230' in each of the two wells, the best screen design is as follows:
  - ◊ Wells fabricated using 4" diameter SDR-11 HDPE.
  - ◊ Screen inside well percent open area = 0.344%.
  - ◊ For 4" diameter SDR-11 HDPE, the inside diameter is 3.633". Hence the total inside circumference is 11.41 sq. in. and the required inside well open space is 0.4712 sq. in. per foot of screen.
  - ◊ Only 1 slot zone is required to achieve uniformity of air sparging down the length of the screened interval.
- A pressure of 6 psig at the well header will produce a pressure of 5.9735 psig at the proximal end of the screen (first slot) and 5.9701 psig on the distal end (last slot) of the screen.
- Equipment must be designed to deliver 6 psig at the well header.
  - ◊ The general industry practice of "over-sizing" blowers will result in different slot requirements to produce uniformity of air flow and frequent shut-downs of blower equipment due to "over-capacity" within the well.
  - ◊ A blower, rather than a compressor, will perform in this application.

- ◊ The blower must be sized to reflect pressure drops due to heat exchanger, elbows, instruments, etc.
- ◊ Provision must be made for straight runs of HDPE post-heat exchanger to accommodate flow measurement device requirements for installation.
- ◊ The heat exchanger must protect HDPE (140 deg. F. melting point).
- ◊ An acoustical enclosure around the blower and/or acoustical housing must be included in the equipment specification so as to protect neighboring facilities and personnel.
- ◊ The equipment must be designed to allow proper start-up of the systems.

- Horizontal wells are normally grouted and cemented at their ends consistent with vertical well practices.
- The step-back distance on each end of the horizontal wells shown in Figures 1 and 2 are expected to be approximately 93'. A value of 100' was used in these modeling efforts to reflect additional well length above-ground between the well exit and the blower compound.

Flow Requirements

STAR defines air sparge wells to operate at 1 SCFM per foot of screen and biosparge wells to operate at 0.5 SCFM per foot of screen. The intent of air sparge wells is to physically volatilize contaminants; the intent of biosparge wells is to introduce oxygen for *in situ* bioremediation. Commonly, regulatory agencies require that a soil vapor extraction system be used with air sparge wells to capture, contain, and treat physically evolved vapors. Contrarily, regulators have not required the use of SVE systems when the goal is *in situ* bioremediation. At 0.5 SCFM, each of the two wells planned for this project must be operated at a total of 115 SCFM (i.e., 1/2 of the total screen length of 230' each).

It should be noted that it is possible to design air sparge and biosparge wells with lower volumetric flow rates from those specified above. Such wells are easier to design but generally do not produce the minimum volumetric air flow required to achieve reasonable distances-of-influence. Hence, the use of lower flow rates is not suggested.

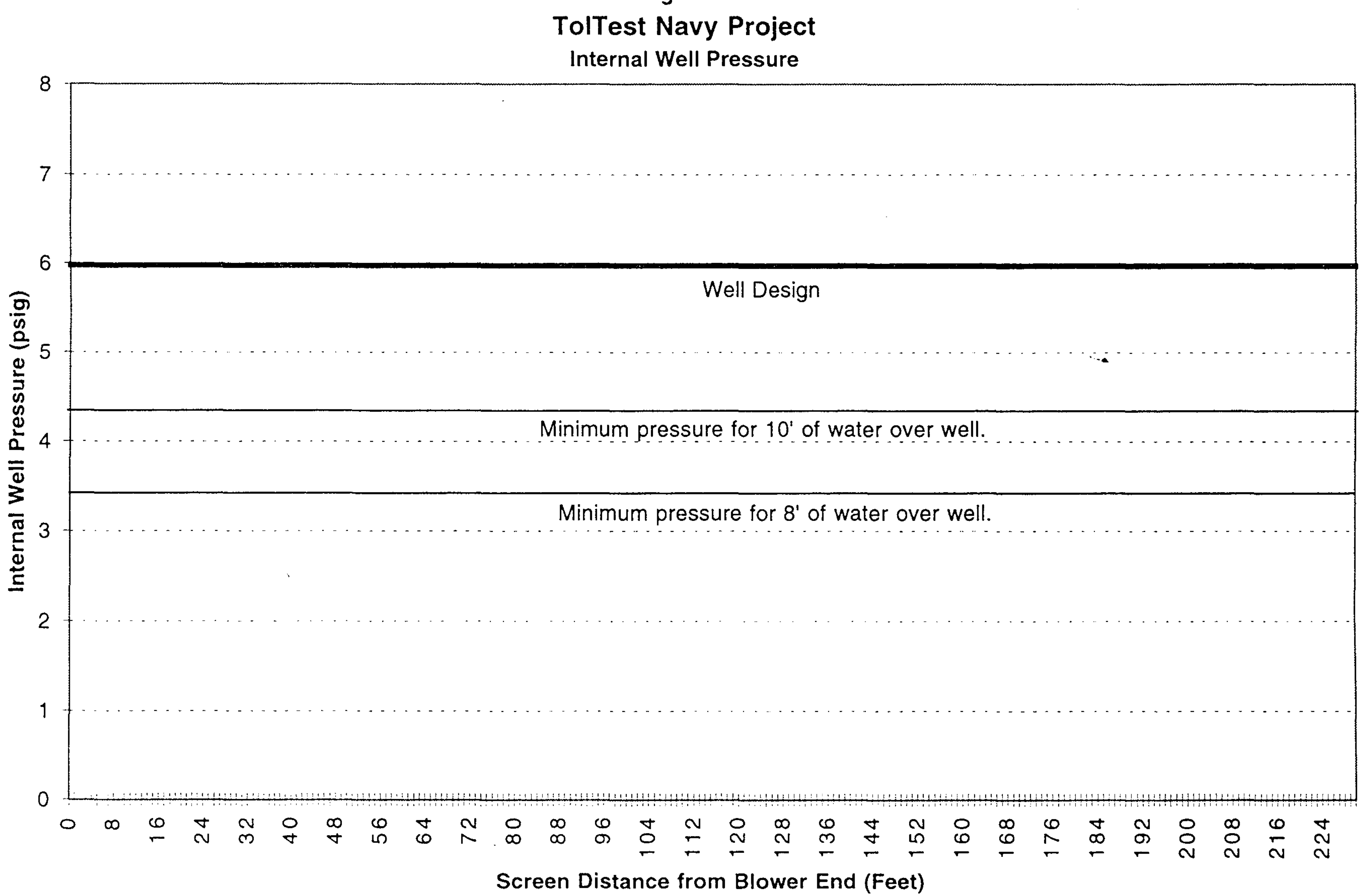
Table 1

Design Parameters and Constraints for Navy Wells

Design Parameter	Specified Value
Total Well Length	430 feet (approximate)
Screened Interval Length	230 feet
Well Material	SDR-11, HDPE
Well Size	3.633" I.D./4.500" O.D.
Well Header Length	100 feet
Target Flow Rate	115 SCFM
Stratigraphy	Homogeneous Sand
Air Permeability	120 Darcy
Ambient Air Temperature	90 deg. F
Well Depth Below Grade	10 feet (uniform)
Height of Water Above Well	8 feet (nominal)
Air Distribution Target	Uniformity of Discharge (± 10% Average Flow Maximum)

Inside pipe area for 1' pipe segment = 136.96 sq. in.

Figure 3

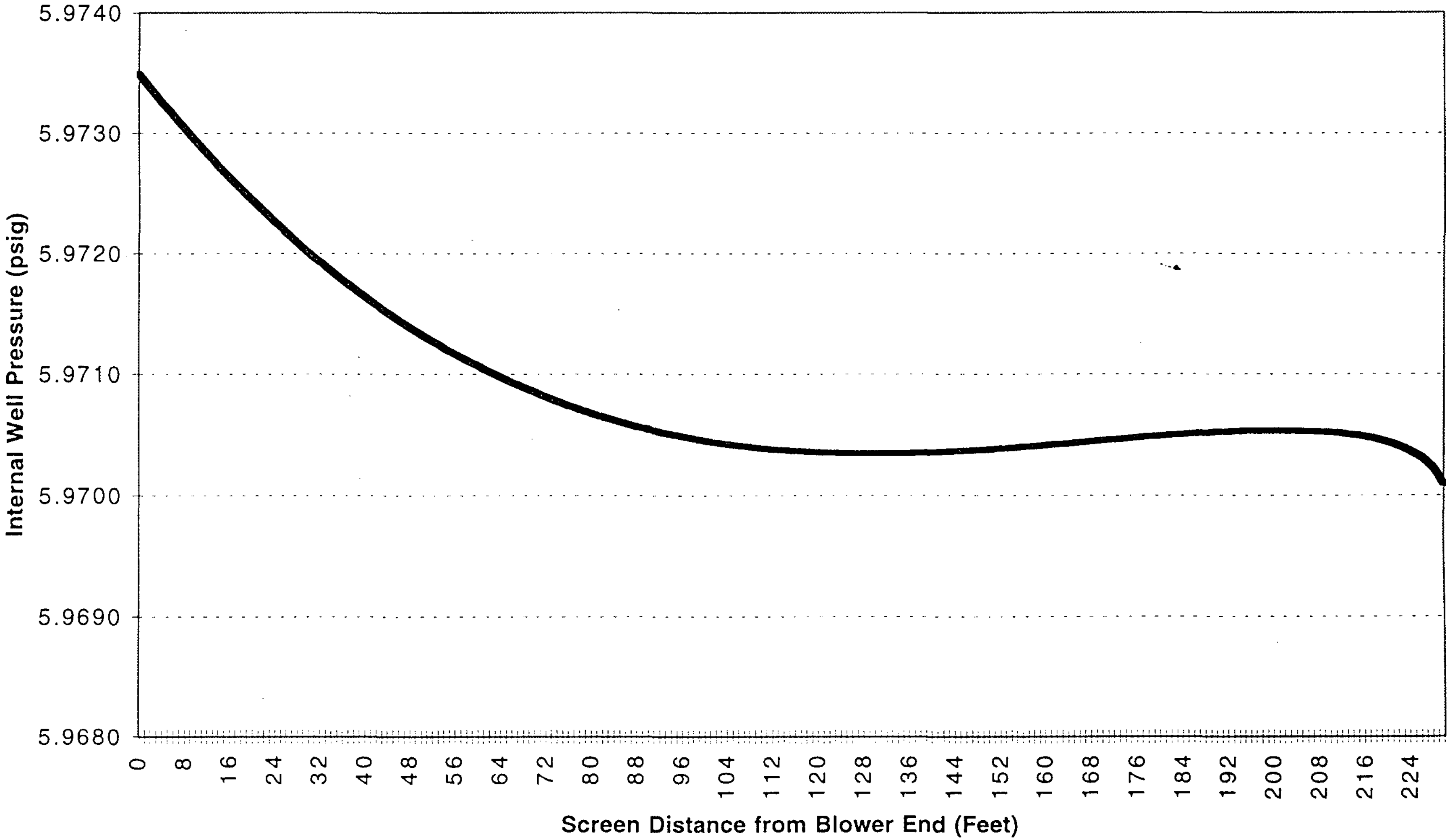


 Graph prepared using SpargerTM computer modeling program. 4" x 230' screen at 115 scfm.

Figure 4

TolTest Navy Project

Internal Well Pressure (Narrow Range)

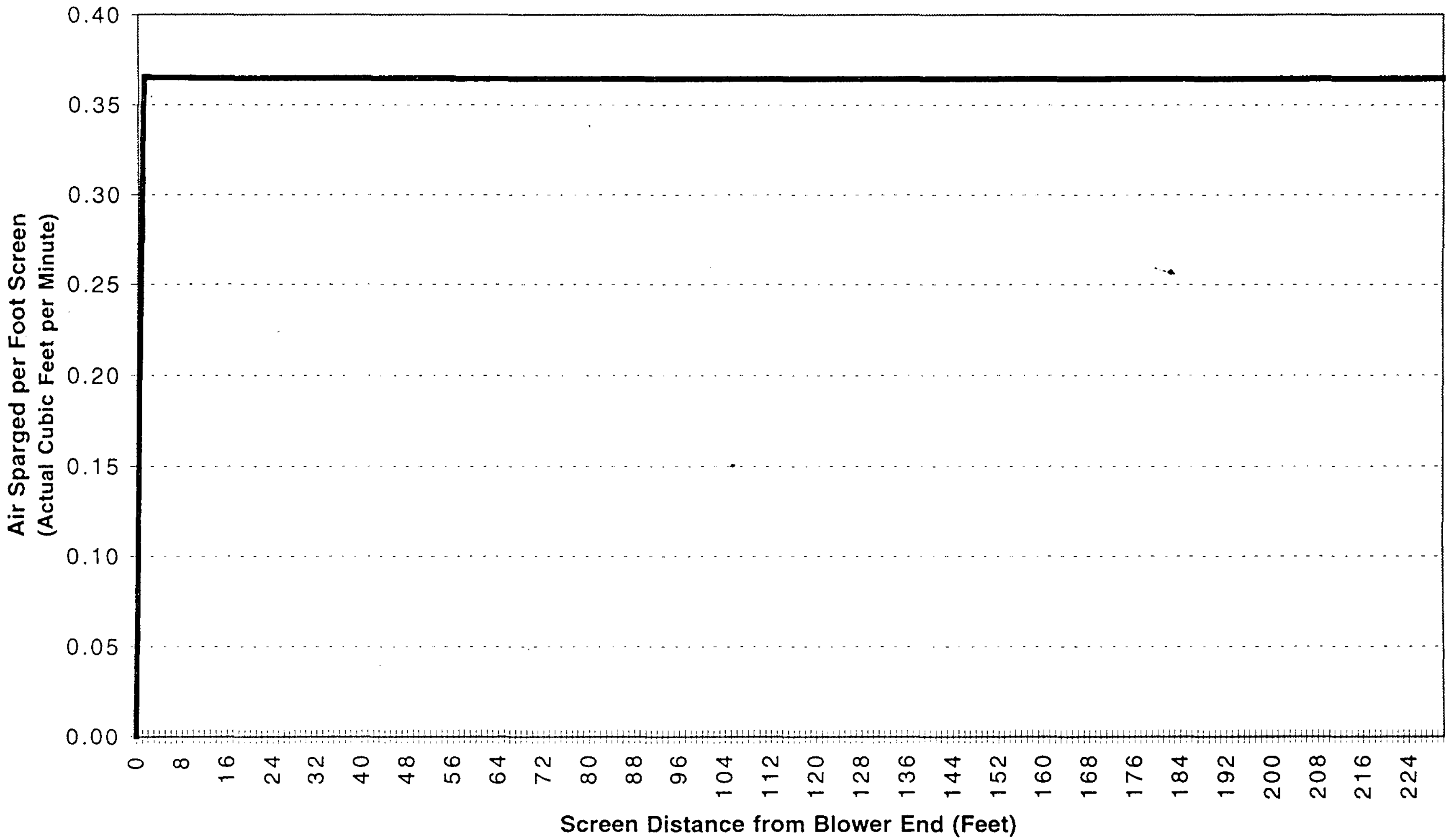


4" x 230' screen at 115 scfm.

Figure 5

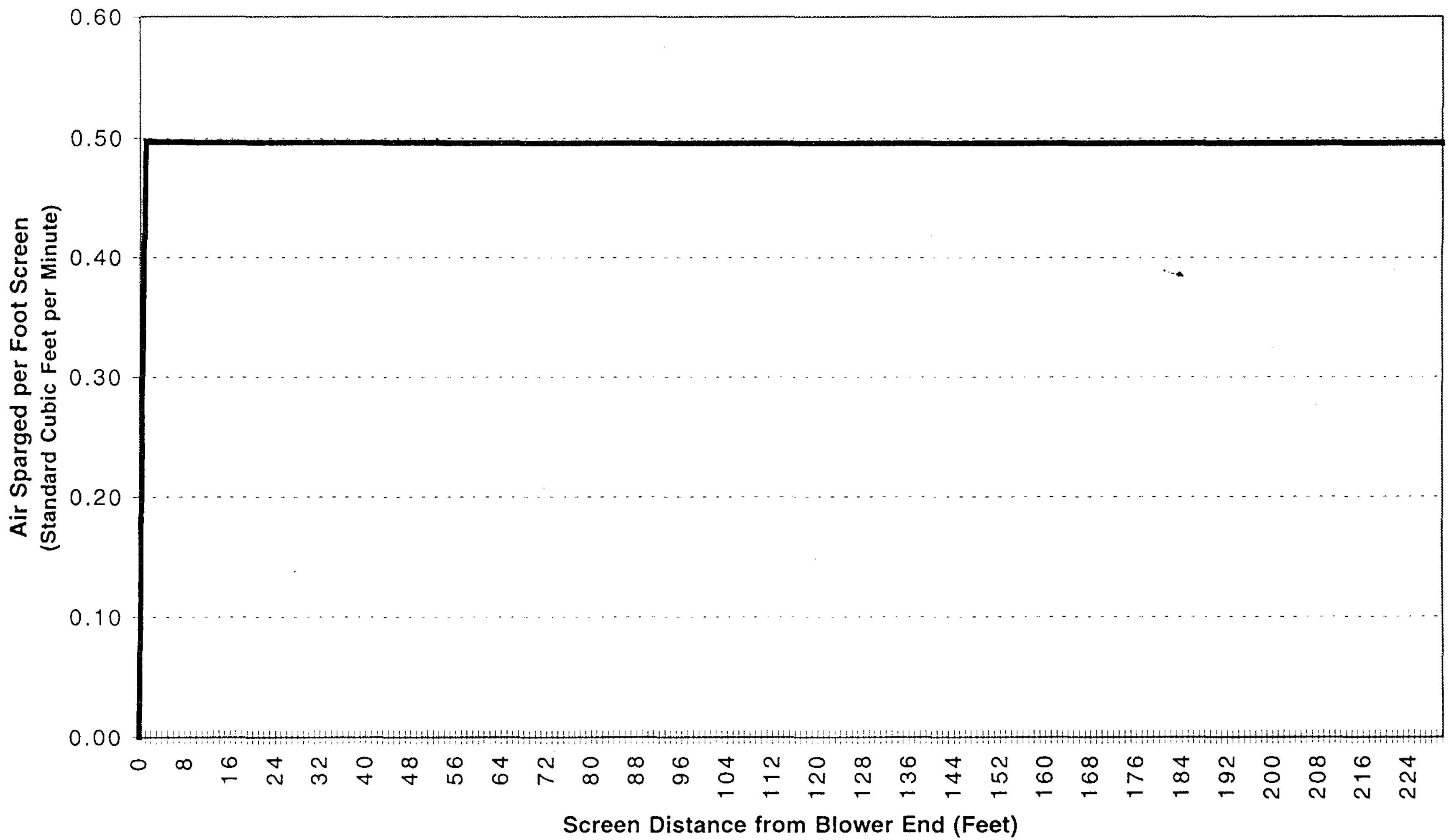
TolTest Navy Project

Air Sparged per Foot Screen (ACFM)



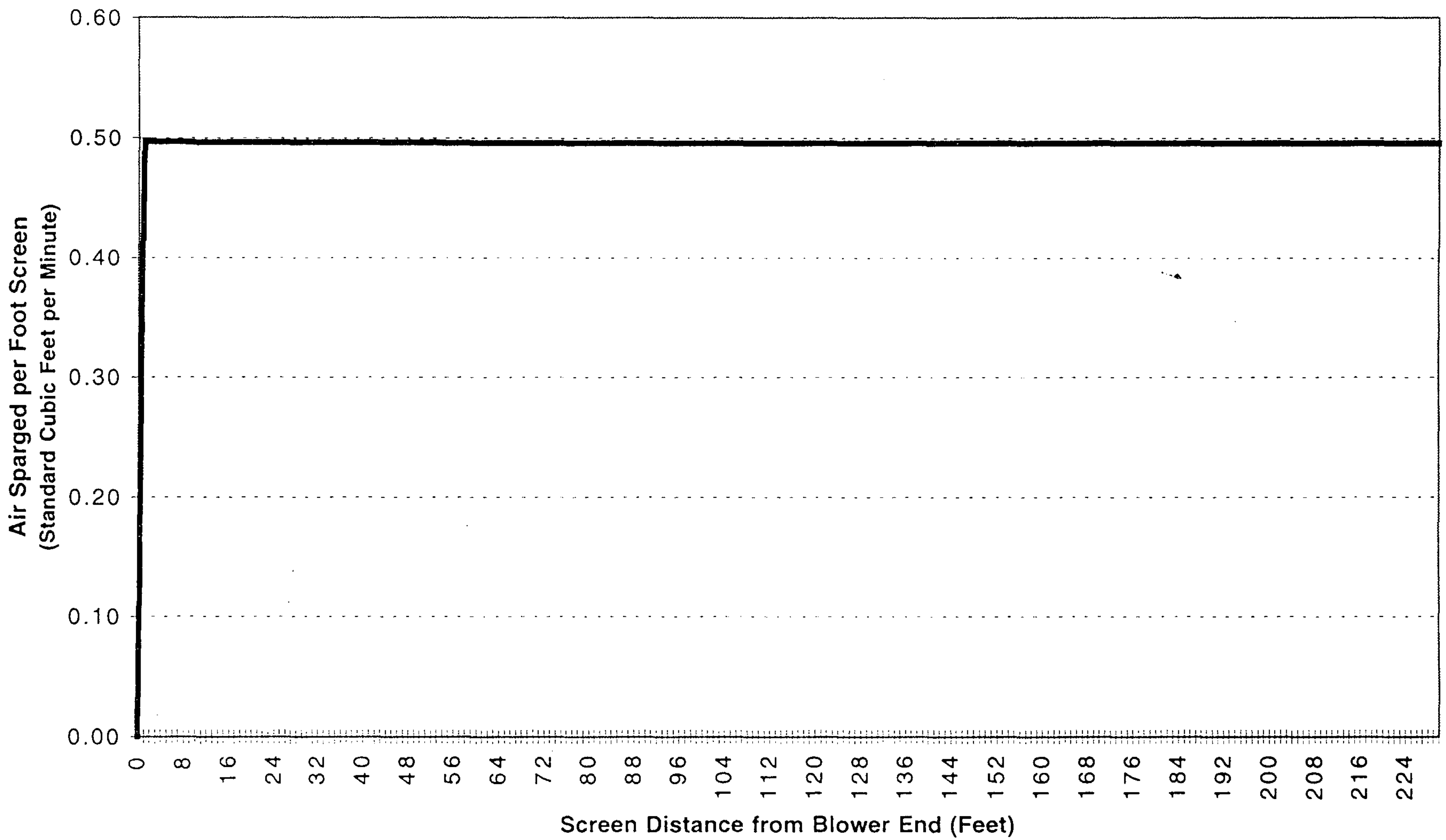
4" x 230 screen at 115 scfm.

Figure 6
TolTest Navy Project
Air Sparged per Foot Screen (SCFM)



4" x 230' screen at 115 scfm.

Figure 6
TolTest Navy Project
Air Sparged per Foot Screen (SCFM)



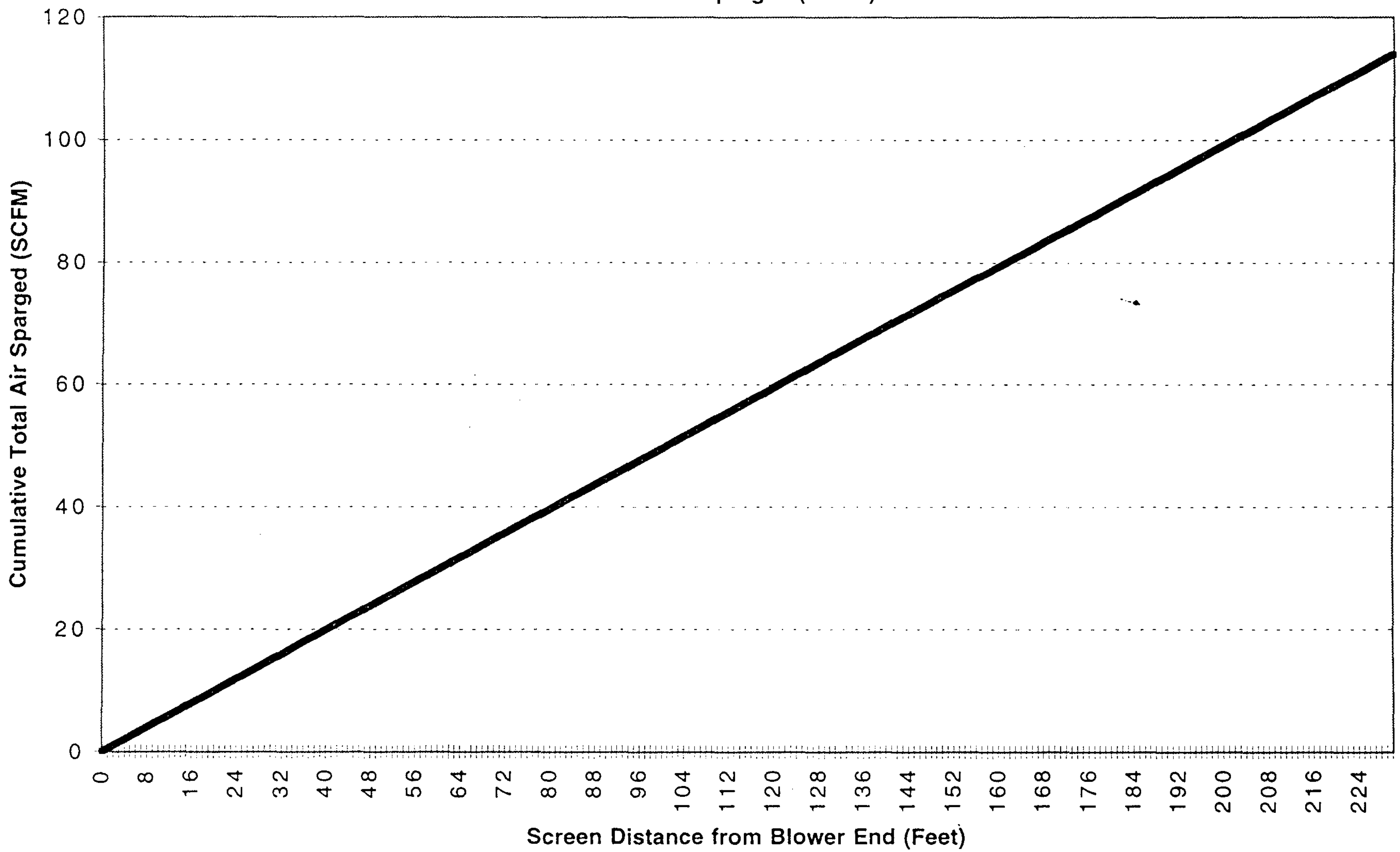
 Graphed with SpargerTM computer modeling program.

4" x 230' screen at 115 scfm.

Figure 7

TolTest Navy Project

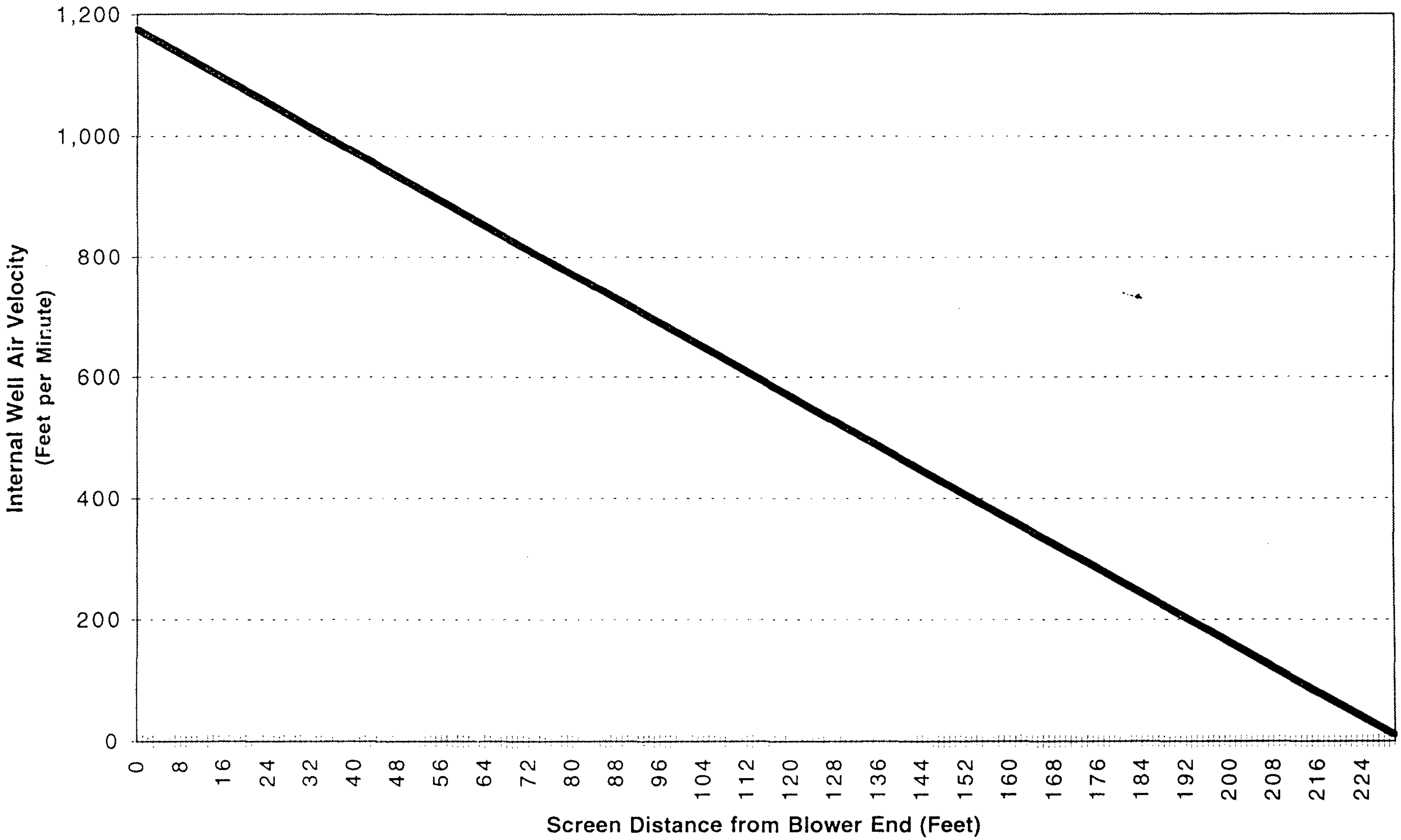
Cumulative Air Sparged (SCFM)



(c) STAR Environmental, Inc., 2000. Graphed with SpargerTM computer modeling program.

4" x 230' screen at 115 scfm.

Figure 8
TolTest Navy Project
Internal Well Air Velocity (FPM)



 Graphed with SpargerTM computer modeling program. 4" x 230' screen at 115 scfm.

Uniformity of Air Flow from Wells

STAR defines the uniformity of air flow from wells in terms of "% Skew" or "% Linearity":

- *Skew* is defined to be the difference between the volumetric air flow at the first slot and the last slot divided by the value at the first slot. *Percent Skew* is this value times 100.
- *Linearity* is defined as 100 minus *Skew*. *Percent Linearity* is this value times 100.

For the present wells, the results from the Sparger® computer program give the flow at the first slot as 0.4964 SCFM and at the last slot as 0.4955 SCFM. The difference between these is 0.0009 SCFM. Thus the % Skew for these wells is 0.18%. Conversely, the linearity of flow down the well screen (under the conditions specified) is 99.8%. This is reflected in Figures 3 - 6.

Screen Alternatives

4"-diameter, SDR-11, HDPE well materials can be slotted with either circumferencial slotting (the slotting arrangement most often used with vertical wells) or longitudinal slotting. The latter is about 20% more expensive than the former but offers greater tensile strength during pull-back. On the other hand, conventionally-slotted (i.e., circumferentially-slotted) well materials have had ample pull-back strength for most applications and would be expected to perform well in this particular project. Table 2 provides the required slotting dimensions for each of these alternatives.

The decrease of pull-back strength with slotting is directly proportional to the amount of circular area removed during slotting. Since a greater amount is removed from the outside perimeter than the inside of the pipe with circumferencial slotting, it is a fairly complicated calculation to determine the exact reduction in pull-back strength. A common practice is to approximate this reduction based on the average of the outside diameter and the inside diameter. This average diameter is multiplied by pi to obtain an average circumference for the pipe being used. For SDR-11 HDPE, the average of the outside diameter (4.50") and the inside diameter (3.633") is 4.0665". Thus, the "average"

Uniformity of Air Flow from Wells

STAR defines the uniformity of air flow from wells in terms of "% Skew" or "% Linearity":

- *Skew* is defined to be the difference between the volumetric air flow at the first slot and the last slot divided by the value at the first slot. *Percent Skew* is this value times 100.
- *Linearity* is defined as 100 minus *Skew*. *Percent Linearity* is this value times 100.

For the present wells, the results from the Sparger® computer program give the flow at the first slot as 0.4964 SCFM and at the last slot as 0.4955 SCFM. The difference between these is 0.0009 SCFM. Thus the % Skew for these wells is 0.18%. Conversely, the linearity of flow down the well screen (under the conditions specified) is 99.8%. This is reflected in Figures 3 - 6.

Screen Alternatives

4"-diameter, SDR-11, HDPE well materials can be slotted with either circumferencial slotting (the slotting arrangement most often used with vertical wells) or longitudinal slotting. The latter is about 20% more expensive than the former but offers greater tensile strength during pull-back. On the other hand, conventionally-slotted (i.e., circumferentially-slotted) well materials have had ample pull-back strength for most applications and would be expected to perform well in this particular project. Table 2 provides the required slotting dimensions for each of these alternatives.

The decrease of pull-back strength with slotting is directly proportional to the amount of circular area removed during slotting. Since a greater amount is removed from the outside perimeter than the inside of the pipe with circumferencial slotting, it is a fairly complicated calculation to determine the exact reduction in pull-back strength. A common practice is to approximate this reduction based on the average of the outside diameter and the inside diameter. This average diameter is multiplied by pi to obtain an average circumference for the pipe being used. For SDR-11 HDPE, the average of the outside diameter (4.50") and the inside diameter (3.633") is 4.0665". Thus, the "average" circumference of this well material is 12.775 inches. This "average" diameter is often used in pull-back strength reduction calculations.

An alternative method of calculating pull-back strength reduction is to base the calculation on the inside diameter and inside circumference of the well rather than an average diameter and circumference. An inside diameter of 3.633" gives an inside-well circumference of 11.413396".

Figure 9 illustrates circumferencial slotting using HDPE and a circular saw blade. Figure 10 illustrates longitudinal slotting using HDPE and a circular saw blade.

While mathematical computations will show that longitudinally-slotted wells will have greater tensile or pull-back strength than conventionally-slotted wells, this increase and the increased cost of procuring longitudinally slotted wells are not warranted for the wells for the present project. Conventionally-slotted wells up to about 1000' long and less than about 25' below grade have ample pull-back strength.

Table 2

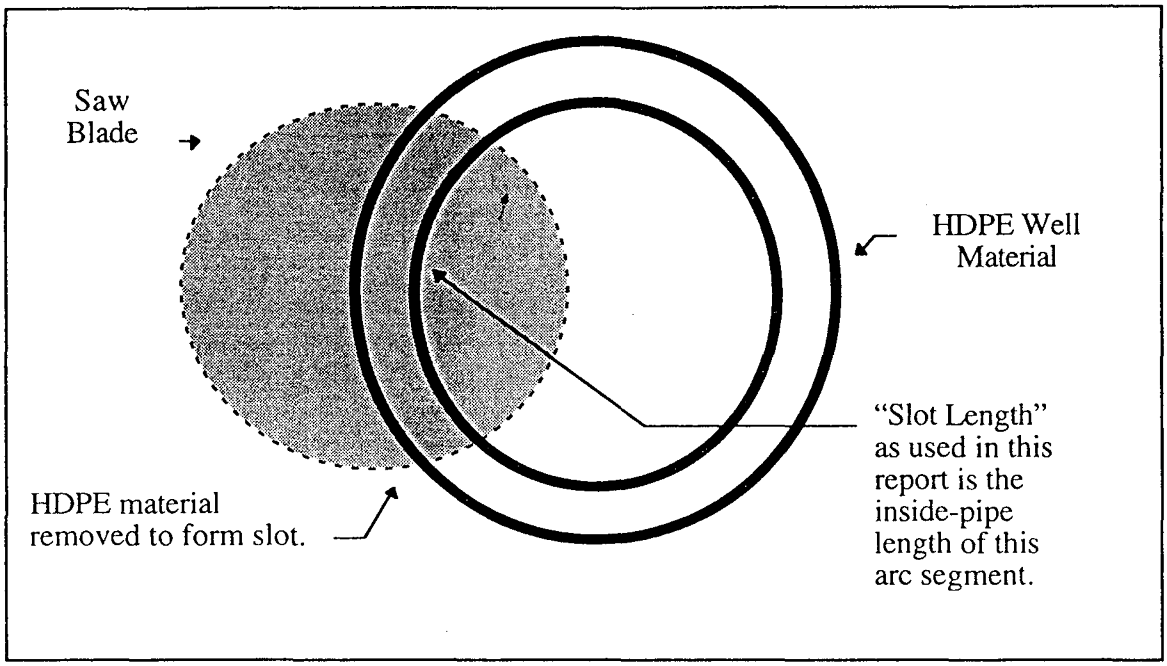
Navy Well Slot Designs

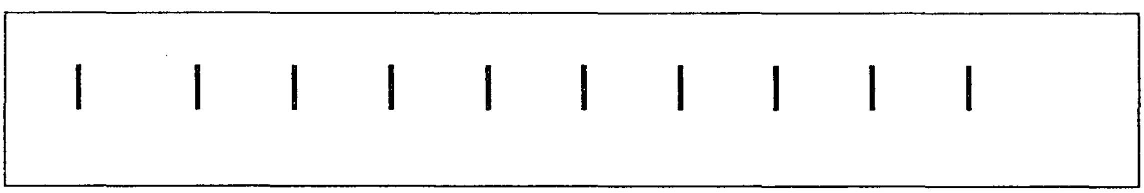
Design Parameter	Circumferencial Slots	Longitudinal Slots
Zone Length	0 to 230 feet	0 to 230 feet
Slot Width	0.020"	0.020"
Slot I.D. Length	1.178"	1.4725"
Number of rows	2	8
Number of slots/row-foot	10	2
ID Open Area/ft. screen	0.4712 sq. in.	0.4712 sq. in.
Percent Open Area	0.344	0.344

Inside-Pipe Nominal Slot Lengths = 1 3/16-inch for Circumferencial Slots and 1 15/32-inch for Longitudinal Slots.

Figure 9

Circumferencial Slotting

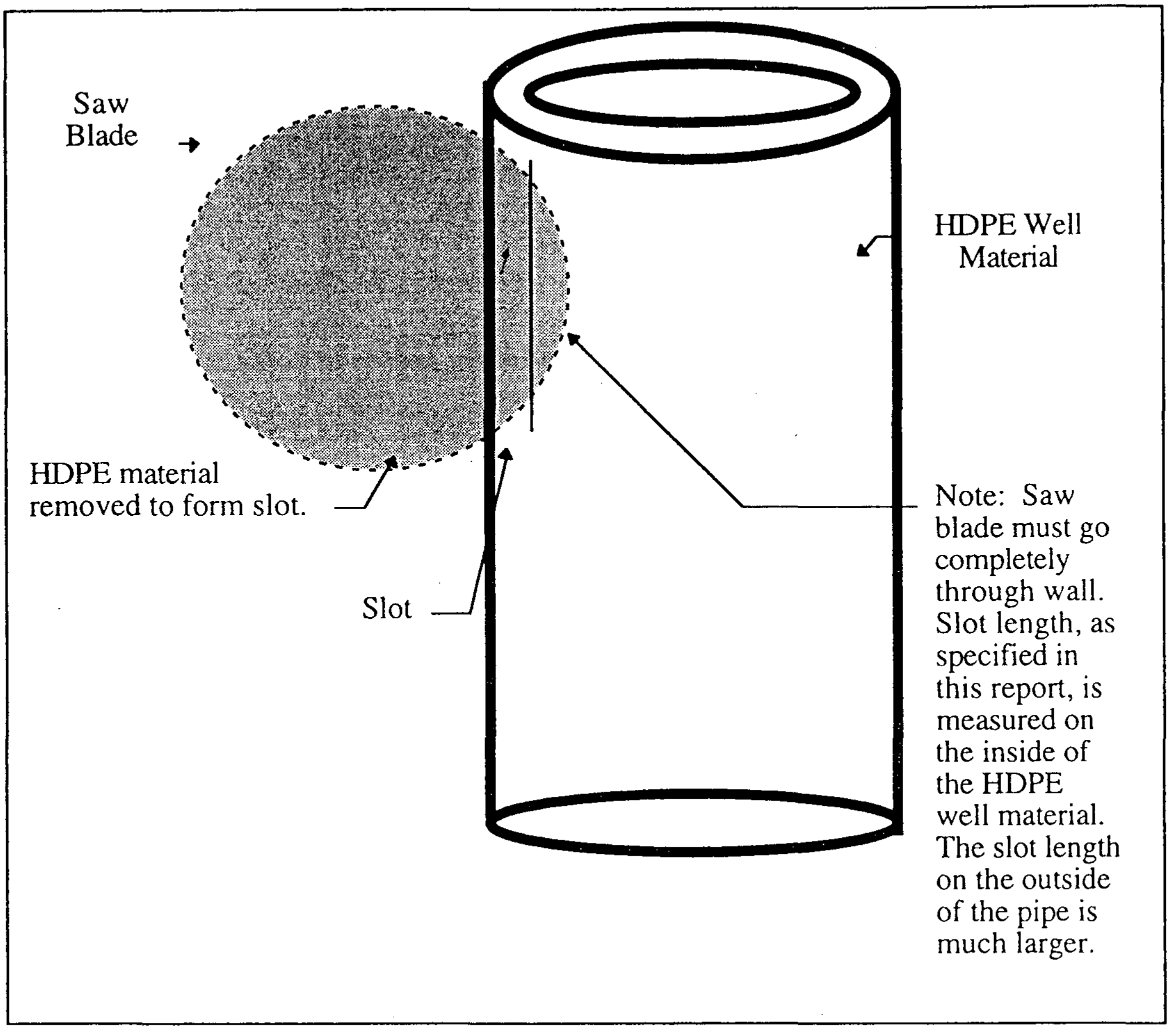


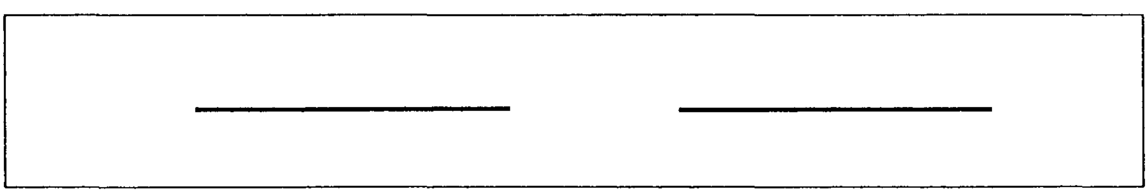


1 foot segment of well material. Single <u>row</u> of *circumferencial* slots illustrated. 10 slots per row shown.

Figure 10

Longitudinal Slotting





1 foot segment of well material showing a single <u>row</u> of two *longitudinal* slots.

CONCLUSION

As a result of the present effort, it was determined that the desired well material (nominal SDR-11 HDPE) could be acceptably utilized for the well and header. This conclusion is based upon the fluid dynamics consideration of the material (at the site specified) being capable of delivering the specified compressed air (in total and incrementally per foot of screen) without excessive pressure loss. The conclusion, however, does not encompass whether the material can be inserted into the subsurface during pull-back to meet the required radii-of-curvature needed to place the well where desired and at depth.

It was additionally determined that the best well performance would be realized by using a single propagation of well slots (defined as "zone") over the screened interval's full length. This single zone screen design is applied over the screen distance from 0 feet to 230 feet. The single screen design will achieve acceptably uniform sparge air flow over the entire length of the screen. Internal pressure degradation and increasingly-lesser flow discharge with distance will result with any slot design employed. With the slot pattern specified, this change is minimal for these well materials and for the present project.

Circumferencial slotting is recommended for the wells for this project. The required inside-well percent open area is 0.344 for 4" diameter SDR-11 HDPE piping. This is equivalent to 0.4712 sq. in. open area per foot of well material (as measured on the inside of the well). Table 2 provides one possible design. The final design must be determined after consultation with the slotter.

APPENDIX B

Groundwater Treatment System Drawing Package

GROUNDWATER TREATMENT SYSTEM DRAWING PACKAGE

BUILDING 1600A, NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

PREPARED FOR

UNITED STATES NAVY

PREPARED BY

TOLTEST, INC.

DRAWING INDEX

NO.	TITLE
G01	COVER SHEET/LEGEND
F01	PROCESS FLOW DIAGRAM
F02	PIPING AND INSTRUMENTATION DIAGRAM
E01	ONE-LINE DIAGRAM
E02	LADDER DIAGRAM

PIPING SYMBOLS

- BUG SCREEN
- MOTOR STARTER
- FLAME ARRESTOR
- PUMP
- BLOWER
- INTERLOCK
- GATE VALVE
- BALL VALVE
- GLOBE VALVE
- SAMPLE PORT
- CHECK VALVE
- BUTTERFLY VALVE
- UNION
- FILTER
- SILENCER
- RESET
- PRESSURE REGULATOR
- MOTOR OPERATED BUTTERFLY VALVE
- INSTRUMENT BUBBLE
- PANEL MOUNTED INSTRUMENT
- PITOT TUBE
- VENTURI TUBE
- ACTUATED VALVE
- SOLENOID VALVE
- BLAST GATE VALVE
- VACUUM RELIEF VALVE
- PIPING MATERIAL CHANGE

ELECTRICAL SYMBOLS

- SWITCH
- CIRCUIT BREAKER
- FUSE
- PRESSURE SWITCH
- FLOAT SWITCH
- SOLENOID COIL
- NORMALLY OPEN CONTACT
- NORMALLY CLOSED CONTACT
- TRANSFORMER
- NORMAL OVERLOAD

GENERAL SYMBOLS

- 3/16 — FILLET WELD
- PIPE SUPPORT DETAIL: PIPE DIAMETER; SHEET WHERE DETAIL IS FOUND; DETAIL NUMBER
- STANDARD DETAIL: DETAIL NUMBER; SHEET WHERE DETAIL IS FOUND
- SECTION: SECTION DESIGNATION; SHEET WHERE DETAIL IS FOUND; SHEET WHERE DETAIL IS CUT

ABBREVIATIONS

A
- AA AMBIENT AIR
- AF AMP FRAME
- AT AMP TRIP

B
- BS BUG SCREEN
- BV BALL VALVE
- BFV BUTTERFLY VALVE
- BGV BLAST GATE VALVE

C
- CV CHECK VALVE
- CA COMPRESSED AIR
- C COLUMN

F
- FAL FLOW ALARM LOW
- FCV FLOW CONTROL VALVE
- FO FUEL OIL
- FT FLOW TRANSMITTER
- F BURNER/THERMAL UNIT
- FE FLOW ELEMENT
- FI FLOW INDICATOR
- FQI FLOW TOTALIZER

G
- GBV GLOBE VALVE
- GV GATE VALVE
- GW GROUNDWATER

H
- HV HYDROCARBON VAPOR

I
- I INTERLOCK
- IW INJECTION WELL

K
- K COMPRESSOR

L
- LSL LEVEL SWITCH LOW
- LSH LEVEL SWITCH HIGH
- LSHH LEVEL SWITCH HIGH HIGH
- LG LEVEL GLASS
- LE LEVEL ELEMENT
- LT LEVEL TRANSMITTER
- LCV LEVEL CONTROL VALVE

M
- M MOTOR STARTER

P
- P PUMP
- PI PRESSURE INDICATOR
- PSH PRESSURE SWITCH HIGH
- PRV PRESSURE REGULATOR
- PW PROCESS WATER
- PSV PRESSURE SAFETY VALVE
- PP POWER PANEL

R
- RW RECOVERY WELL

S
- S SEPARATOR
- SV SOLENOID VALVE
- SP SAMPLE PORT
- SI SILENCER

T
- TDR TIME DELAY RELAY
- T TANK

V
- V VESSEL

Z
- Z PIPE SCRAPPER LAUNCHER/RECEIVER

EQUIPMENT AND INSTRUMENTATION NOMENCLATURE

L S H - 1 0 0 1

ABBREVIATIONS — AREA DESIGNATION — INDEX

STREAM NOMENCLATURE

G W - 1 0 0 1 - 2" - B

SERVICE — AREA DESIGNATION — INDEX — INSIDE DIAMETER — PIPING MATERIAL CLASSIFICATION

PIPING MATERIAL CLASSIFICATIONS

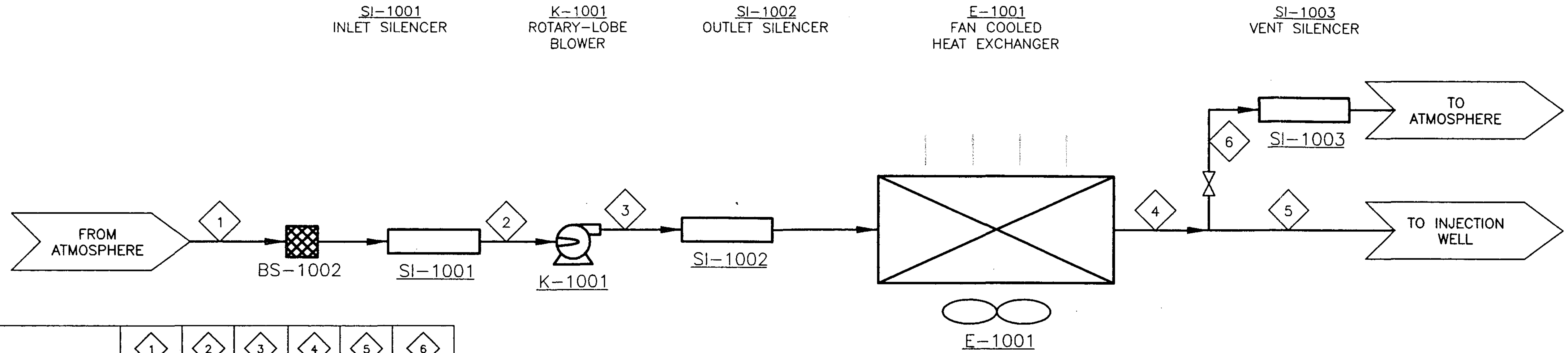
- A – SCH 40 PVC
- B – SCH 80 PVC
- C – SCH 40 GALVANIZED STEEL
- D – VENDOR SPECIFIED HOSE
- E – COMPRESSED AIR HOSE RATED TO 200 PSI
- F – FIBERGLASS
- G – SCH 40, 306 STAINLESS STEEL

SUBMITTED BY: TOLTEST, INC.	DATE: 22 JUNE 00
DESIGNED BY: C. BLANCHARD	CHECKED BY: [signature] DATE: 8/22/00
DRAWN BY: M. CIESLEWSKI	APPROVED BY: [signature] DATE: 8/22/00
DELIVERY ORDER NO:	DWG NO: 37755PFDPID
SCALE: NONE	SHEET NO: 1 of 4

TITLE: FIGURE G01 COVER SHEET/LEGEND BUILDING 1600A NAVAL TRAINING CENTER GREAT LAKES, ILLINOIS

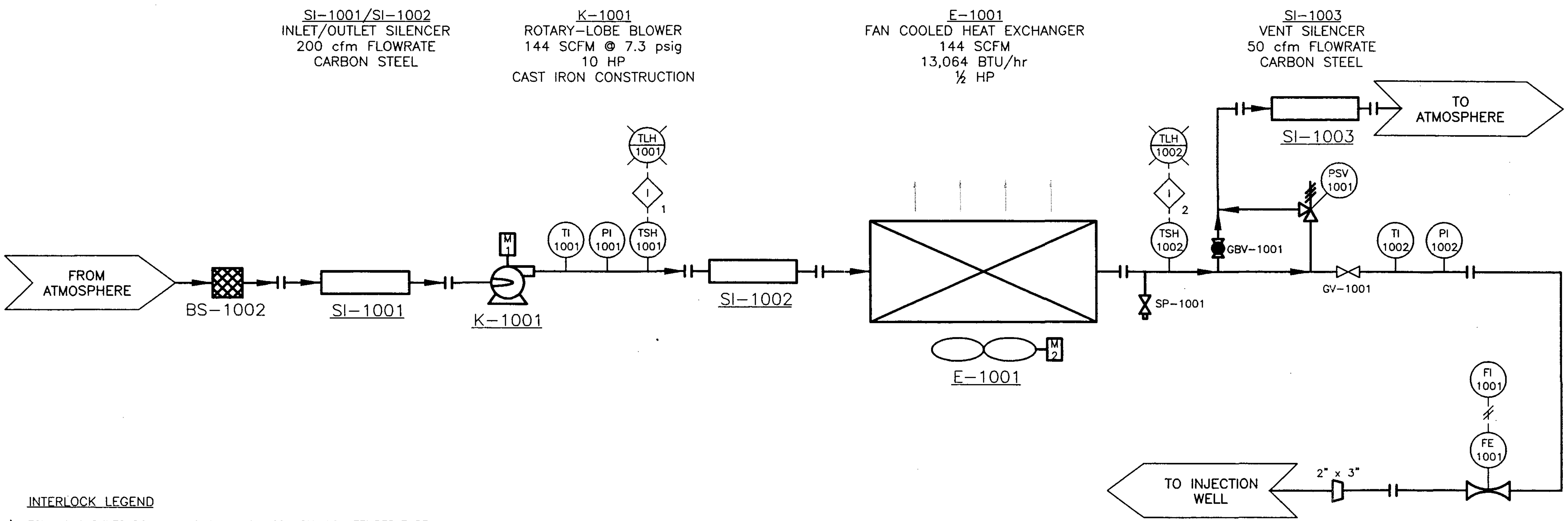
Department of the Navy
Naval Facilities Engineering Command
NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

TOLTEST INC.



STREAM NUMBER	1	2	3	4	5	6
AIR FLOWRATE (SCFM)	144	144	144	144	115	29
AIR FLOWRATE (ACFM)	148	150	113	108	86	32
TEMPERATURE (deg. F)	70	70	149.5	110	110	110
PRESSURE (psia)	14.35	14.14	21.68	21.10	21.10	14.45
MASS FLOWRATE (lb/hr)	604.8	604.8	604.8	604.8	483	121.8
MASS FLOWRATE (ton/yr)	2625	2625	2625	2625	2096	529

FIGURE F01: PROCESS FLOW DIAGRAM



INTERLOCK LEGEND

1) TSH-1001 SHUTS DOWN K-1001 AND E-1001 ON HIGH TEMPERATURE AND LIGHTS TLH-1001.

2) TSH-1002 SHUTS DOWN K-1001 AND E-1001 ON HIGH TEMPERATURE AND LIGHTS TLH-1002.

FIGURE F02: PIPING & INSTRUMENTATION DIAGRAM

SUBMITTED BY: TOLTEST, INC | DATE: 22 JUNE 00 | SCALE: NONE
DESIGNED BY: C. BLANCHARD | CHECKED BY: | DATE: 8/22/00
DRAWN BY: M. CIESLEWSKI | APPROVED BY: | DATE: 8/22/00
DELIVERY ORDER NO: | DWG NO: 37755PFDPID | SHEET NO: 2 of 4

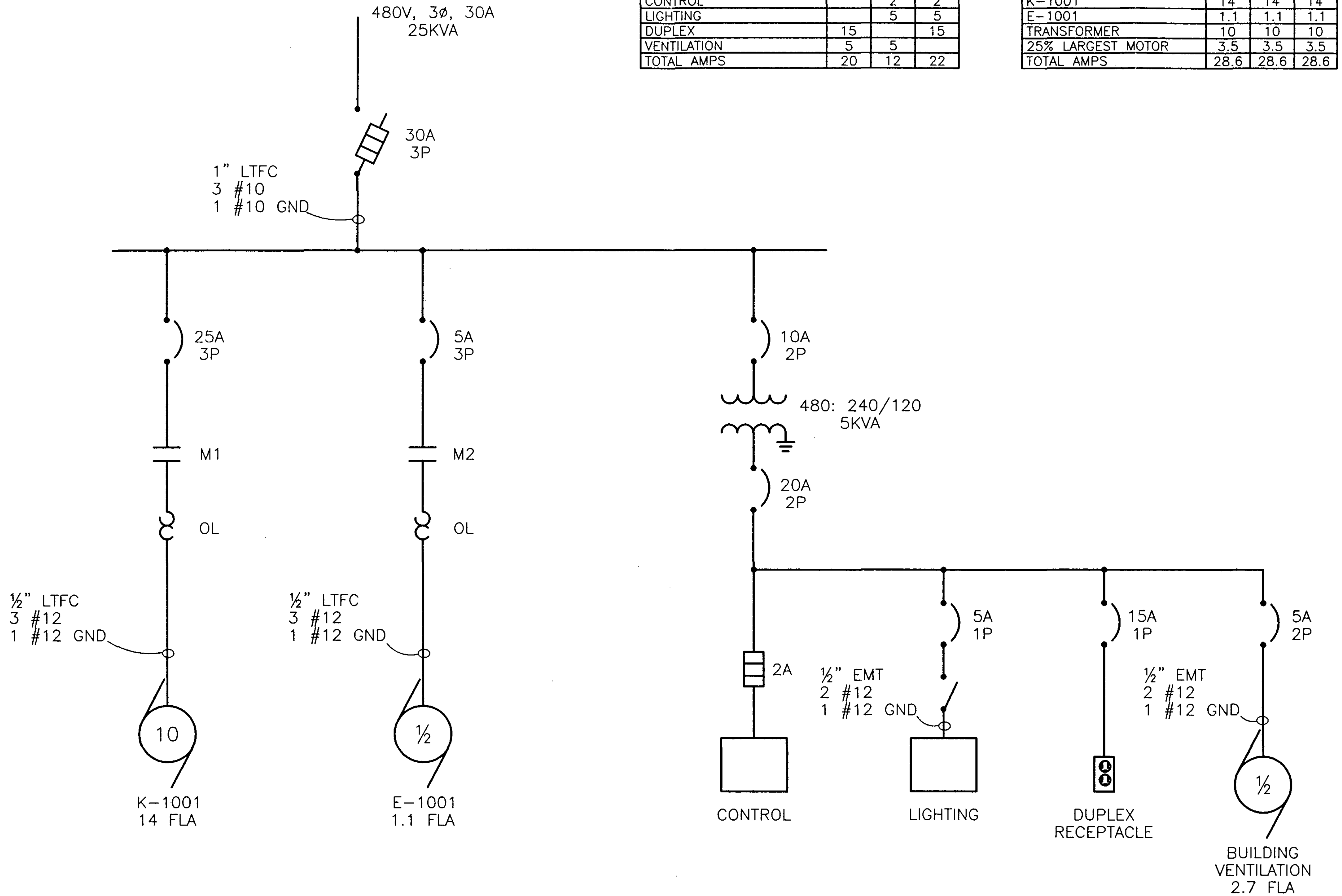
TITLE: PROCESS FLOW DIAGRAM AND PIPING AND INSTRUMENTATION DIAGRAM
BUILDING 1600A
NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS

Department of the Navy
Naval Facilities Engineering Command
NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

TOLTEST INC.

SINGLE-PHASE LOAD ANALYSIS			
LOAD	L1	L2	N
CONTROL		2	2
LIGHTING		5	5
DUPLEX	15		15
VENTILATION	5	5	
TOTAL AMPS	20	12	22

THREE-PHASE LOAD ANALYSIS			
LOAD	A	B	C
K-1001	14	14	14
E-1001	1.1	1.1	1.1
TRANSFORMER	10	10	10
25% LARGEST MOTOR	3.5	3.5	3.5
TOTAL AMPS	28.6	28.6	28.6



ONE-LINE DIAGRAM

SUBMITTED BY: TOLTEST, INC. DATE: 22 JUNE 00 SCALE: NONE

DESIGNED BY: C. BLANCHARD CHECKED BY: DATE:

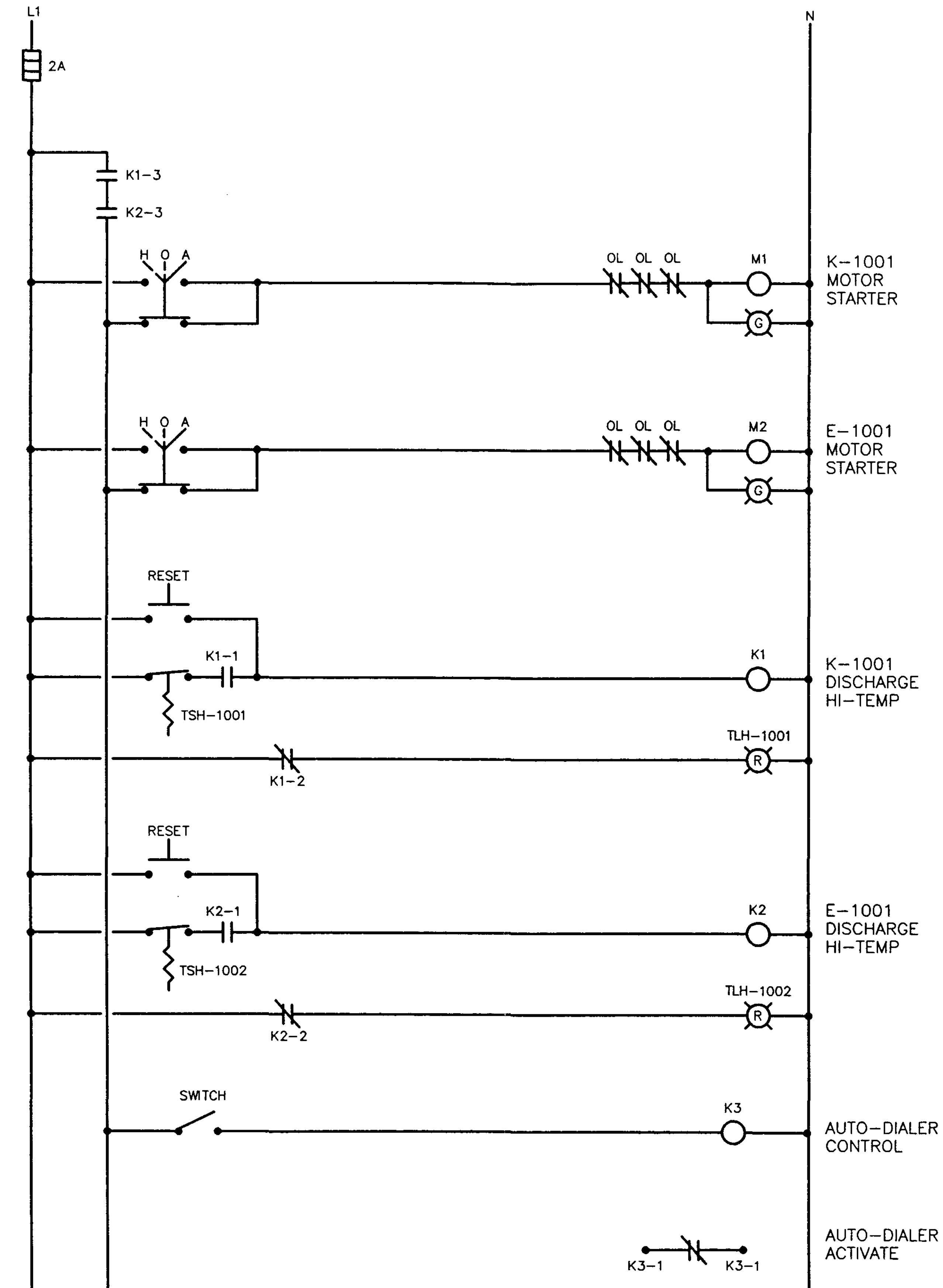
DRAWN BY: M. CIESLEWSKI APPROVED BY: DATE:

DELIVERY ORDER NO: DWG NO: 37755PFDPID SHEET NO: 3 of 4

TITLE: FIGURE E01 ONE-LINE DIAGRAM BUILDING 1600A NAVAL TRAINING CENTER GREAT LAKES, ILLINOIS

Department of the Navy
Naval Facilities Engineering Command
NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

TOLTEST INC.



LADDER DIAGRAM

NOTES:

1) AREA IS CONSIDERED NON-HAZARDOUS

2) PROVIDE NEMA 1 PANELS

SUBMITTED BY: TOLTEST, INC.	DATE: 22 JUNE 00
DESIGNED BY: C. BLANCHARD	CHECKED BY: [signature] DATE: 8/22/00
DRAWN BY: M. CIESLEWSKI	APPROVED BY: [signature] DATE: 8/22/00
DELIVERY ORDER NO:	DWG NO: 37755PFDPID
SCALE: NONE	SHEET NO: 4 of 4

TITLE: FIGURE E02
LADDER DIAGRAM
BUILDING 1600A
NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS

Department of the Navy
Naval Facilities
Engineering Command

NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

TOLTEST INC.

APPENDIX C

Carbonair Services
Equipment Submittals

TABLE OF CONTENTS

Section A. SYSTEM DRAWINGS (Layout & P&ID) AND/OR MODELING

Section B. LIST OF PROPOSED EQUIPMENT AND EQUIPMENT CUT SHEETS

The below sections contain detail information relating to specific equipment or sections of the system.

Section 1. AIR SPARGE SYSTEM

Section 2. AFTER COOLER

Section C: CONTROL PACKAGE DESCRIPTION

Section A: System Drawings and/or models

Company:	Carbonair Environmental Systems
Address:	
	800-526-4999
Contact:	GH

ROOTS BLOWER PERFORMANCE SUMMARY: (07/26/2000)

AMBIENT CONDITIONS:

Gas	AIR	
Relative Humidity	40.00%	
Molecular Wt.	28.861	
k-Value	1.396	
Specific Gravity	.996	
Ambient Temp.	68	deg F
Ambient Pressure	14.25	PSIA
Elevation	850	feet

INPUT CONDITIONS:

Actual Volume	156	ACFM
Std. Volume	144	SCFM
System Inlet Pressure	14.25	PSIA
Inlet Pr. Loss	0.7	PSI
Blower Inlet Pressure	13.55	PSIA
System Disch Pressure	7.3	PSIG
Disch Pr. Loss	0.7	PSI
Blower Disch Pressure	22.25	PSIA
Inlet Temperature	68	deg F

STANDARD CONDITIONS:

Pressure	14.7	PSIA
Temperature	68	deg F
Relative Humidity	36	%

SELECTED UNIT DETAIL:

Model	45	URAI	
Speed	1936	RPM	53.8%
Power at Blower Shaft	9.3	BHP	
Blower Differential Pressure	8.70	PSI	87.0%
Temperature Rise	136	deg F	60.4%
Discharge Temperature	204	deg F	
Discharge Volume	119	ACFM	
Gear Tip Speed	2029	FPM	
V-Belt: Est. B10 Brg Life:	95203	hours	
Coupling: Est. B10 Brg Life:	207551	hours	
Est. Free Field Noise @ 1 m.	85.8	dBa	
CFR	0.121		
Weight	109	lbs.	
Shaft Dia.	0.875	in.	
Min. Sheave Dia.	5	in.	
Inlet/Disch Conn.	2.5T		

American Industrial Heat Transfer, Inc
Sizing Program Air/Air COOLERS
Performance of One Unit
by Mark A. Loeffler

Customer: Carbon Aire
Selection: ACA-3302-3
Required Sq.ft: 17.8
Design Sq.Ft: 22.1

******************************Conditions*************************

Tubes			Ambient		
Enter Fluid-------->		Air	Enter Fluid------->		air
Specific Gravity		1.000	Altitude Sea Level +	ft	0
Density	lb/ft^3	0.1080			0.0722
Flow Rate	lbs/hr	649.7			19273.8
Enter Flow Rate	SCFM	144.00	Flow Fan	CFM	4450
Calc Flow Rate	SCFM	144.0			
Enter Flow Rate	ACFM	0.0			
Calc Flow Rate	ACFM	100.2			
Operating Pressure	PSIG	10.0	Atmospheric Pressure		14.696
Operating Pres	in.water	0.0			
Temp. Entering	F	210.0			90.0
Temp. Exiting	F	105.0			93.6
Approach Temperature	F	15.0			
Spec. heat	BTU/lb-f	0.25			0.25
Viscosity	Cps	0.0200			0.0190
Conduct	Btu/hr ft^2 F/ft	0.0160			0.0160

*****************************CALCULATIONS**********************

Heat Load	BTU/hr	17259			17259
Mass Vel.	lb/hr-ft^2	25061			5206
Mol weight		28.97			28.97
Pressure Drop	in.water	11.3			
Pressure Drop	^PSI	0.407			
Velocity Tubes	FPS	64.43	External air	FPM	1201.97
Calc Nr		14023			5486
Overall U value		19.25			
Required Area	Sq.Ft.	17.75			

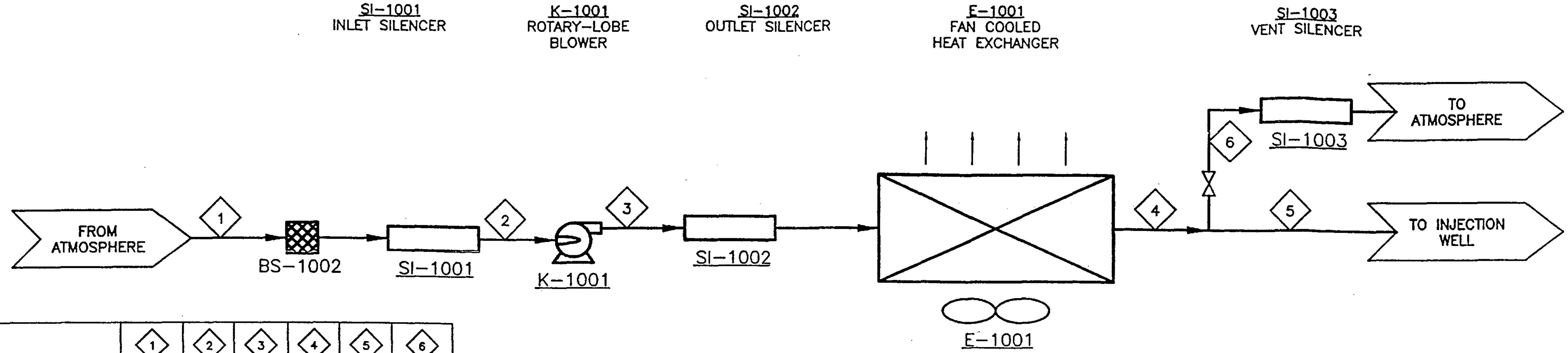
********************************SELECTION************************

Surface Area	Sq. Ft.	22.09			6.3
Tube Diameter	inch	0.375	Fins Per Inch		8
Tube Wall Dia.	inch	0.025	Estimated pass	1=	1
Length tubes	inch	30.0	Enter Number Passes		2
Parallel Tube Rows		3	Est. Min Nozzel	inch	2.0
Total Number Tubes		90	Manifold		2.50
Fouling Resistence					0.0000

********************************MATERIALS************************

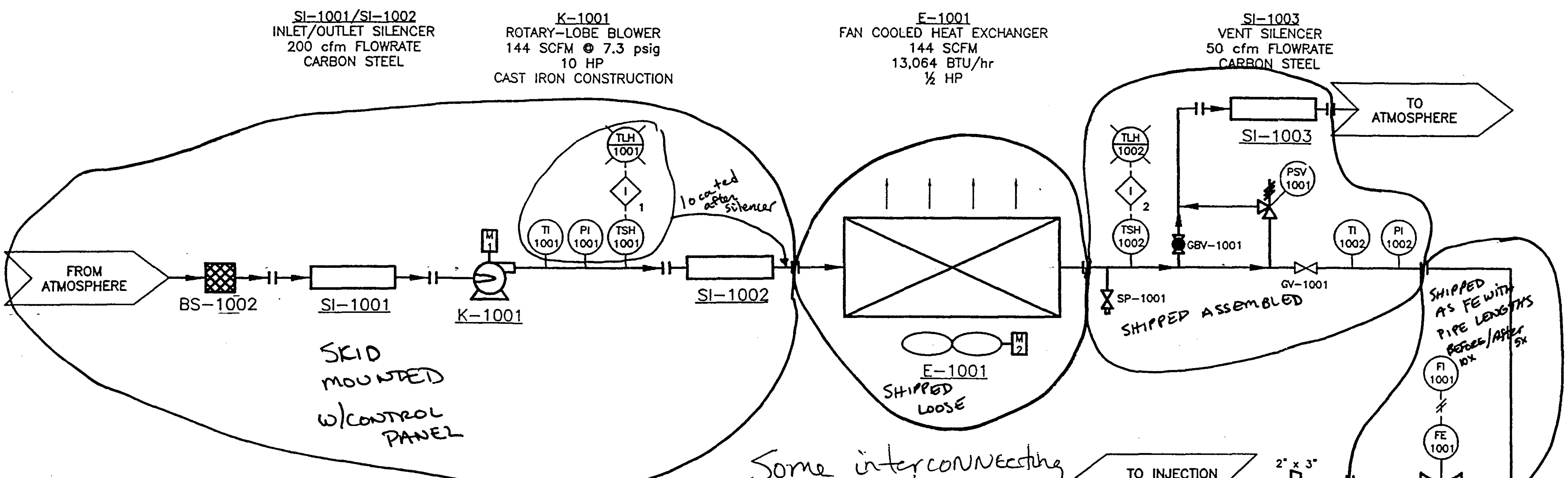
TUBES	copper	TURBULATORS	none
FINS	alum	FAN	Comp
MANIFOLDS	CS Braze	COATING	enamel
CABINET	CS	GASKETS	

Motor .5 HP 3/60/230-460
Nozzel size 2.00 NPT



STREAM NUMBER	1	2	3	4	5	6
AIR FLOWRATE (SCFM)	144	144	144	144	115	29
AIR FLOWRATE (ACFM)	148	150	113	108	86	32
TEMPERATURE (deg. F)	70	70	149.5	110	110	110
PRESSURE (psia)	14.35	14.14	21.68	21.10	21.10	14.45
MASS FLOWRATE (lb/hr)	604.8	604.8	604.8	604.8	483	121.8
MASS FLOWRATE (ton/yr)	2625	2625	2625	2625	2096	529

FIGURE F01: PROCESS FLOW DIAGRAM



INTERLOCK LEGEND

1) TSH-1001 SHUTS DOWN K-1001 AND E-1001 ON HIGH TEMPERATURE AND LIGHTS TLH-1001.

2) TSH-1002 SHUTS DOWN K-1001 AND E-1001 ON HIGH TEMPERATURE AND LIGHTS TLH-1002.

FIGURE F02: PIPING & INSTRUMENTATION DIAGRAM

SUBMITTED BY:	TOLTEST, INC.
DATE:	22 JUNE 00
SCALE:	NONE
DESIGNED BY:	C. BLANCHARD
CHECKED BY:	
DATE:	
DRAWN BY:	M. CIESLEWSKI
APPROVED BY:	
DATE:	
DELIVERY ORDER NO:	
DWG NO:	37755PFDPID
SHEET NO:	2 of 4

TITLE: PROCESS FLOW DIAGRAM AND PIPING AND INSTRUMENTATION DIAGRAM
BUILDING 1600A
NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS

Department of the Navy
Naval Facilities
Engineering Command
NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

TOLTEST INC.

Section B: Equipment Description

---

(2) Carbonair model AS 4005 soil vapor extraction system

Blower, Roots URAI model 45
Flexible couplings for vibration isolation on blower inlet and outlet
144 scfm at 7.3 psig discharge pressure
US Electric model T779
10 HP, 230/460 VAC, 3Ø, TEFC motor
Motor mounted on adjustable sliding base
V belt drive with OSHA belt guard
Kunckle model 337, set to 8 psi
Pressure relief valve on heat exchanger discharge
Pressure gage on discharge, 0-15 psi, vibration dampened
Temperature indicator on blower discharge
Barksdale model ML1H-GH3545 temperature switch on blower discharge
Stoddard model D13-2 ½ Inlet silencer, chambered
Stoddard model PD13-2 ½ Discharge silencer/stand, chambered
Inlet filter with replaceable element
Above equipment mounted on common painted steel forkliftable skid

(2) Heat Exchanger, American Industrial Heat Transfer Inc. Model ACA-3302-3

Copper tube aluminum finned heat exchanger
Steel stand with shroud, horizontal discharge
1/2 hp, 230/460VAC, 3Ø, TEFC motor
Approximately 90F ΔT at 144 scfm air flow
11.3" wc pressure drop at 144 scfm
8 psi operating pressure, 200 psi max pressure
Barksdale model ML1H-GH3545 temperature switch on heat exchanger discharge
Temperature gage on heat exchanger discharge
Pressure gage on heat exchanger discharge, 0-15 psi, vibration dampened
Bleed valve with 1 ½" silencer on heat exchanger discharge
3" Gate valve on discharge
Rotron model FM30C250Q flow meter
Venturi flow meter with direct read gage on discharge, scfm
50-250 scfm, 3" connections

(1) Carbonair Series 1000 control system in a NEMA 4 enclosure to mount on the sparge skid. For operation on 460 volt, 3Ø, 3 wire incoming electrical service. To provide control for the 10 HP air sparge blower and 1/2 HP heat exchanger. With all required control pilot devices, alarms and interlocks.

To include:

QTY	DESCRIPTION
1	NEMA 4 enclosure, 24x24x8 with sub-panel
1	Disconnect switch, 60A non-fused with door-interlocked/padlockable operator
1	Power distribution terminal block; 3P
1	Contactor 23A/Circuit protector 1.6-2.5A; (three phase) heat exchanger
1	Contactor 30A/Circuit protector 25.0-40A; air sparge blower
2	Circuit breaker, 1P15A DIN mount; lights, vent fan
1	Circuit breaker, 1P20A DIN mount; receptacle(s)
2	Light, red/LED; alarms
1	Pushbutton, red/NC; alarm reset
2	Switch, three position/Hand-Off-Auto/illuminated-green
1	Control power transformer 460-115 VAC 5kVA (externally mounted) with primary and secondary fusing
	Engraved laminated legends for all door mounted devices
	Terminal blocks for customer connections and fusing as required
	Color-coded wiring with wire markers at all terminations
	Serialized UL508 Industrial Control Panel label
	Fully documented, assembled, wired and pre-shipment test

Notes/Clarifications:

1. Based on 460 volt, 3Ø, 3 wire electrical service.
2. To mount inside the building (no swing panel, padlockable door operator, etc.). Control items mounted on the enclosure outer door.
3. Add a Sensaphone 1104 alarm dialer

Please review and initial each section

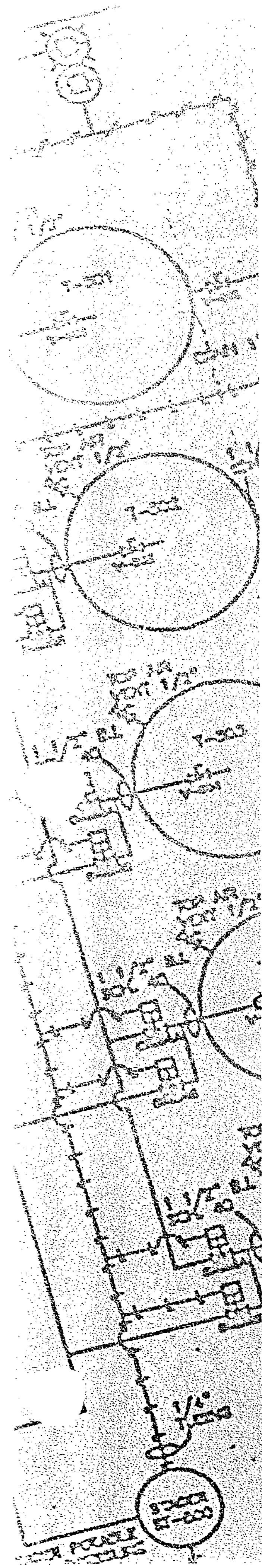
Section 1: AIR SPARGE SYSTEM

(2) Carbonair model AS 4005 soil vapor extraction system

Blower, Roots URAI model 45
Flexible couplings for vibration isolation on blower inlet and outlet
144 scfm at 7.3 psig discharge pressure
US Electric model T779
10 HP, 230/460 VAC, 3Ø, TEFC motor
Motor mounted on adjustable sliding base
V belt drive with OSHA belt guard
Kunckle model 337, set to 8 psi
Pressure relief valve on heat exchanger discharge
Pressure gage on discharge, 0-15 psi, vibration dampened
Temperature indicator on blower discharge
Barksdale model ML1H-GH3545 temperature switch on blower discharge
Stoddard model D13-2 ½ Inlet silencer, chambered
Stoddard model PD13-2 ½ Discharge silencer/stand, chambered
Inlet filter with replaceable element
Above equipment mounted on common painted steel forkliftable skid

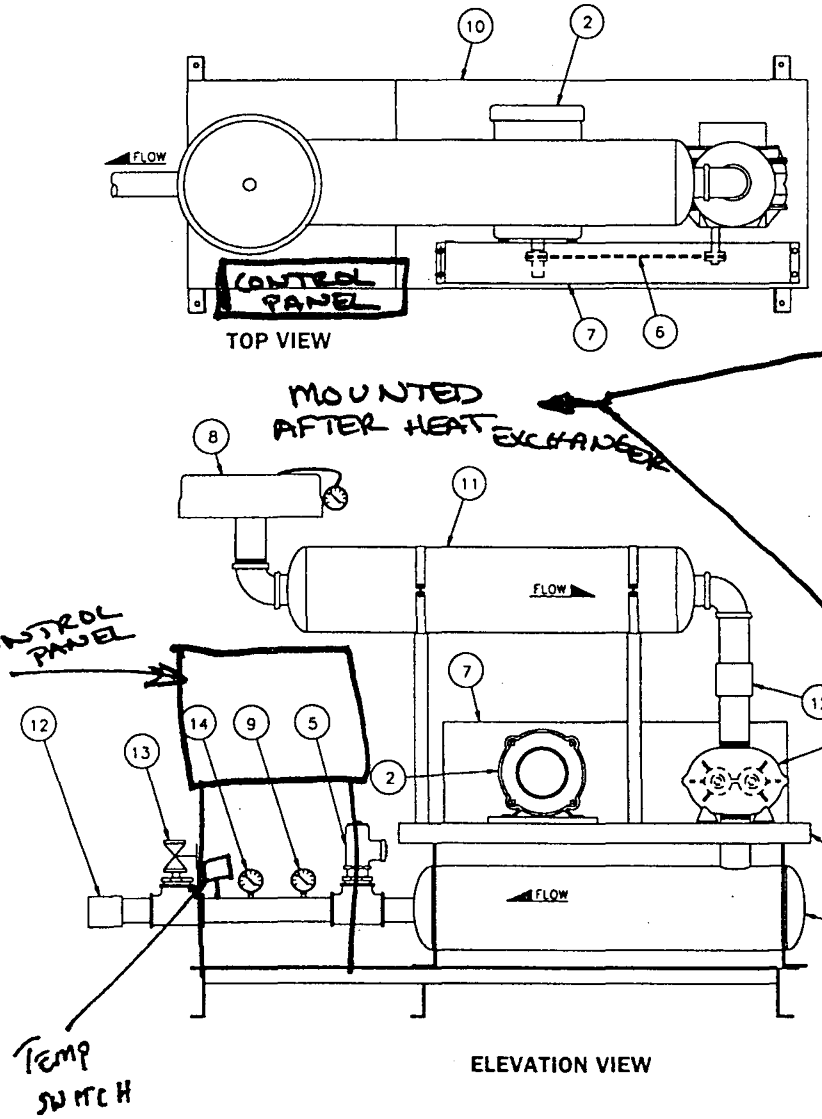
Please review the above Information & Initial the correct box

Approved as is (initial) ______________	
Approved as noted (initial) ______________	



Positive Displacement (PD) Blower Air Sparging Systems

Carbonair's skid-mounted PD blower air sparging systems are sized to meet your requirements and are designed for high performance and ease of installation. A complete line of standard packages are available for quick delivery. Custom packages can be designed to meet specific applications.



1. Blower
2. TEFC or explosion proof motor
3. Equipment stand
4. Discharge silencer
5. Pressure relief valve
6. Belt
7. Belt guard
8. Inlet filter with pressure indicator
9. Pressure gauge
10. Coated carbon steel frame
11. Inlet silencer
12. Flex connection (3)
13. Bleed valve (optional)
14. Temperature indicator (optional)

CARBONAIR®
ENVIRONMENTAL SYSTEMS
2731 Nevada Avenue North
New Hope, MN 55427
800-526-4999 *Toll-free*
612-544-2154 *Voice*
612-544-2151 *Fax*
www.Carbonair.com

Standard Features

- Appropriately sized positive displacement blower with totally enclosed, fan cooled (TEFC) motor.
- Pressure relief valve to provide blower protection from excessive outlet line restrictions.
- All system components mounted on a coated carbon steel skid.
- Low loss inlet filter with replaceable filter element.
- Inlet and outlet silencers.
- System pressure gauge.
- OSHA Belt guard.

Options

- NEMA 7 (explosion proof; for hazardous locations) manual motor starter with thermal overload protection.
- NEMA 4 (waterproof/weather resistant) manual motor starter with thermal overload protection.
- Custom control panel with appropriate NEMA enclosure, with or without UL label.
- Remote control and monitoring package.
- Pressure relief, throttling and air make-up valves.
- Additional pressure and temperature gauges.
- Trailer-mounted or custom enclosures.
- Calibrated flow monitoring assemblies.
- Explosion-proof (XP) blower motor.
- Piping packages.

Specifications

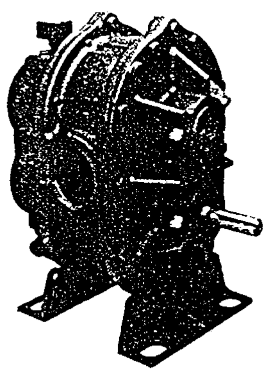
Model	AS 2004	AS 3003	AS 4005	AS 5006	AS 6008	AS 6015
scfm @ 2 PSI	103	136	278	405	595	1116
scfm @ 12 PSI	78	104	228	337	494	986**
Maximum pressure (PSI)	12	12	12	12	12	8
Motor horsepower	3-7.5	5-15	7.5-25 10	10-30	15-50	25-60
Voltage	115/230/460	115/230/460	230/460	230/460	230/460	230/460
Phase*	1 & 3	1 & 3	3	3	3	3
Discharge size	2" NPT	2" NPT	2.5" NPT	4" NPT	5"NPT	6" Flange
Dimensions (LxWxH)	45"X26"X54"	45"X26"X54"	45"X26"X61"	80"X30"X72"	80"x30"x80"	80"x34"x87"
Unit weight	494 pounds	557 pounds	719.5 pounds	1,168 pounds	1,566 pounds	2,058 pounds

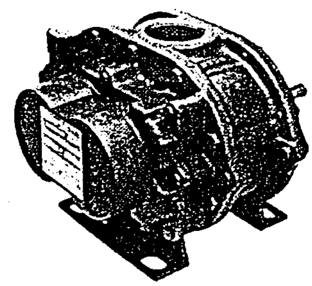
*Only use single phase power for motors less than 7.5 H.P.
**Flow at 8 PSI maximum pressure.

All specifications subject to change without notice.

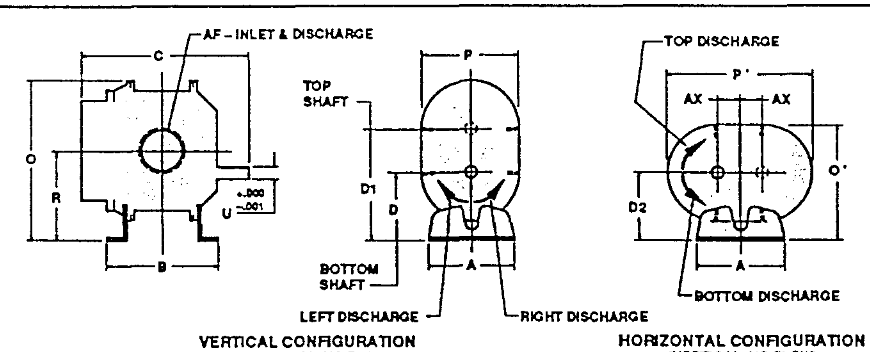
ROOTS Universal RAI® ROTARY POSITIVE BLOWERS

FRAMES 22 THRU 718





OUTLINE DRAWING & DIMENSIONAL TABLE



NOTES:
1. All dimensions are in inches.
2. Do not use for construction.

Frame Size	A	B	C	Drive shaft location D	Drive shaft location D1	Drive shaft location D2	O	O'	P	P'	R	U	Keyway	AF Inlet & Discharge Diameter	AX	Approx. Net Wt. (Lbs.)
22	5.13	5.00	9.75	3.75	6.25	3.75	9.63	6.88	6.25	9.25	5.00	.625	.188 x .094	1.0 NPT	1.25	32
24	5.13	7.00	11.75	3.75	6.25	3.75	9.63	6.88	6.25	9.25	5.00	.625	.188 x .094	2.0 NPT	1.25	43
32	7.25	6.75	11.25	5.00	8.50	5.00	12.81	8.88	7.75	12.13	6.75	.750	.188 x .094	1.25 NPT	1.75	69
33	7.25	7.63	12.13	5.00	8.50	5.00	12.81	8.88	7.75	12.13	6.75	.750	.188 x .094	2.0 NPT	1.75	74
36	7.25	10.00	14.63	5.00	8.50	5.00	12.81	8.88	7.75	12.13	6.75	.750	.188 x .094	2.5 NPT	1.75	102
42	8.00	7.25	13.00	6.25	10.25	6.25	15.06	10.63	8.75	13.63	8.25	.875	.188 x .094	1.5 NPT	2.00	88
45	8.00	10.00	15.50	6.25	10.25	6.25	15.06	10.63	8.75	13.63	8.25	.875	.188 x .094	2.5 NPT	2.00	109
47	8.00	11.75	17.63	6.25	10.25	6.25	15.06	10.50	8.50	13.63	8.25	.875	.188 x .094	3.0 NPT	2.00	128
53	10.50	8.38	15.38	6.25	11.25	6.75	17.38	11.88	10.25	17.25	8.75	1.125	.250 x .125	2.5 NPT	2.50	143
56	10.50	11.00	18.00	6.25	11.25	6.75	17.38	12.25	11.00	17.25	8.75	1.125	.250 x .125	4.0 NPT	2.50	170
59	10.50	14.00	21.18	6.25	11.25	6.75	17.38	12.25	11.00	17.25	8.75	1.125	.250 x .125	4.0 NPT	2.50	204
65	11.00 *	10.00	18.38	8.75	14.75	8.75	21.63	15.13	12.75	19.75	11.75	1.375	.312 x .156	3.0 NPT	3.00	245
68	11.00 *	13.00	21.38	8.75	14.75	8.75	21.63	15.13	12.75	19.75	11.75	1.375	.312 x .156	5.0 NPT	3.00	285
615	11.00 *	20.00	28.38	8.75	14.75	8.75	21.63	16.25	15.00	19.75	11.75	1.375	.312 x .156	6.0 FLG	3.00	425
76	14.00 **	11.75	19.94	11.00	18.00	11.00	26.13	20.69	19.38	23.25	14.50	1.562	.375 x .188	4.0 NPT	3.50	400
711	14.00 **	16.75	25.19	11.00	18.00	11.00	26.13	19.50	17.00	23.25	14.50	1.562	.375 x .188	6.0 FLG	3.50	530
718	14.00 **	23.75	32.19	11.00	18.00	11.00	26.13	19.50	17.00	23.25	14.50	1.562	.375 x .188	8.0 FLG	3.50	650

* 17.00 in horizontal configuration
** 21.00 in horizontal configuration

BASIC BLOWER DESCRIPTION

Universal RAI® blowers are heavy duty rotary blowers in a compact, sturdy design engineered for continuous service when operated within speed and pressure/vacuum ratings.

The basic model features a grey iron casing, carburized and ground alloy steel spur timing gears secured to steel shafts with a taper mounting and locknut, and grey iron involute impellers. Oversized anti-friction bearings are used, with a cylindrical roller bearing at the drive shaft to withstand V-belt pull.

Detachable rugged steel mounting feet permit easy in-field adaptability to either vertical or horizontal installation requirements. Because of the detachable mounting feet, these units can be easily adapted to any of four drive shaft positions – right hand, left hand, bottom or top. All frame sizes are center-timed to allow rotation in either direction.

The Universal RAI incorporates thrust control, and has grease lube on the drive end and splash oil lube on the gear end. Roots exclusive "Figure 8" gearbox design improves oil distribution and lengthens bearing and gear life.

All Universal RAI blowers are covered by an uncontested warranty that guarantees repair or replacement of any unit that malfunctions for any reason. This protects you for a full 18 months from date of original start-up or 24 months from date of shipment, whichever occurs first.

Also available in 5 sizes are RootsPak™ factory-engineered, completely assembled packaged units incorporating 16 frame sizes of Universal RAI rotary positive blowers. For complete information on these units, please turn to pages 8 and 9.

Uncontested Warranty

For details, see page 3.

UNIVERSAL RAI® PERFORMANCE TABLE

ROOTS DRESSER

FRAME SIZE	SPEED RPM	1 PSI		2 PSI		3 PSI		4 PSI		5 PSI		6 PSI		7 PSI		10 PSI		11 PSI		12 PSI		15 PSI		MAX. VACUUM		
		CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	"Hg	CFM	BHP
	1160	10	0.2	7	0.3	4	0.3	2	0.4															4	6	0.3
22	3600	49	0.6	46	0.8	43	1.1	41	1.3	39	1.6	38	1.8	36	2.1	32	2.8	31	3.1	29	3.3			14	28	2.0
	5275	76	0.8	73	1.2	70	1.6	68	1.9	66	2.3	64	2.7	63	3.1	59	4.2	57	4.5	56	4.9			14	55	3.0
	1160	24	0.3	19	0.4	15	0.6	11	0.8	8	0.9													6	12	0.6
24	3600	102	0.8	97	1.3	93	1.8	89	2.3	86	2.8	83	3.3	81	3.8									14	69	3.8
	5275	156	1.2	150	1.9	146	2.7	143	3.4	140	4.2	137	4.9	135	5.6									14	122	5.5
	1160	40	0.4	34	0.6	30	0.9	27	1.1	24	1.3	21	1.6	19	1.8									10	18	1.3
32	2800	113	1.0	108	1.6	104	2.1	101	2.7	98	3.2	95	3.8	93	4.3	86	6.0	84	6.5	82	7.1	77	8.7	15	78	4.5
	3600	149	1.3	144	2.0	140	2.7	137	3.4	134	4.1	131	4.8	129	5.5	122	7.7	120	8.4	118	9.1	113	11.2	15	114	5.8
	1160	55	0.5	48	0.8	43	1.1	39	1.4	35	1.7	31	2.1	28	2.4									10	27	1.7
33	2800	156	1.2	149	2.0	144	2.7	140	3.5	136	4.2	132	5.0	129	5.7	120	8.0	118	8.7	116	9.5			14	113	5.6
	3600	205	1.6	199	2.5	193	3.5	189	4.5	185	5.4	181	6.4	178	7.4	170	10.3	167	11.2	165	12.2			14	163	7.2
	1160	95	0.7	85	1.2	78	1.7	72	2.3	66	2.8	61	3.3	57	3.8									10	55	2.7
36	2800	262	1.7	253	3.0	245	4.2	239	5.4	234	6.7	229	7.9	224	9.2									12	213	7.8
	3600	344	2.2	334	3.8	327	5.4	321	7.0	315	8.6	310	10.2	306	11.8									14	284	11.6
	860	38	0.4	32	0.6	28	0.9	24	1.1	21	1.3	18	1.5	15	1.8									8	19	1.1
42	1760	92	0.8	87	1.3	82	1.8	78	2.2	75	2.7	72	3.1	69	3.6	62	5.0	60	5.5	58	5.9			14	56	3.5
	3600	204	1.7	198	2.6	194	3.6	190	4.5	186	5.5	183	6.4	181	7.4	173	10.2	171	11.2	169	12.1	163	15.0	14	167	7.2
	860	79	0.6	68	1.1	60	1.5	53	2.0	48	2.4	42	2.9	37	3.4									8	46	1.9
45	1760	188	1.3	177	2.2	169	3.1	162	4.1	156	5.0	151	5.9	146	6.9	133	9.6							12	134	5.8
	3600	410	2.6	400	4.5	392	6.4	385	8.3	379	10.2	374	12.1	369	14.0	356	19.7							14	345	13.7
	860	109	0.8	97	1.4	89	2.0	81	2.6	74	3.2	68	3.8	63	4.4									8	72	2.5
47	1760	253	1.6	241	2.8	232	4.0	225	5.3	218	6.5	212	7.7	206	8.9									12	193	7.5
	3600	546	3.2	535	5.7	526	8.2	518	10.7	511	13.2	505	15.8	500	18.3									14	473	17.9
	700	72	0.6	63	1.0	56	1.4	51	1.8	46	2.2	42	2.6	38	3.0									10	36	2.2
53	1760	211	1.5	203	2.6	196	3.6	191	4.6	186	5.6	181	6.6	177	7.6	167	10.7	163	11.7	160	12.7			14	158	7.5
	2850	355	2.5	346	4.1	340	5.8	334	7.4	329	9.1	325	10.7	321	12.3	310	17.2	307	18.9	304	20.5	295	25.4	14	301	12.1
	700	123	0.9	110	1.6	100	2.2	92	2.9	85	3.6	78	4.3	72	4.9									10	70	3.5
56	1760	358	2.2	345	3.9	335	5.6	326	7.3	319	9.0	312	10.7	306	12.4	290	17.5							14	276	12.1
	2850	598	3.6	585	6.4	575	9.1	567	11.9	560	14.6	553	17.3	547	20.1	531	28.3							14	517	19.7
	700	187	1.2	170	2.2	158	3.2	147	4.2	138	5.1	130	6.1											8	135	4.1
59	1760	529	3.0	513	5.5	500	8.0	490	10.5	480	12.9	472	15.4	464	17.9									12	445	15.1
	2850	881	4.9	865	8.9	852	12.9	842	16.9	832	20.9	824	25.0	816	29.0									14	779	28.3
	700	140	1.0	126	1.8	116	2.6	107	3.3	100	4.1	93	4.8	86	5.5	70	7.8							12	71	4.7
65	1760	400	2.6	387	4.5	377	6.4	368	8.3	360	10.2	353	12.1	347	13.9	330	19.6	325	15.3	320	23.4	307	29.1	16	300	15.5
	2350	546	3.5	532	6.0	522	8.5	513	11.1	506	13.6	499	16.1	492	18.6	475	26.2	470	28.7	466	31.2	452	38.8	16	445	20.7
	700	224	1.5	203	2.7	187	3.9	172	5.1	160	6.3	149	7.5	139	8.7									10	135	6.2
68	1760	643	3.8	621	6.8	605	9.8	591	12.9	579	15.9	567	18.9	557	22.0	530	31.0	522	34.1	515	37.1			15	495	23.0
	2350	876	5.0	855	9.1	838	13.1	824	17.2	812	21.2	801	25.3	790	29.3	763	41.5	755	45.5	748	49.6			16	715	32.6
	700	420	2.6	380	4.8	351	7.1	323	9.3	301	11.6	279	13.8											8	292	9.1
615	1760	1205	6.4	1164	12.1	1133	17.8	1107	23.5	1084	29.1	1063	34.8											12	997	34.1
	2350	1641	8.6	1601	16.1	1570	23.7	1544	31.3	1521	38.9	1500	46.5											12	1433	45.5
	575	195	1.3	179	2.3	168	3.3	158	4.3	150	5.4	142	6.4	134	7.4	115	10.4							12	117	6.2
76	1400	526	3.2	511	5.7	500	8.1	490	10.6	481	13.0	473	15.5	466	17.9	447	25.3	441	27.8	436	30.2	421	37.6	16	413	20.0
	2050	788	4.7	772	8.3	761	11.9	751	15.5	742	19.1	734	22.7	727	26.3	708	37.1	703	40.7	697	44.2	682	55.0	16	674	29.2
	575	362	2.2	336	4.0	316	5.9	299	7.7	284	9.6	271	11.4	258	13.3	226	18.8							12	228	11.2
711	1400	970	5.3	944	9.8	925	14.3	908	18.8	893	23.3	880	27.8	867	32.3	835	45.8							15	793	33.8
	2050	1450	7.7	1424	14.3	1404	20.9	1387	27.5	1373	34.1	1359	40.7	1347	47.3	1315	67.1							16	1256	52.7
	575	600	3.3	563	6.3	534	9.3	510	12.3	489	15.4	470	18.4											10	446	15.0
718	1400	1590	8.1	1553	15.4	1524	22.7	1500	30.1	1479	37.4	1460	44.7											12	1398	43.8
	2050	2370	11.9	2333	22.6	2304	33.3	2280	44.0	2259	54.8	2240	65.5											12	2178	64.1

Notes: 1. Pressure ratings based on inlet air at standard pressure of 14.7 psia, standard temperature of 68°F, and specific gravity of 1.0.
2. Vacuum ratings based on inlet air at standard temperature of 68°F, discharge pressure of 30" Hg and specific gravity of 1.0.

Performance specifications

Universal RAI® Pressure table

ROOTS DRESSER

Frame Size	Speed RPM	1 PSI		2 PSI		4 PSI		6 PSI		7 PSI		8 PSI		10 PSI		12 PSI		15 PSI	
		CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
	1160	10	0.2	7	0.3	2	0.4												
22	3600	49	0.6	46	0.8	41	1.3	38	1.8	36	2.1	35	2.3	32	2.8	29	3.3		
	5275	76	0.8	73	1.2	68	1.9	64	2.7	63	3.1	61	3.4	59	4.2	56	4.9		
	1160	24	0.3	19	0.4	11	0.8												
24	3600	102	0.8	97	1.3	89	2.3	83	3.3	81	3.8								
	5275	156	1.2	150	1.9	143	3.4	137	4.9	135	5.6								
	1160	40	0.4	34	0.6	27	1.1	21	1.6	19	1.8	17	2.0						
32	2800	113	1.0	108	1.6	101	2.7	95	3.8	93	4.3	90	4.9	86	6.0	82	7.1	77	8.7
	3600	149	1.3	144	2.0	137	3.4	131	4.8	129	5.5	126	6.2	122	7.7	118	9.1	113	11.2
	1160	55	0.5	48	0.8	39	1.4	31	2.1	28	2.4								
33	2800	156	1.2	149	2.0	140	3.5	132	5.0	129	5.7	126	6.5	120	8.0	116	9.5		
	3600	205	1.6	199	2.5	189	4.5	181	6.4	178	7.4	175	8.3	170	10.3	165	12.2		
	1160	95	0.7	85	1.2	72	2.3	61	3.3	57	3.8								
36	2800	262	1.7	253	3.0	239	5.4	229	7.9	224	9.2								
	3600	344	2.2	334	3.8	321	7.0	310	10.2	306	11.8								
	860	38	0.4	32	0.6	24	1.1	18	1.5	15	1.8								
42	1760	92	0.8	87	1.3	78	2.2	72	3.1	69	3.6	67	4.1	62	5.0	58	5.9		
	3600	204	1.7	198	2.6	190	4.5	183	6.4	181	7.4	178	8.3	173	10.2	169	12.1	163	15.0
	860	79	0.6	68	1.1	53	2.0	42	2.9	37	3.4								
45	1760	188	1.3	177	2.2	162	4.1	151	5.9	146	6.9	141	7.8	133	9.6				
	3600	410	2.6	400	4.5	385	8.3	374	12.1	369	14.0	364	15.9	356	19.7				
	860	109	0.8	97	1.4	81	2.6	68	3.8	63	4.4								
47	1760	253	1.6	241	2.8	225	5.3	212	7.7	206	8.9								
	3600	546	3.2	535	5.7	518	10.7	505	15.8	500	18.3								
	700	72	0.6	63	1.0	51	1.8	42	2.6	38	3.0								
53	1760	211	1.5	203	2.6	191	4.6	181	6.6	177	7.6	173	8.6	167	10.7	160	12.7		
	2850	355	2.5	346	4.1	334	7.4	325	10.7	321	12.3	317	14.0	310	17.2	304	20.5	295	25.4
	700	123	0.9	110	1.6	92	2.9	78	4.3	72	4.9	66	5.6						
56	1760	358	2.2	345	3.9	326	7.3	312	10.7	306	12.4	300	14.1	290	17.5				
	2850	598	3.6	585	6.4	567	11.9	553	17.3	547	20.1	541	22.8	531	28.3				
	700	187	1.2	170	2.2	147	4.2	130	6.1										
59	1760	529	3.0	513	5.5	490	10.5	472	15.4	464	17.9								
	2850	881	4.9	865	8.9	842	16.9	824	25.0	816	29.0								
	700	140	1.0	126	1.8	107	3.3	93	4.8	86	5.5	80	6.3	70	7.8				
65	1760	400	2.6	387	4.5	368	8.3	353	12.1	347	14.0	341	15.8	330	19.6	320	23.4	307	29.1
	2350	546	3.5	532	6.0	513	11.1	499	16.1	492	18.6	486	21.1	475	26.2	466	31.2	452	38.8
	700	224	1.5	203	2.7	172	5.1	149	7.5	139	8.7	129	9.9						
68	1760	643	3.8	621	6.8	591	12.9	567	18.9	557	22.0	548	25.0	530	31.0	515	37.1		
	2350	876	5.0	855	9.1	824	17.2	801	25.3	790	29.3	781	33.4	763	41.5	748	49.6		
	700	420	2.6	380	4.8	323	9.3	279	13.8										
615	1760	1205	6.4	1164	12.1	1107	23.5	1063	34.8										
	2350	1641	8.6	1601	16.1	1544	31.3	1500	46.5										
	575	195	1.3	179	2.3	158	4.3	142	6.4	134	7.4	128	8.4	115	10.4				
76	1400	526	3.2	511	5.7	490	10.6	473	15.5	466	17.9	459	20.4	447	25.3	436	30.2	421	37.6
	2050	788	4.7	772	8.3	751	15.5	734	22.7	727	26.3	721	29.9	708	37.1	697	44.2	682	55.0
	575	362	2.2	336	4.0	299	7.7	271	11.4	258	13.3	247	15.1	226	18.8				
711	1400	970	5.3	944	9.8	908	18.8	880	27.8	867	32.3	856	36.8	835	45.8				
	2050	1450	7.7	1424	14.3	1387	27.5	1359	40.7	1347	47.3	1335	53.9	1315	67.1				
	575	600	3.3	563	6.3	510	12.3	470	18.4										
718	1400	1590	8.1	1553	15.4	1500	30.1	1460	44.7										
	2050	2370	11.9	2333	22.6	2280	44.0	2240	65.5										

Ratings based on inlet air at standard temperature of 68°F, ambient pressure of 14.7 psia and specific gravity of 1.0.

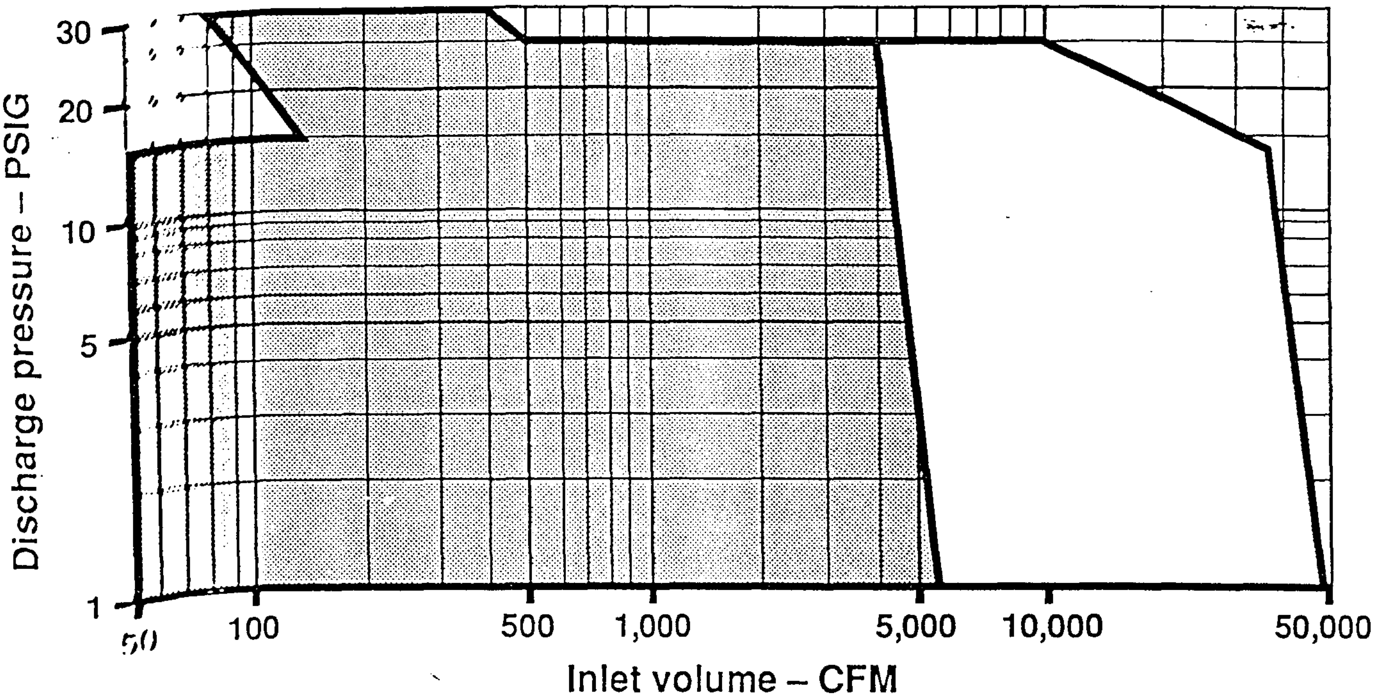
Universal RAI® Vacuum table

ROOTS DRESSER

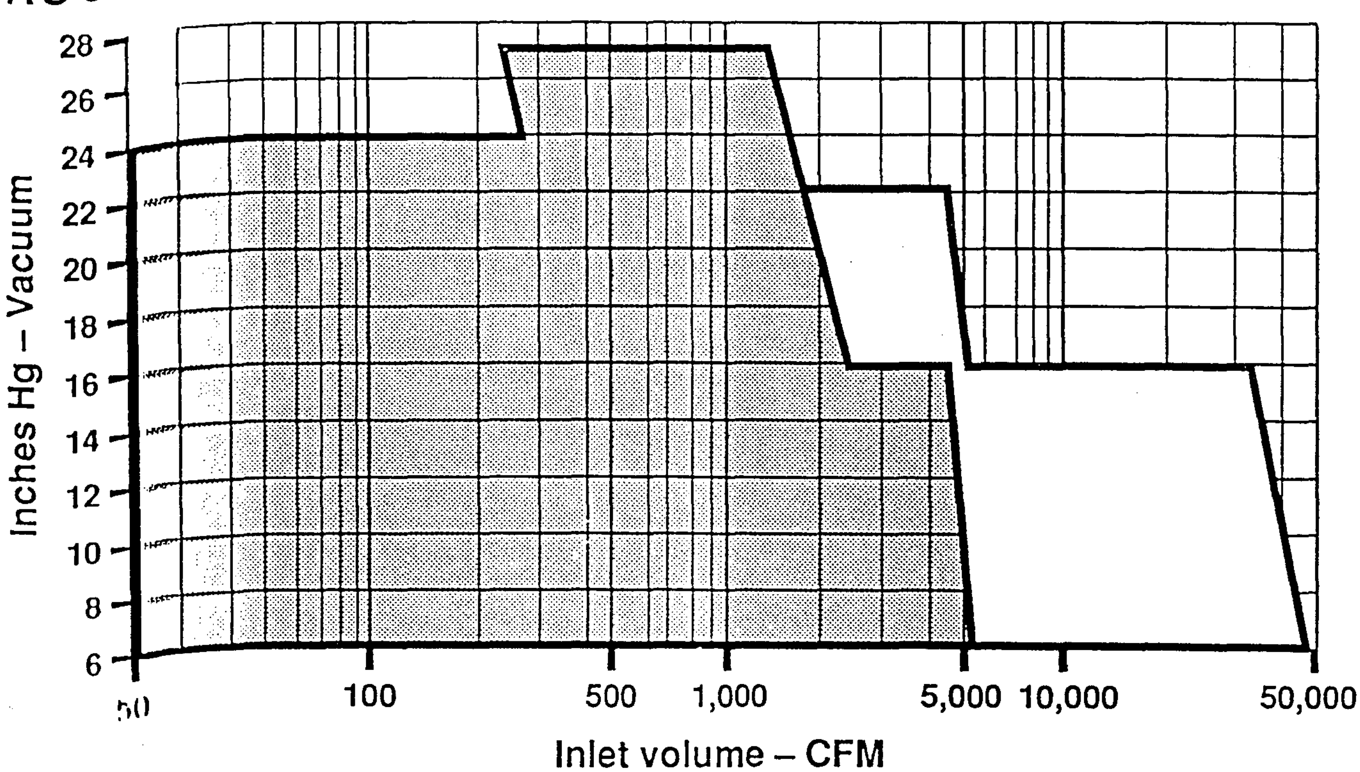
Frame Size	Speed RPM	4" Hg Vacuum		6" Hg Vacuum		8" Hg Vacuum		10" Hg Vacuum		12" Hg Vacuum		14" Hg Vacuum		15" Hg Vacuum		16" Hg Vacuum	
		CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
22	1160	6	0.3														
	3600	45	0.8	42	1.1	39	1.3	35	1.6	32	1.8	28	2.0				
	5275	72	1.2	69	1.6	66	1.9	62	2.3	59	2.6	55	3.0				
24	1160	18	0.4	12	0.6												
	3600	96	1.3	90	1.8	85	2.3	80	2.8	75	3.3	69	3.8				
	5275	149	1.9	144	2.6	139	3.4	134	4.1	128	4.8	122	5.5				
32	1160	33	0.6	28	0.9	23	1.1	18	1.3								
	2800	107	1.5	102	2.1	97	2.6	92	3.1	87	3.7	81	4.2	78	4.5		
	3600	143	2.0	138	2.7	133	3.4	128	4.0	123	4.7	117	5.4	114	5.8		
33	1160	47	0.8	40	1.1	33	1.4	27	1.7								
	2800	148	1.9	141	2.7	134	3.4	128	4.1	121	4.9	113	5.6				
	3600	197	2.5	190	3.4	184	4.4	177	5.3	170	6.3	163	7.2				
36	1160	83	1.2	74	1.7	65	2.2	55	2.7								
	2800	251	2.9	241	4.1	232	5.3	223	6.6	213	7.8						
	3600	332	3.7	323	5.3	313	6.9	304	8.4	294	10.0	284	11.6				
42	860	31	0.6	25	0.8	19	1.1										
	1760	85	1.3	79	1.7	74	2.2	68	2.6	62	3.1	56	3.5				
	3600	197	2.6	191	3.5	185	4.4	180	5.4	174	6.3	167	7.2				
45	860	66	1.1	56	1.5	46	1.9										
	1760	175	2.2	164	3.1	154	4.0	144	4.9	134	5.8						
	3600	398	4.4	387	6.3	377	8.2	367	10.0	356	11.9	345	13.7				
47	860	95	1.3	83	1.9	72	2.5										
	1760	239	2.8	227	3.9	216	5.1	205	6.3	193	7.5						
	3600	532	5.6	520	8.1	509	10.5	498	13.0	486	15.4	473	17.9				
53	700	61	1.0	53	1.4	44	1.8	36	2.2								
	1760	201	2.5	192	3.5	184	4.5	176	5.5	167	6.5	158	7.5				
	2850	345	4.1	336	5.7	328	7.3	320	8.9	311	10.5	301	12.1				
56	700	108	1.5	95	2.2	82	2.9	70	3.5								
	1760	342	3.9	329	5.5	316	7.2	304	8.8	291	10.5	276	12.1				
	2850	583	6.2	570	8.9	557	11.6	545	14.3	532	17.0	517	19.7				
59	700	167	2.1	151	3.1	135	4.1										
	1760	509	5.4	493	7.8	477	10.2	462	12.7	445	15.1						
	2850	861	8.7	845	12.6	829	16.6	814	20.5	797	24.4	779	28.3				
65	700	123	1.8	110	2.5	97	3.2	84	4.0	71	4.7						
	1760	384	4.4	371	6.3	358	8.1	345	10.0	331	11.8	317	13.7	308	14.6	300	15.5
	2350	529	5.9	516	8.4	503	10.8	490	13.3	476	15.8	462	18.2	454	19.5	445	20.7
68	700	198	2.7	177	3.8	156	5.0	135	6.2								
	1760	617	6.7	595	9.6	575	12.6	554	15.6	532	18.5	508	21.5	495	23.0		
	2350	850	8.9	828	12.9	808	16.8	787	20.8	765	24.7	741	28.7	728	30.7	715	32.6
615	700	371	4.7	331	6.9	292	9.1										
	1760	1156	11.8	1115	17.4	1077	23.0	1038	28.5	997	34.1						
	2350	1592	15.8	1552	23.2	1513	30.6	1474	38.1	1433	45.5						
76	575	176	2.3	161	3.3	147	4.3	132	5.2	117	6.2						
	1400	508	5.6	493	8.0	478	10.4	464	12.8	448	15.2	432	17.6	423	18.8	413	20.0
	2050	769	8.2	754	11.7	740	15.2	725	18.7	710	22.2	693	25.7	684	27.5	674	29.2
711	575	330	3.9	304	5.7	279	7.6	254	9.4	228	11.2						
	1400	939	9.6	913	14.0	888	18.4	863	22.8	837	27.2	808	31.6	793	33.8		
	2050	1419	14.0	1393	20.5	1368	26.9	1343	33.4	1317	39.8	1288	46.3	1272	49.5	1256	52.7
718	575	555	6.2	517	9.1	482	12.1	446	15.0								
	1400	1545	15.1	1507	22.3	1472	29.4	1436	36.6	1398	43.8						
	2050	2325	22.1	2287	32.6	2252	43.1	2216	53.6	2178	64.1						

Ratings based on inlet air at standard temperature of 68°F, discharge pressure of 30" Hg and specific gravity of 1.0.

PRESSURE CAPABILITY FOR ROOTS ROTARY LOBE BLOWERS



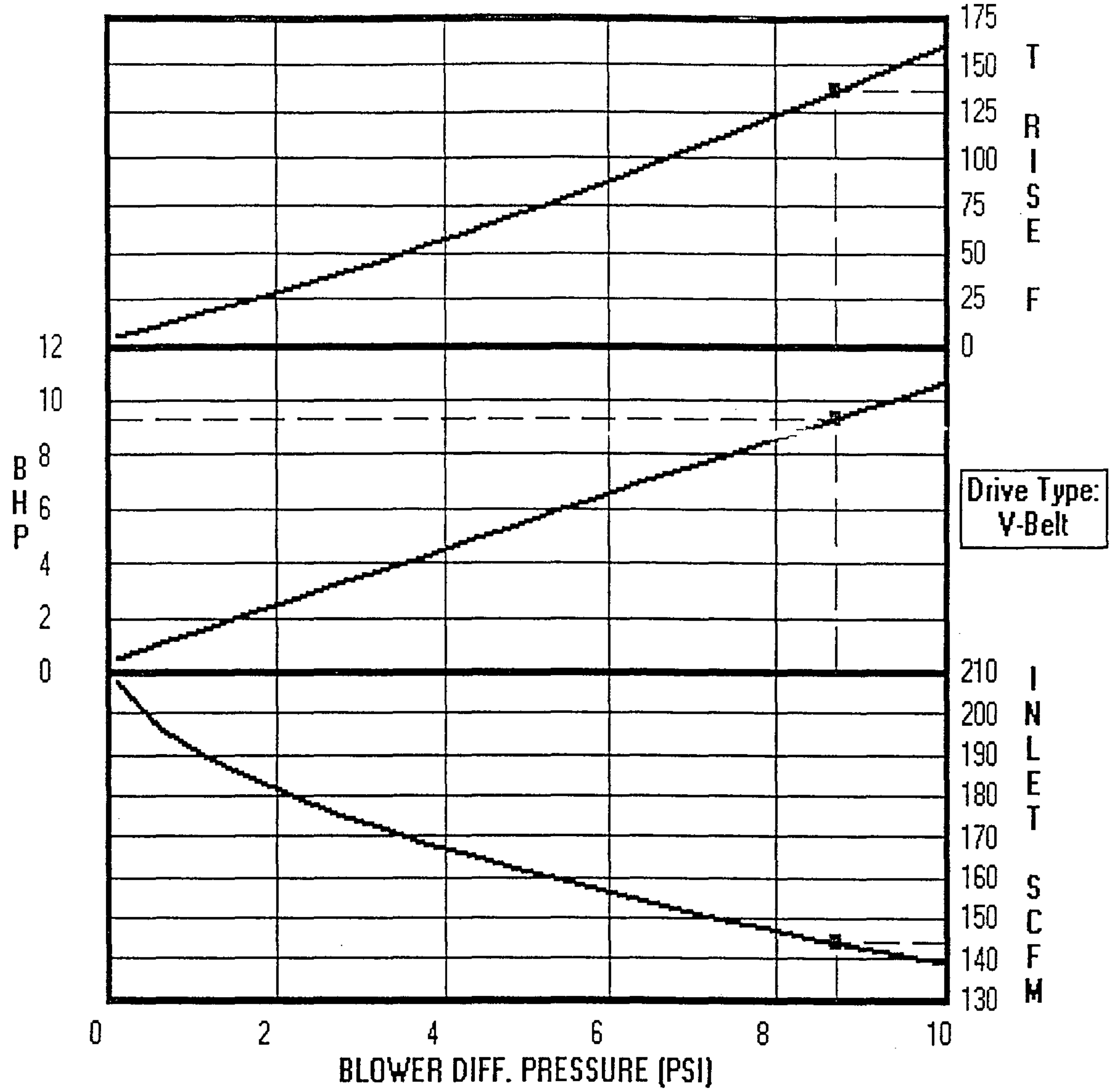
VACUUM CAPABILITY FOR ROOTS ROTARY LOBE BLOWERS & VACUUM PUMPS



NOTE: Units described in this bulletin are shown as shaded areas in the performance maps above. For larger capacity units in the white areas, please contact Factory.

45 URAI: Variable Pressure Performance

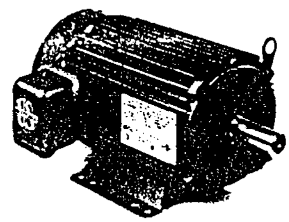
ROOTS DIVISION, DRESSER EQUIPMENT GROUP



COND'S: AIR
RH = 40.00%, MW = 28.861, k = 1.396, Tin = 68 deg F
DESIGN: Speed = 1936 RPM
System Inlet P = 14.25 PSIA, Inlet P Loss = 0.7 PSI
System Disch P = 7.3 PSIG, Disch P Loss = 0.7 PSI
STD: RH = 36%, T = 68 deg F, P = 14.7 PSIA

NERAL PURPOSE
THREE PHASE, TEFC UNIMOUNT
ENERGY EFFICIENT

WORLD MOTOR



Typical 184T frame

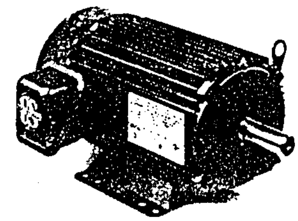
APPLICATIONS:
Pumps, Fans, Compressors, Material Handling and other general purpose applications in damp, dusty or dirty environments.

FEATURES:
* Fully comply with EPACT '92 and NRCan efficiency standards
* Suitable for wye-delta start on 250T frame and larger
* Dual voltage ratings suitable for part wind start on lower voltage
* Full 50 and 60 Hz operating data on nameplate (3)
* Sealed bearings on 140T frame, double shielded bearings on 180T and larger
* Class F insulation system, class B rise at full load (4)
* C-face, D-flange, brake and dripcover kits available. See page 145-149
* Removeable base
* NEMA Design B performance (4)
* 56C - 140T Rolled steel frame construction
* 180T - 280T Aluminum frame construction
* Aluminum end shields
* Lifting provisions on 180T frame and larger
* "CE" mark on nameplate

HP	RPM	FRAME	VOLTS	CATALOG NUMBER	MODEL	TYPE	LIST $	DS SYM	SF(1)	FULL LOAD EFF	FULL LOAD PF	SHIP WGT	NOTES
4	1800	56C	208-230/460	U14S2AC	F001	UT	$196	3F	1.25	66.0	49.2	25	26
	1800	56C	575	U14S2GC	F002	UT	$196	3F	1.25	74.0	68.1	25	26
	1200	56C	208-230/460	U14S3AC	F003	UT	$276	3F	1.25	72.0	54.5	25	26
1/3	1800	56C	208-230/460	U13S2AC	F004	UT	$220	3F	1.25	70.0	57.7	25	26
	1800	56C	575	U13S2GC	F005	UT	$220	3F	1.25	74.0	69.7	25	26
	1200	56C	208-230/460	U13S3AC	F006	UT	$292	3F	1.25	74.0	63.5	25	26
	1200	56C	575	U13S3GC	G84934	UT	$292	3F	1.25	74.0	63.5	25	26
1/2	3600	56C	208-230/460	U12S1AC	F007	UT	$188	3F	1.25	70.0	85.8	25	26
	1800	56C	208-230/460	U12S2AC	F008	UT	$246	3F	1.25	74.0	71.1	25	26
	1800	56C	575	U12S2GC	F009	UT	$246	3F	1.25	74.0	67.8	25	26
	1200	56C	208-230/460	U12S3AC	F010	UT	$320	3F	1.25	72.0	60.9	25	26
	1200	56C	575	U12S3GC	G64947	UT	$320	3F	1.25	72.0	60.9	25	26
3/4	3600	56C	208-230/460	U34S1AC	F011	UT	$224	3F	1.25	74.0	85.3	25	26
	1800	56C	208-230/460	U34S2AC	F012	UT	$272	3F	1.25	75.5	66.6	27	26
	1800	56C	575	U34S2GC	F013	UT	$272	3F	1.25	75.5	66.7	27	26
	1200	56C	208-230/460	U34S3AC	F014	UT	$330	3F	1.25	72.0	61.2	30	26
	1200	56C	575	U34S3GC	G81998	UT	$330	3F	1.25	72.0	61.2	30	26
1	3600	56	200	U1E1H	S401	FUT	$252	3FF	1.25	75.5	80.9	32	
	3600	56	208-230/460	U1E1D	S402	FUT	$252	3FF	1.25	75.5	88.7	32	3
	3600	56	460	U1E1F	S403	FUT	$252	3FF	1.25	75.5	85.7	32	3
	3600	56	575	U1E1G	S404	FUT	$252	3FF	1.25	75.5	81.1	32	
	1800	143T	200	U1E2H	S405	FUT	$260	3FTE	1.25	82.5	76.2	35	
	1800	143T	208-230/460	U1E2D	S406	FUT	$260	3FTE	1.25	82.5	76.2	35	3
	1800	143T	460	U1E2F	S407	FUT	$260	3FTE	1.25	82.5	76.2	35	3
	1800	143T	575	U1E2G	S408	FUT	$260	3FTE	1.25	82.5	76.1	35	

GENERAL PURPOSE
THREE PHASE, TEFC UNIMOUNT
ENERGY EFFICIENT

WORLD MOTOR



Typical 184T frame

APPLICATIONS:

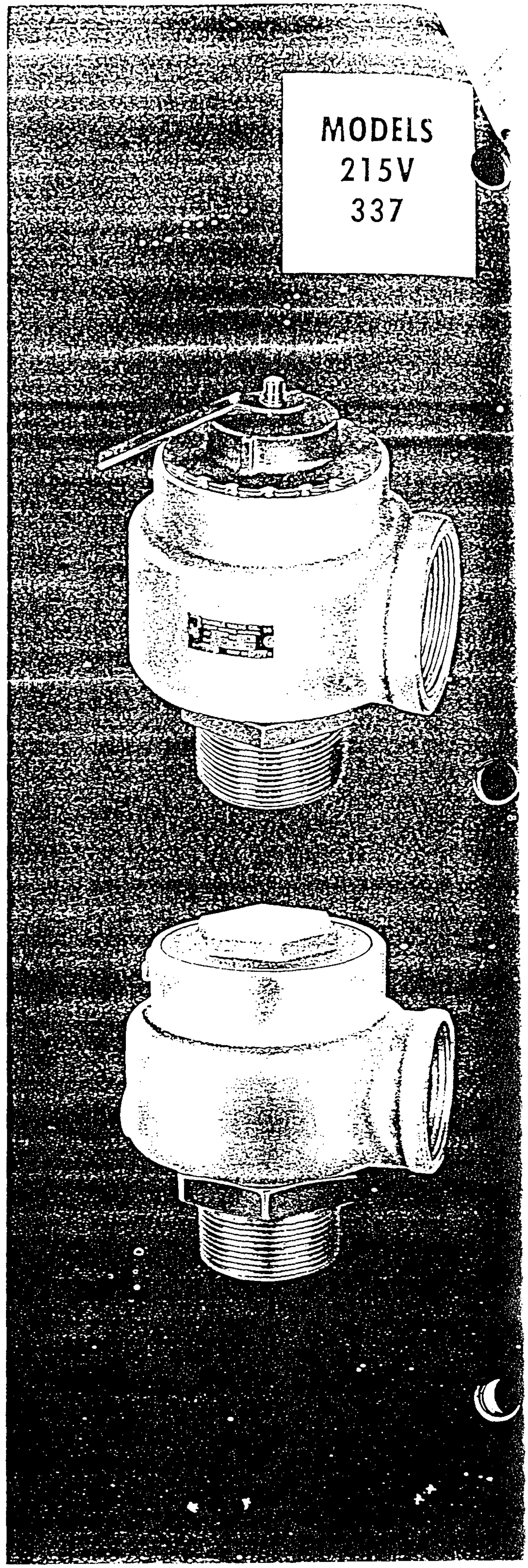
Pumps, Fans, Compressors, Material Handling and other general purpose applications in damp, dusty or dirty environments.

HP	RPM	FRAME	VOLTS	CATALOG NUMBER	MODEL	TYPE	LIST $	DS SYM	SF(1)	FULL LOAD EFF	FULL LOAD PF	SHIP WGT	NOTES
5	1800	184T	200	U5E2H	T746	FUT	$396	3FTE	1.25	87.5	83.6	70	
	1800	184T	208-230/460	U5E2D	T747	FUT	$396	3FTE	1.25	87.5	83.6	70	3
	1800	184T	460	U5E2F	T748	FUT	$396	3FTE	1.25	87.5	83.6	70	3
	1800	184T	575	U5E2G	T749	FUT	$396	3FTE	1.25	87.5	83.5	70	
	1200	215T	200	U5E3H	T750	FUT	$702	3FTE	1.25	87.5	74.7	135	
	1200	215T	208-230/460	U5E3D	T751	FUT	$702	3FTE	1.25	87.5	73.7	135	3
	1200	215T	460	U5E3F	T752	FUT	$702	3FTE	1.25	87.5	73.7	135	3
	1200	215T	575	U5E3G	T753	FUT	$702	3FTE	1.25	87.5	73.7	135	
	900	254T	200	U5E4H	S569	FUT	$1,421	3FTE	1.25	85.5	75.5	200	2
	900	254T	208-230/460	U5E4D	S570	FUT	$1,421	3FTE	1.25	85.5	74.2	200	3, 2
	900	254T	460	U5E4F	S571	FUT	$1,421	3FTE	1.25	85.5	74.2	200	3, 2
	900	254T	575	U5E4G	S572	FUT	$1,421	3FTE	1.25	85.5	74.4	200	2
7-1/2	3600	213T	200	U7E1H	T758	FUT	$568	3FTE	1.25	88.5	86.3	100	
	3600	213T	208-230/460	U7E1D	T759	FUT	$568	3FTE	1.25	88.5	86.4	100	3
	3600	213T	460	U7E1F	T760	FUT	$568	3FTE	1.25	88.5	86.4	100	3
	3600	213T	575	U7E1G	T761	FUT	$568	3FTE	1.25	88.5	86.0	100	
	1800	213T	200	U7E2H	T762	FUT	$568	3FTE	1.25	89.5	83.7	110	
	1800	213T	208-230/460	U7E2D	T763	FUT	$568	3FTE	1.25	89.5	83.7	110	3
	1800	213T	460	U7E2F	T764	FUT	$568	3FTE	1.25	89.5	83.7	110	3
	1800	213T	575	U7E2G	T765	FUT	$568	3FTE	1.25	89.5	83.8	110	
	1200	254T	200	U7E3H	S573	FUT	$924	3FTE	1.25	89.5	84.9	200	
	1200	254T	208-230/460	U7E3D	S574	FUT	$924	3FTE	1.25	89.5	84.8	200	3, 2
	1200	254T	460	U7E3F	S575	FUT	$924	3FTE	1.25	89.5	84.8	200	3, 2
	1200	254T	575	U7E3G	S576	FUT	$924	3FTE	1.25	89.5	84.6	200	2
	900	256T	200	U7E4H	S577	FUT	$1,762	3FTE	1.25	85.5	76.5	250	2
	900	256T	230/460	U7E4D	S578	FUT	$1,762	3FTE	1.25	85.5	76.4	250	3, 2
	900	256T	460	U7E4F	S579	FUT	$1,762	3FTE	1.25	85.5	76.4	250	3, 2
	900	256T	575	U7E4G	S580	FUT	$1,762	3FTE	1.25	85.5	76.7	250	2
10	3600	215T	200	U10E1H	T774	FUT	$663	3FTE	1.25	89.5	88.0	110	
	3600	215T	208-230/460	U10E1D	T775	FUT	$663	3FTE	1.25	89.5	88.1	110	3
	3600	215T	460	U10E1F	T776	FUT	$663	3FTE	1.25	89.5	88.1	110	3
	3600	215T	575	U10E1G	T777	FUT	$663	3FTE	1.25	89.5	88.1	110	
	1800	215T	200	U10E2H	T778	FUT	$688	3FTE	1.25	89.5	84.7	130	
	1800	215T	208-230/460	U10E2D	T779	FUT	$688	3FTE	1.25	89.5	84.9	130	3
	1800	215T	460	U10E2F	T780	FUT	$688	3FTE	1.25	89.5	84.9	130	3
	1800	215T	575	U10E2G	T781	FUT	$688	3FTE	1.25	89.5	84.8	130	

KUNKLE®
Valve Division

CAST IRON SAFETY VALVES

FOR AIR AND VACUUM SERVICE



KUNKLE®
Valve Division

IRON SAFETY AND VACUUM VALVES

MODELS 215V 337

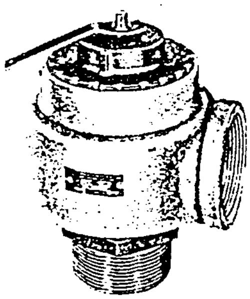
PRESSURE LIMITS 337 — 60 PSIG-300°F.

VACUUM LIMITS 215V — 22" HG.-300°F.

ASME Standard
UV
N.B. Certified

APPLICATIONS

- Protection of low to medium pressure high volume blowers, compressors and pneumatic conveying systems.
- Bulk hauling trailers/equipment.
- Light gauge tanks.
- Protection of high volume vacuum pumps and conveying systems.



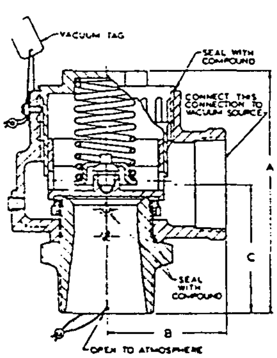
MODEL 337

FEATURES

High capacity full nozzle design. Bronze nozzle, disc and guide with cast iron housing. Flat bronze valve seats are lapped for optimum performance. Warn ring offers easy adjustability for precise opening with minimum preopen or simmer and exact blowdown control. Pivot between disc and spring corrects mis-alignment and compensates for spring side thrust. Model 337 has reversible lift lever for "pull-up" or "pull-down" manual testing. Every valve 100% tested/inspected for pressure setting, blowdown and leakage. All adjustments are factory sealed to prevent tampering or dis-assembly.

SPECIFICATIONS

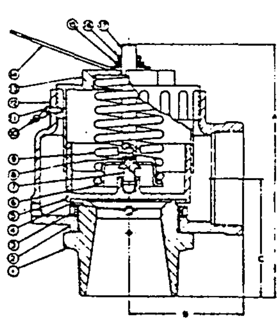
SIZE IN & OUT	A		B	C	WGHT LBS.
	337	215V			
2"	7¼	6¾	3¼	3¼	8
2½"	8	7½	3¾	3¾	12
3"	9½	9	4¼	4¼	19



MODEL 215V

CAPACITIES SCFM Air, 60°F., 10% Accumulation

Set Pressure PSIG	MODEL 337 2"	MODEL 337 2½"	MODEL 337 3"	Set Inches Mercury	MODEL 215V 2"	MODEL 215V 2½"	MODEL 215V 3"
5	527	799	1157	1	140	213	308
10	743	1127	1632	2	217	329	477
15	903	1368	1982	3	264	400	579
20	1062	1609	2331	4	299	453	657
25	1221	1850	2680	5	331	501	726
30	1380	2091	3029	6	352	533	772
35	1539	2332	3379	7	372	564	817
40	1698	2573	3728	8	391	592	858
45	1857	2814	4076	9	403	610	884
50	2017	3055	4428	10	413	625	906
60	2335	3537	5125	12	424	642	930
				12.8+	426	646	935



MODEL 337

MODEL NUMBER/ORDER GUIDE

MODEL NO. POSITION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
EXAMPLE	2	1	5	V	—	H	0	1	—	Q	E				
	0	3	3	7											

INLET SIZE
H — 2"
J — 2½"
K — 3"

VARIATION (01 thru 99)
Number Provided Only by Manufacturer to Cover Specific Feature or Option.

DESIGN REVISION
Indicates Non-Interchangeable Revision. Dash (-) If Original Design.

VALVE SERVICE
K-Air ASME Sec VIII (Model 337 Only)
Q-Vacuum (Model 215V Only)

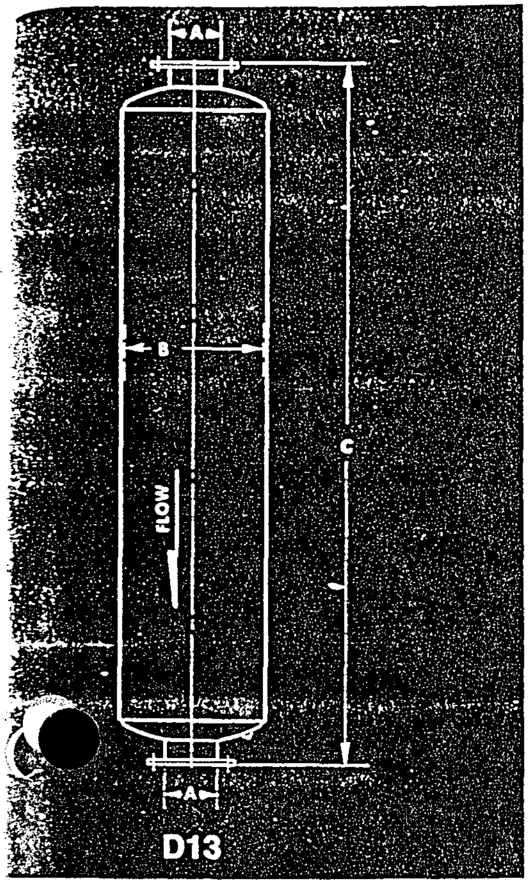
SPRING MATERIAL
E-Stainless (302)

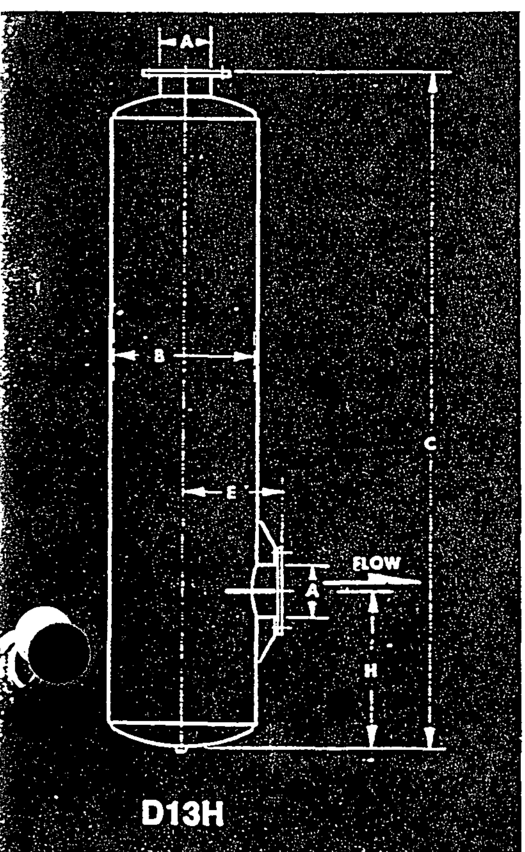
SET PRESSURE
Models 337 2 PSIG (0002) thru 60 PSIG (0060)
Model 215V 1" HG (Inches of Mercury) (0001) thru 22" HG (0022) Vacuum

8222 Bluffton Road
Box 1740
Fort Wayne, Indiana 46801-1740
219-747-1533
FAX 219-747-7958

REV. 1/91

Chamber Silencers





Application

Blower Intake Silencer for maximum silencing at blower speeds below transition speed.

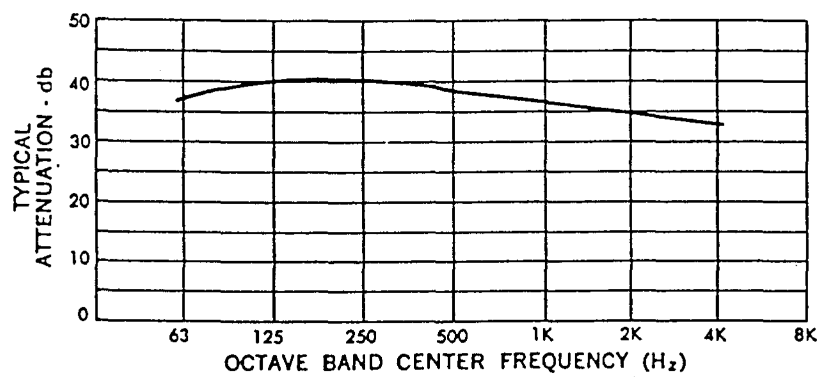
Design

A multi-chambered silencer containing a special arrangement of volumes and air passageways to effectively reduce pulsations through the conversion of noise energy into heat. D13 and D13H may be installed horizontally or vertically. Design parameters permit nozzle orientation to suit installation requirements.

Construction

All welded steel sheet and plate construction for long service life. Exterior surfaces are prime coated. Flanges are drilled to match 125 lb. American Standard Flanges. Inspection opening, mounting brackets, relief valve nozzles or special paint available at extra charge.

Typical Attenuation Curve



Model	A	B	C	Wt.
D13-1	1*	4½	21	7
D13-1½	1½*	6½	24	14
D13-2	2*	8	33	23
D13-2½	2½*	10	33	36
D13-3	3*	10	51	45
D13-3½	3½*	12	52	65
D13-4	4**	14	53	125
D13-5	5**	16	65	145
D13-6	6**	18	72	175

* NPT Connections
** Available in both NPT or Flange Connections

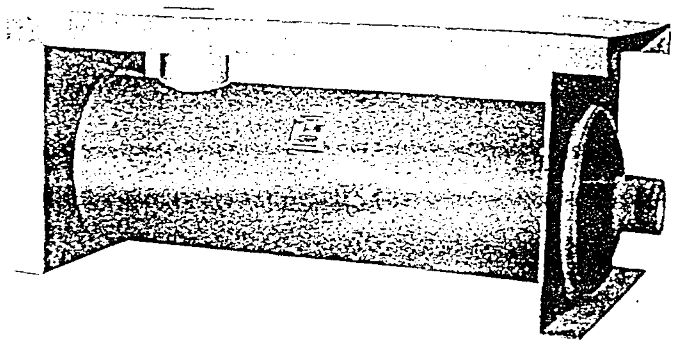
Model	A	B	C	E	H		Wt.
					Min.	Max.	
D13H-2	2*	8	30	7	6	10	25
D13H-2½	2½*	10	31	8	6	10	36
D13H-3	3*	10	49	8	6	10	45
D13H-4	4**	14	49	11	7	24	125
D13H-5	5**	16	62	12	8	28	145
D13H-6	6	18	68	13	9	34	175

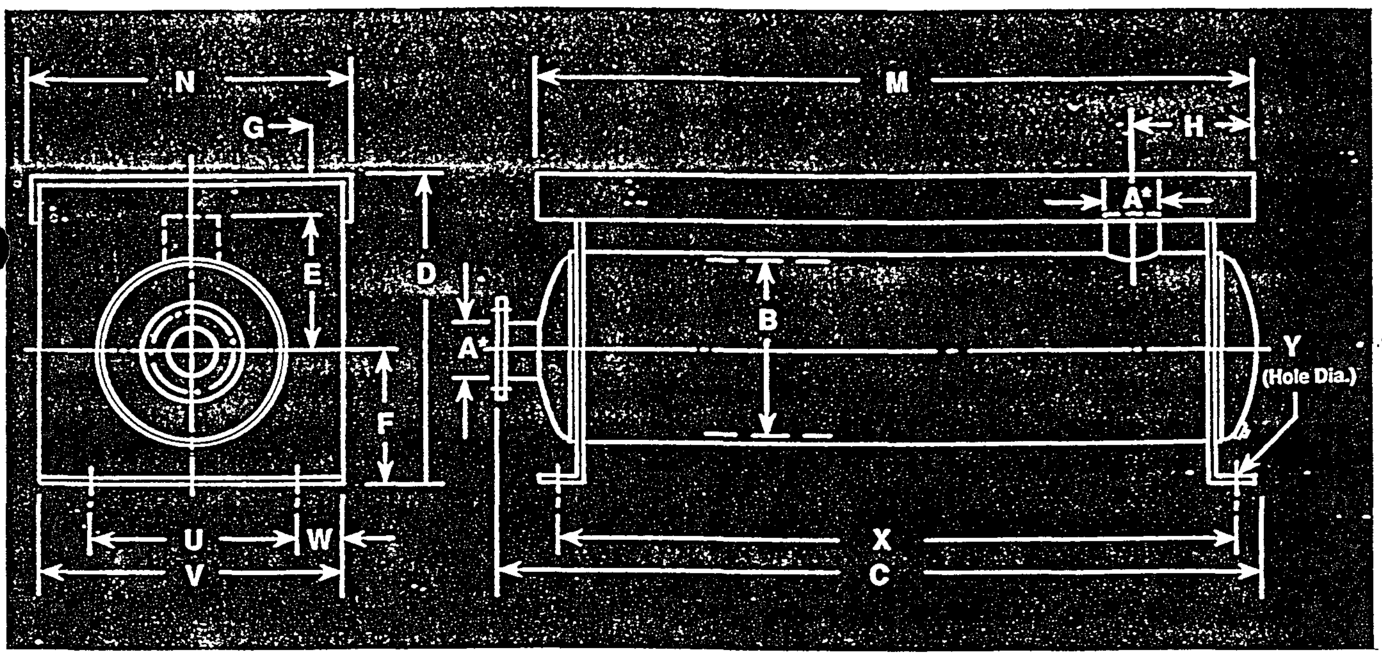
PD13 Discharge Silencer

The PD13 is a premium discharge silencer for blowers operating below transition speed, on which the blower, motor and belt guard are mounted as an integral part of the silencer. The PD13 is designed to facilitate package assembly thereby reducing labor and the overall costs of assembling smaller blower packages. The design also enables the package to be pretested and shipped to the jobsite without any disassembly.

The PD13 incorporates all the benefits of the D13H series silencer seen in Bulletin "D". The inlet is designed to accept a slip-on style flex connector. When provided with dimensional data for mounting the blower and motor, STODDARD SILENCERS will pre-drill up to twelve (12) holes in the base plate of the PD13. Blowers, motors, slide-rails and belt guards are not included; however, special flanges, pressure relief valve connections and special finishes and materials of construction are available at an extra cost.

See STODDARD SILENCER'S Bulletin "D" for sizing, pressure drop calculations and attenuation data for discharge silencers.





MODEL	A*	B	C	D	E	F	G	H	M	N	U	V	W	X	Y	WT.
PD13-2	2	8	30	14 1/8	7	5	2 1/8	7	30	16 3/8	12	16	2	25	5/8	70
PD13-2 1/2	2 1/2	10	31	15 5/8	8	6	1 5/8	7	30	20 3/8	15	20	2 1/2	25 1/2	5/8	90
PD13-3	3	10	49 1/2	17 3/16	8	7	2 3/16	7	48	24 1/2	18	24	3	44	3/4	220
PD13-4	4	14	49 3/8	21 1/4	11	8	2 1/4	11	48	24 5/8	18	24	3	44	3/4	280
PD13-5	5	16	62	24 1/4	12	10	2 1/4	11	60	30 5/8	24	30	3	56	3/4	410
PD13-6	6	18	67 3/4	27 5/16	13	12	2 5/16	12	66	30 3/4	24	30	3	62	3/4	550

*OUTLET CONNECTIONS: NPT up to 3"
NPT or Flanged 4" to 6"

Section 2: HEAT EXCHANGER

(2) Heat Exchanger, American Industrial Heat Transfer Inc. Model ACA-~~2~~4302-3

- Copper tube aluminum finned heat exchanger
- Steel stand with shroud, horizontal discharge
- 1/2 hp, 230/460VAC, 3Ø, TEFC motor
- Approximately 90F ΔT at 144 scfm air flow
- 11.3" wc pressure drop at 144 scfm
- 8 psi operating pressure, 200 psi max pressure
- **Barksdale model ML1H-GH3545 temperature switch on heat exchanger discharge**
- Temperature gage on heat exchanger discharge
- Pressure gage on heat exchanger discharge, 0-15 psi, vibration dampened
- Bleed valve with 1 ½" silencer on heat exchanger discharge
- 3" Gate valve on discharge
- **Rotron model FM30C250Q flow meter**
- Venturi flow meter with direct read gage on discharge, scfm
- 50-250 scfm, 3" connections

Please review the above Information & Initial the correct box

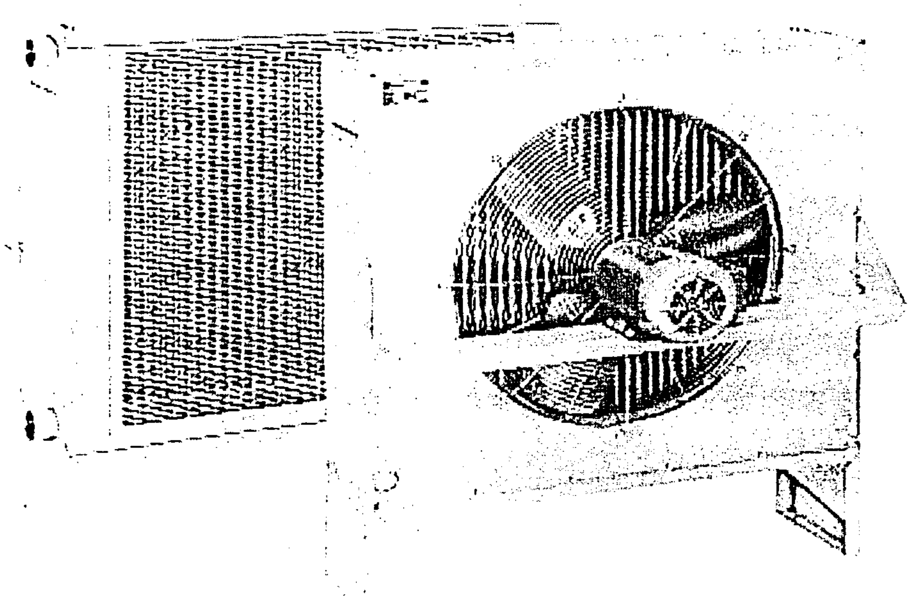
Approved as is (initial) ______________

Approved as noted (initial) ______________

American Industrial
Heat Transfer Inc.

Manufacturers of Quality Heat Exchangers

ACA & ACH SERIES



AIR COOLED

AFTER COOLERS

FOR COMPRESSED AIR AND GAS APPLICATIONS

- Standard NPT, or flange connections.
- Mounting legs included for easy installation.
- Horizontal and Vertical designs.
- Operating temperature of 400°F & pressure of 300 PSI.
- Can be customized to fit your needs.
- Cools: Pneumatic systems, compressors, dryers, etc.
- Visit our web site at www.aihti.com

by Mark A. Locl...

Customer: John Henry Foster
Selection: ACA-4302-3
Required Sq.ft: 21.1
Design Sq.Ft: 29.5

************************Conditions************************

Tubes			Ambient		
Enter Fluid-------->		Air	Enter Fluid-------->		air
Specific Gravity		1.000	Altitude Sea Level	ft	0
Density	lb/ft^3	0.1000			0.0722
Flow Rate	lbs/hr	649.7			19273.8
Enter Flow Rate	SCFM	144.00	Flow Fan	CFM	4450
Calc Flow Rate	SCFM	144.0			
Enter Flow Rate	ACFM	0.0			
Calc Flow Rate	ACFM	100.2			
Operating Pressure	PSIG	10.0	Atmospheric Pressure		14.696
Operating Pres	in.water	0.0			
Temp. Entering	F	210.0			90.0
Temp. Exiting	F	105.0			93.6
Approach Temperature	F	15.0			
Spec. heat	BTU/lb-f	0.25			0.25
Viscosity	Cps	0.0200			0.0200
Conduct Btu/hr ft^2 F/ft		0.0160			0.0160

************************CALCULATIONS************************

Heat Load	BTU/hr	17259			17259
Mass Vel.	lb/hr-ft^3	10795			5206
Mol weight		28.97			28.97
Pressure Drop	in.water	6.1			
Pressure Drop	PSI	0.219			
Velocity Tubes	FPS	48.32	External air	FPM	1201.37
Calc Nr		10517			5186
Overall U value		16.70			
Required Area	Sq.Ft.	21.10			

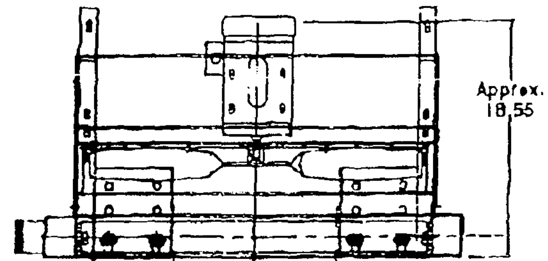
************************SELECTION************************

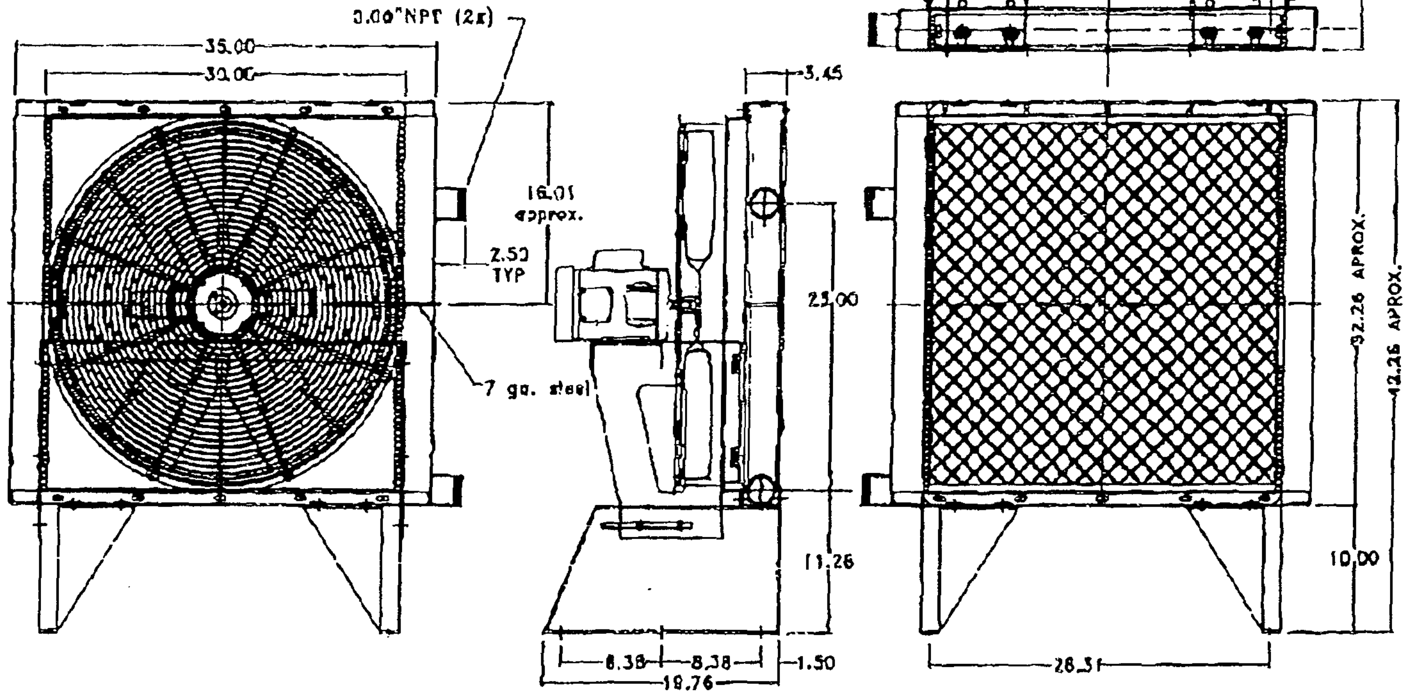
Surface Area	Sq. Ft.	29.45			6.3
Tube Diameter	inch	0.375	Fins Per Inch		8
Tube Wall Dia.	inch	0.025	Estimated pass	1o	1
Length tubes	inch	30.0	Enter Number Passes		2
Parallel Tube Rows		4	Est. Min Nozzel	inch	2.0
Total Number Tubes		120	Manifold		3.00
Fouling Resistance					0.0000

************************MATERIALS************************

TUBES copper — TURBULATORS none
FINS alum — FAN Comp
MANIFOLDS CS Braze — COATING enamel
CABINET CS — GASKETS
Motor .5 HP 3/60/230-460 TEFC
Nozzel size 3.00 NPT

NO.	QTY.	PART NO.	PART DESCRIPTION
1	1	117-0816	AIR SHIELD
2	1	117-0034	FRONT SCREEN
3	1	117-0033	BACK [illegible]
4	11	117-0036	[illegible]
5	1	[illegible]	FAN
6	1	[illegible]-0014	FAN BLADE
7	2	117-0043	MTR. MOUNT. BRACKET
8	1	117-0051-1	[illegible]
9	2	117-0028	UNIT MOUNT BRACKET
10	1		MOTOR





Pieces: 1

Note: All Dimensions May Vary ±.125

STANDARD FEATURES:

CONSTRUCTION MATERIALS:

CABINET........STEEL
FAN GUARD...ZINC PLATED STEEL
TUBES........STEEL
FAN BLADE.....ALUM. W/STEEL HUB

CONNEC. PIPES..STEEL
FINS...............ALUM.
MANIFOLDS.....STEEL

RATINGS:

Oper. Pressure .... 150 PSI
Oper. Temperature..... 300°F

Note: This drawing is the property of AMERICAN INDUSTRIAL HEAT TRANSFER INC. Duplication of this document is not permitted without the expressed written authority of AMERICAN INDUSTRIAL HEAT TRANSFER INC.

American Industrial
Heat Transfer Inc.

Phone#: 847-731-1000
Fax#: 847-731-1010
3905 Route 173
Zion, IL 60099

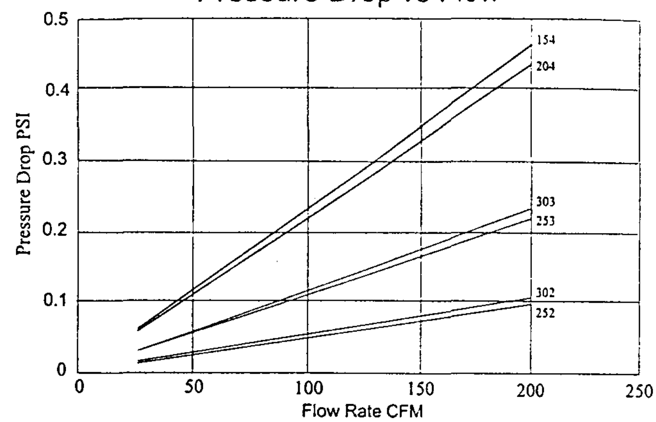
Model#:	Part #:	Description:	Rev.:
ACA-4302-91284		ASSEMBLY	0

Drawn By:	Size:	Approved By:	Scale: 1:12	Date: 8/11/00	Sheet: 1 of 1
CJD	A	[signature] 8/16/00			

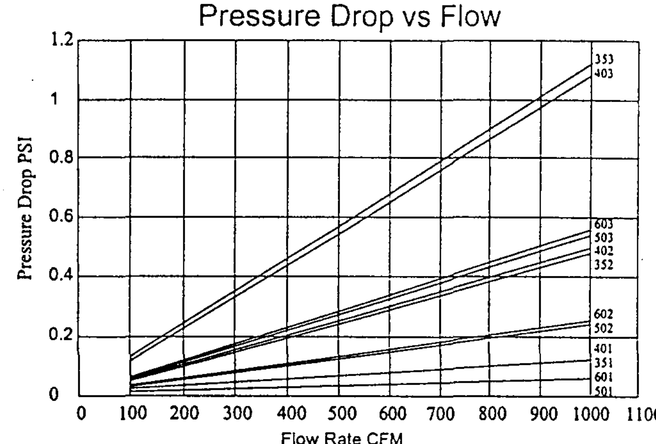
SELECTION

ROTARY SCREW COMPRESSORS (200°F @125 PSI & 36% relative humidity)					
			Model Size Selection		
Compressor (HP)	Approx BTU/hr	Average CFM	Approach °F		
			15°F	10°F	5°F
15	6,328	56	154	204	204
20	8,701	77	203	253	253
30	14,351	127	252	303	353
40	18,419	163	302	352	403
60	28,589	253	402	402	503
75	39,098	346	502	502	603
100	52,884	468	602	602	702
125	66,783	591	602	702	702
150	80,343	711	601	702	802
200	106,446	942	801	801	902
250	130,402	1154	801	801	1002
300	163,624	1448	901	901	1102
350	184,303	1631	1001	1001	1201
400	206,451	1827	1001	1101	1201
500	242,950	2150	1101	1201	1301

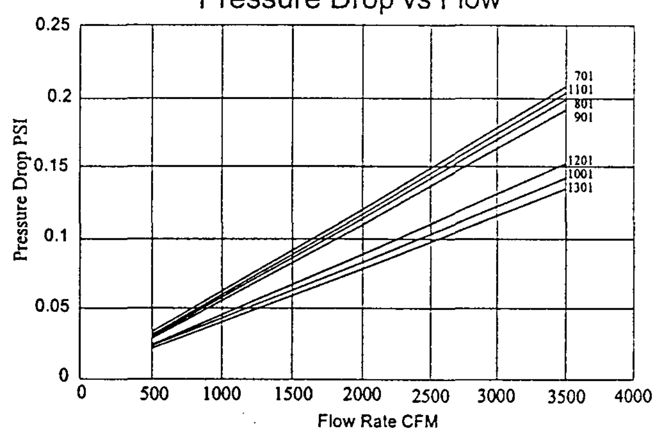
Pressure Drop vs Flow



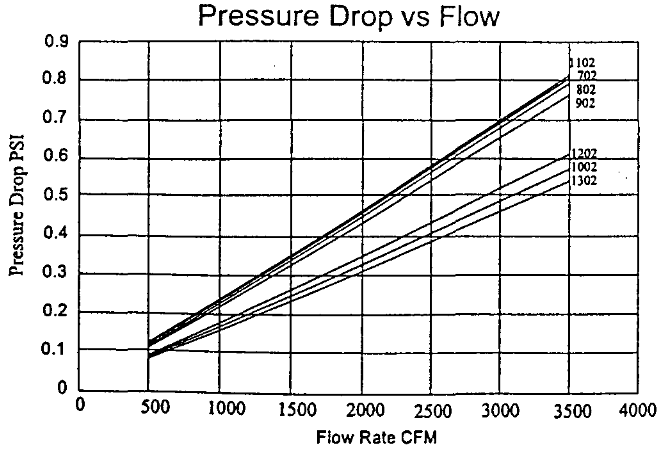
Pressure Drop vs Flow



Pressure Drop vs Flow



Pressure Drop vs Flow



To Size for Compressor

1) Select the correct HP compressor from the chart above.
2) Select the desired approach temperature from the "Model Size Selection" area.
   Approach temperature = Temperature desired out of the Heat Exchanger minus ambient air temperature.
3) Move down the desired approach temperature row until the HP (shown at the left) and the approach temperature intersect. The proper model number will be shown in the box.
4) Insert the model size number selected into the example ordering code, as shown below.

Example

ACA- 602 - 3 - N

Model Series
ACA (VERTICAL MOUNT)
ACH (HORIZONTAL MOUNT)

Model Selection

Drive Motor
1 - 1 Phase
3 - 3 Phase
5 - 575 volt
P - Pneumatic

Connection
N - NPT
A - ANSI Flange
F - SAE Flange

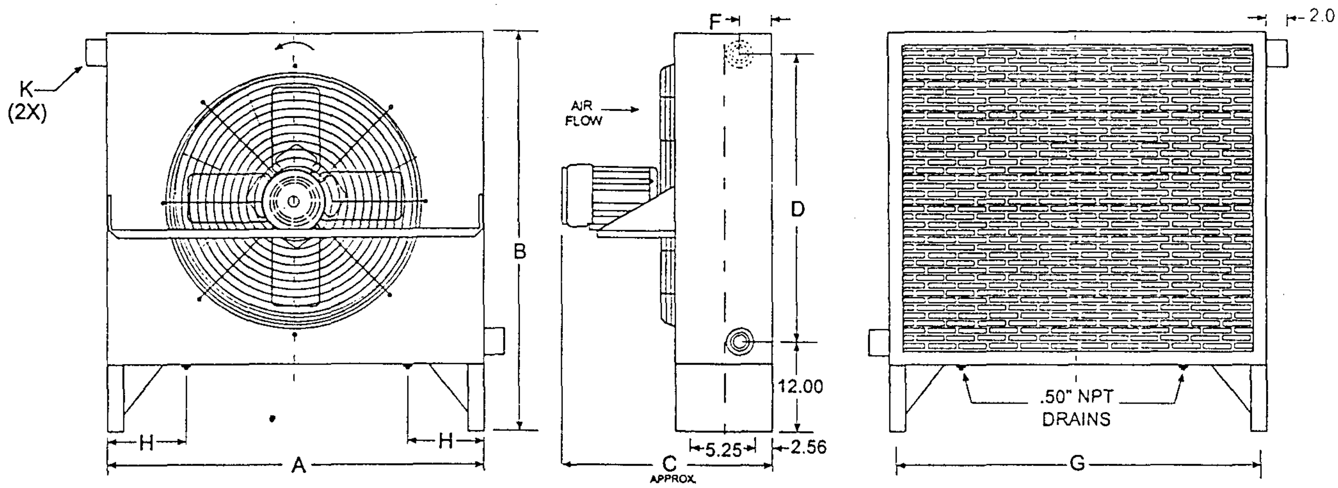
Sizing Notes

When sizing for higher humidity and specific applications not listed in our convenient selection chart, please consult factory at 800-338-5959.

Standard Models

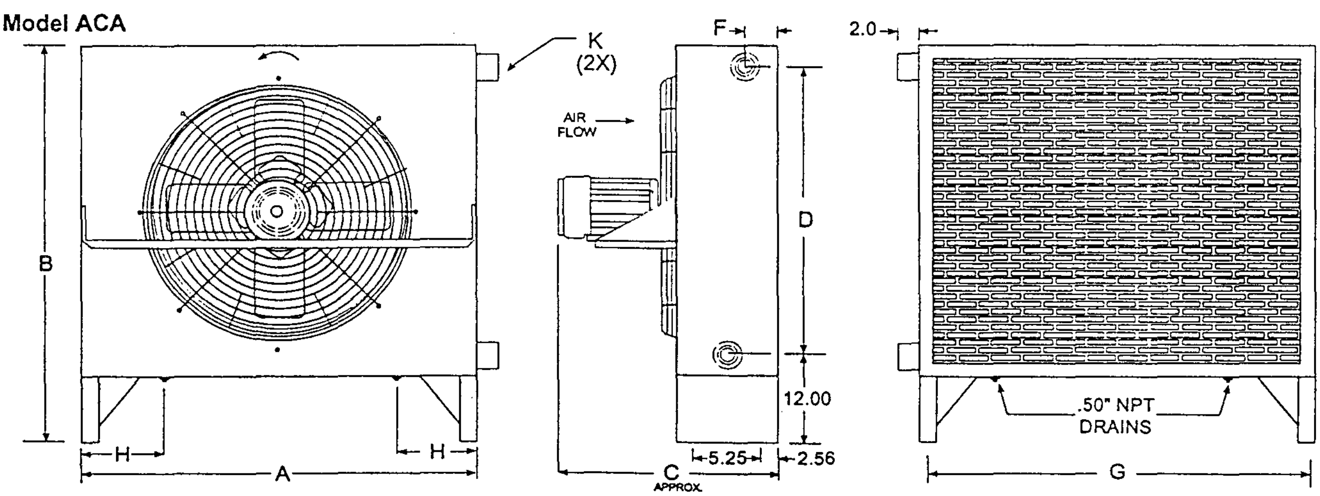
Dimensions and Weights:

Model ACA



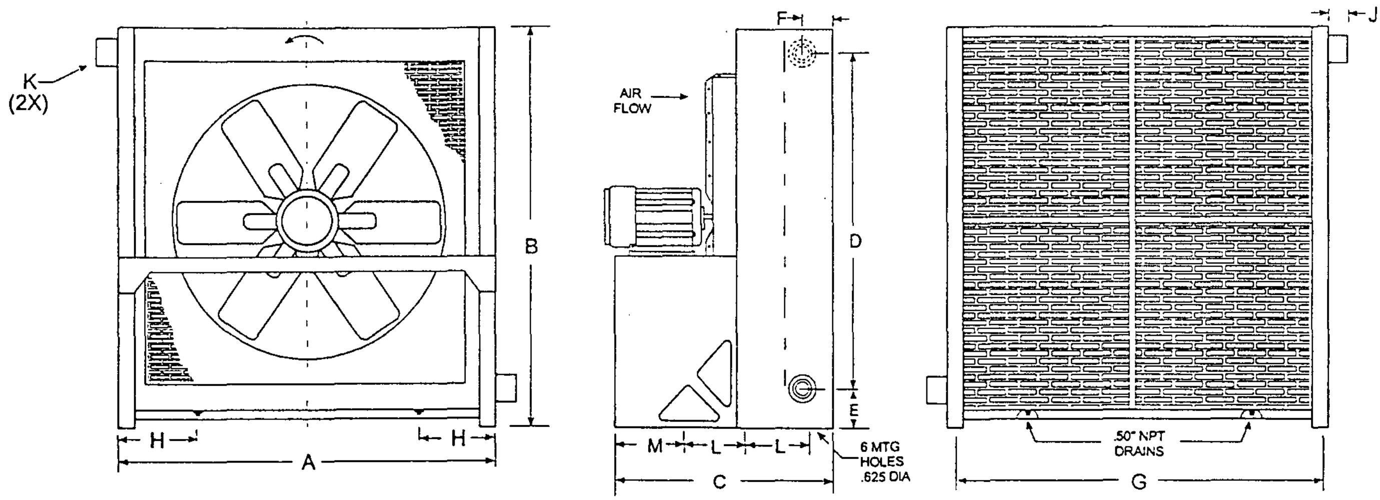
DIMENSIONS (Inches) & WEIGHTS (lbs.)												
Model	A	B	C	D	E	F	G	H	K NPT	K ANSI FLANGE	Weight (lbs.)	Model
ACA-203	23.81	28.50	17.56	14.62	12.00	3.52	22.20	5.90	1.50	1.50	100	ACA-203
ACA-253	26.68	33.75	17.56	19.86	12.00	3.52	25.00	6.70	1.50	1.50	125	ACA-253
ACA-303	31.62	37.69	17.62	23.80	12.00	3.52	30.00	8.00	1.50	1.50	145	ACA-303
ACA-353	33.81	40.31	20.75	26.43	12.00	3.52	32.20	8.50	1.50	1.50	170	ACA-353
ACA-401	41.62	46.88	19.62	32.99	12.00	3.52	40.00	10.40	2.00	2.00	240	ACA-401
ACA-403	41.62	46.88	19.62	32.99	12.00	3.52	40.00	10.40	2.00	2.00	240	ACA-403
ACA-503	33.81	40.31	23.06	26.43	12.00	3.52	32.20	8.50	2.00	2.00	315	ACA-503
ACA-601	41.62	46.88	23.06	32.99	12.00	3.52	40.00	10.40	2.50	2.50	350	ACA-601
ACA-603	41.62	46.88	23.06	32.99	12.00	3.52	40.00	10.40	2.50	2.50	350	ACA-603

Model ACA



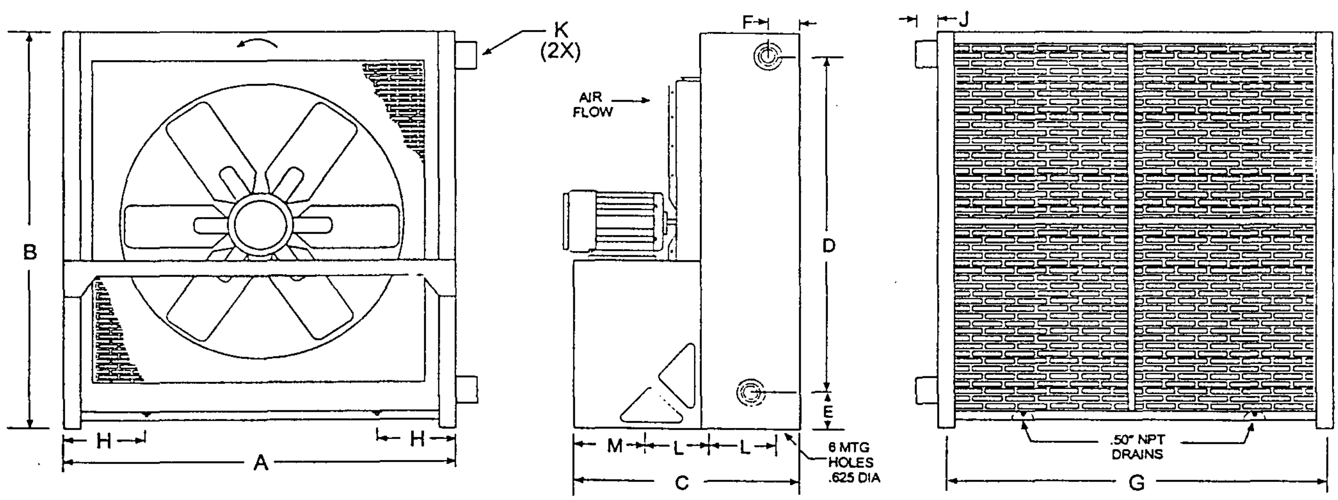
DIMENSIONS (Inches) & WEIGHTS (lbs.)												
Model	A	B	C	D	E	F	G	H	K NPT	K ANSI FLANGE	Weight (lbs.)	Model
ACA-154	20.38	25.88	17.43	11.99	12.00	3.52	18.75	5.10	1.50	1.50	100	ACA-154
ACA-204	23.81	28.50	17.56	14.62	12.00	3.52	22.20	5.90	1.50	1.50	125	ACA-204
ACA-252	26.68	33.75	17.56	19.86	12.00	3.52	25.00	6.70	1.50	1.50	145	ACA-252
ACA-302	31.62	37.69	17.62	23.80	12.00	3.52	30.00	8.00	2.00	1.50	170	ACA-302
ACA-352	33.81	40.31	20.75	26.43	12.00	3.52	32.20	8.50	2.00	2.00	240	ACA-352
ACA-402	41.62	46.88	19.62	32.99	12.00	3.52	40.00	10.40	2.00	2.00	240	ACA-402
ACA-404	41.62	46.88	19.62	32.99	12.00	3.52	40.00	10.40	2.50	2.00	315	ACA-404
ACA-502	33.81	40.31	23.06	26.43	12.00	3.52	32.20	8.50	2.50	2.50	350	ACA-502
ACA-602	41.62	46.88	23.06	32.99	12.00	3.52	40.00	10.40	2.50	2.50	350	ACA-602

Model ACA



DIMENSIONS (Inches) & WEIGHTS (lbs.)														
Model	A	B	C	D	E	F	G	H	J	K NPT	K ANSI FLANGE	L	M	Weight (lbs.)	Model
ACA-801	53.00	56.25	26.84	49.49	4.38	5.19	51.50	14.00	2.00	3.00	3.00	7.69	7.00	890	ACA-801
ACA-901	59.50	65.00	32.13	57.00	5.00	4.44	58.00	14.75	1.50	4.00	4.00	11.06	7.50	1400	ACA-901
ACA-1001	59.50	65.00	32.13	57.00	5.00	4.44	58.00	14.75	1.50	4.00	4.00	11.06	7.05	1400	ACA-1001
ACA-1101	68.00	79.50	35.46	72.00	4.50	4.69	66.50	17.00	1.50	4.00	4.00	11.06	9.00	1850	ACA-1101
ACA-1201	68.00	79.50	35.46	72.00	4.50	4.69	66.50	17.00	1.50	4.00	4.00	11.06	9.00	1850	ACA-1201
ACA-1301	68.00	79.50	35.46	72.00	4.50	4.69	66.50	17.00	1.50	4.00	4.00	11.06.	9.00	1850	ACA-1301

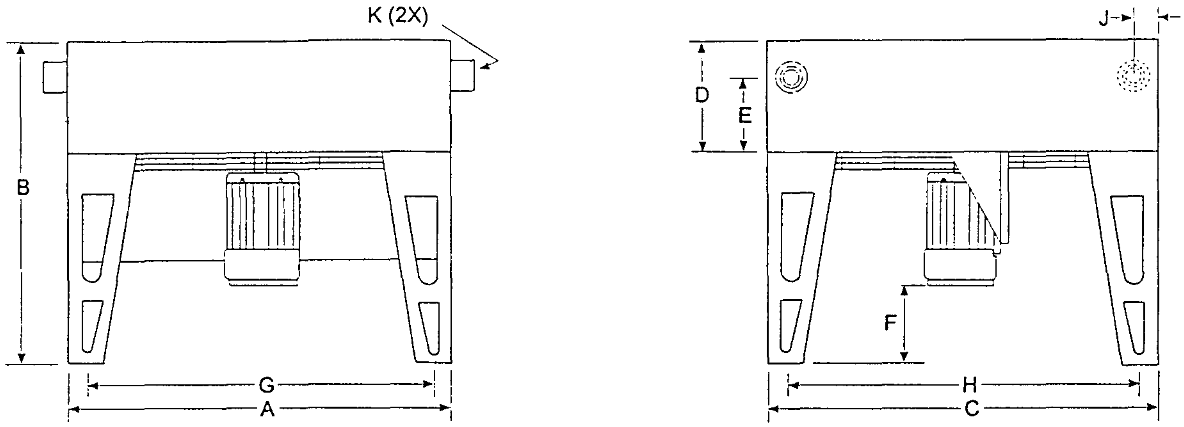
Model ACA



DIMENSIONS (Inches) & WEIGHTS (lbs.)															
Model	A	B	C	D	E	F	G	H	J	K NPT	K ANSI FLANGE	L	M	Weight (lbs.)	Model
ACA-702	45.00	49.00	26.65	46.62	4.38	4.00	43.50	12.00	2.00	3.00	3.00	7.81	7.50	725	ACA-702
ACA-802	53.00	56.00	26.84	53.87	4.38	5.19	51.50	14.00	2.00	4.00	4.00	7.69	7.00	890	ACA-802
ACA-1002	59.50	65.00	32.13	62.00	4.44	4.44	58.00	14.75	1.50	4.50	4.00	11.06	7.50	1400	ACA-1002
ACA-1102	68.00	79.50	35.46	76.50	4.50	4.69	66.50	17.00	1.50	4.50	4.00	11.06	9.00	1850	ACA-1102

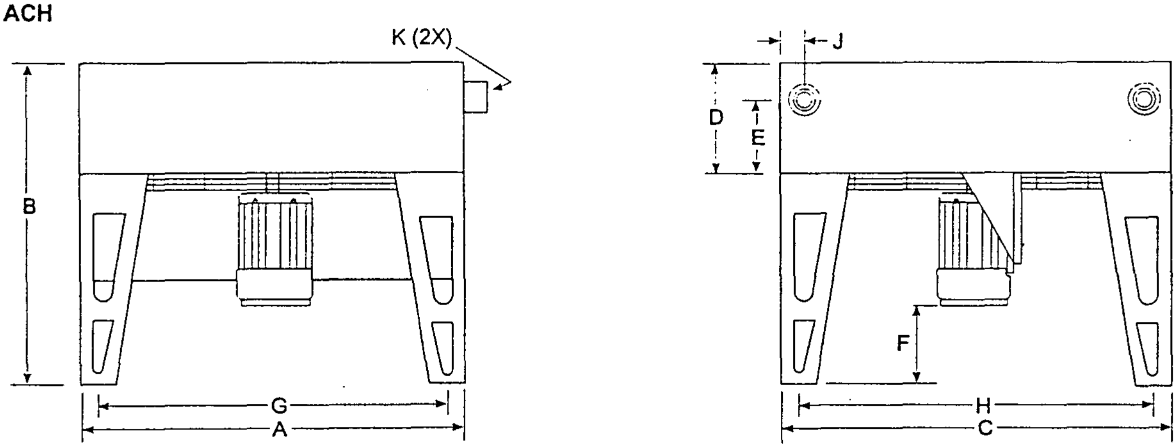
Dimensions and Weights:

Model ACH



DIMENSIONS (Inches) & WEIGHTS (lbs.)													
Model	A	B	C	D	E	F Approx.	G	H	J	K NPT	K ANSI FLANGE	Weight (lbs.)	Model
ACH-503	33.81	31.00	30.19	10.36	6.84	8.06	29.62	26.00	1.88	2.00	2.00	330	ACH-503
ACH-601	41.62	31.00	36.75	10.36	6.84	8.06	37.44	32.56	2.31	2.50	2.50	400	ACH-601
ACH-603	41.62	31.00	36.75	10.36	6.84	8.06	37.44	32.56	2.31	2.50	2.50	400	ACH-603
ACH-801	53.00	42.00	56.25	11.84	6.65	9.00	47.25	50.50	4.38	3.00	3.00	820	ACH-801
ACH-901	59.50	60.00	65.00	14.88	10.44	19.00	53.75	59.25	5.00	4.00	4.00	1020	ACH-901
ACH-1001	59.50	60.00	65.00	14.88	10.44	19.00	53.75	59.25	5.00	4.00	4.00	1020	ACH-1001
ACH-1101	68.00	60.00	79.50	14.75	10.06	16.00	62.25	73.75	4.50	4.00	4.00	1490	ACH-1101
ACH-1201	68.00	60.00	79.50	14.75	10.06	16.00	62.25	73.75	4.50	4.00	4.00	1490	ACH-1201
ACH-1301	68.00	60.00	79.50	14.75	10.06	16.00	62.25	73.75	4.50	4.00	4.00	1490	ACH-1301

Model ACH



DIMENSIONS (Inches) & WEIGHTS (lbs.)													
Model	A	B	C	D	E	F Approx.	G	H	J	K NPT	K ANSI FLANGE	Weight (lbs.)	Model
ACH-502	33.81	31.00	30.19	10.36	6.84	8.06	29.62	26.00	1.88	2.00	2.00	330	ACH-502
ACH-602	41.62	31.00	36.75	10.36	6.84	8.06	37.44	32.56	2.31	2.50	2.50	400	ACH-602
ACH-702	45.00	42.00	48.63	11.84	7.84	9.00	39.25	42.88	2.38	3.00	3.00	650	ACH-702
ACH-802	53.00	42.00	56.25	11.84	6.65	9.00	47.25	50.50	2.38	3.00	3.00	820	ACH-802
ACH-1002	59.50	60.00	65.00	14.88	10.44	19.00	53.75	59.25	3.00	4.00	4.00	1020	ACH-1002
ACH-1102	68.00	60.00	79.50	14.75	10.06	19.00	62.25	73.75	3.00	4.00	4.00	1490	ACH-1102

NOTE: We reserve the right to make reasonable design changes without notice.

ELECTRIC MOTOR & FAN DATA

Model	CFM	Sound dB(A)t at 7 ft.	Horse Power	Hz	PH	Volts	Full Load Amps	Nema Frame	RPM	Type
ACA-15x-1	797	69	1/12	50/60	1	115	1.3/1.1	48	1425/1725	TEFC
ACA-15x-3	1015	71	1/4	60	3	208-230/460	1.4-1.3/.65	48	1725	TEFC
ACA-20x-1	1220	70	1/6	60	1	115/208-230	3.8/2-1.9	48	1725	TEFC
ACA-20x-3	1555	72	1/4	60	3	208-230/460	1.4-1.3/.65	48	1725	TEFC
ACA-25x-1	2160	72	1/6	60	1	115/208-230	4.6/2.4-2.3	48	1140	TEFC
ACA-25x-3	2240	73	1/6	60	3	208-230/460	1.2-1.1/.55	48	1140	TEFC
ACA-30x-1	2990	75	1/6	60	1	115/208-230	4.6/2.4-2.3	48	1140	TEFC
ACA-30x-3	3100	76	1/6	60	3	208-230/460	1.2-1.1/.55	48	1140	TEFC
ACA-35x-1	4370	76	1/2	60	1	115/208-230	8/4.2-4	56	1140	TEFC
ACA-35x-3	4370	77	1/2	60	3	208-230/460	2.5-2.4/1.2	56	1140	TEFC
ACA-40x-1	5450	78	1/2	60	1	115/208-230	8/4.2-4	56	1140	TEFC
ACA-40x-3	5450	79	1/2	60	3	208-230/460	2.5-2.4/1.2	56	1140	TEFC
ACA/ACH-50x-3	5921	84	3	60	3	230/460	9.-8.6/4.3	182T	1725	TEFC
ACA/ACH-60x-3	9609	85	3	60	3	230/460	9.-8.6/4.3	182T	1725	TEFC
ACA/ACH-70x-3	16000	84	5	60	3	230/460	16.8/8.4	215T	1160	TEFC
ACA/ACH-80x-3	21000	87	5	60	3	230/460	16.8/8.4	215T	1160	TEFC
ACA/ACH-90x-3	26000	92	10	60	3	230/460	29/14.5	256T	1160	TEFC
ACA/ACH-100x-3	26000	92	10	60	3	230/460	29/14.5	256T	1160	TEFC
ACA/ACH-110x-3	39000	91	15	60	3	230/460	45/22.5	286T	870	TEFC
ACA/ACH-120x-3	39000	91	15	60	3	230/460	45/22.5	286T	870	TEFC
ACA/ACH-130x-3	39000	91	15	60	3	230/460	45/22.5	286T	870	TEFC

Note: 575 volt motors and others availalbe. Published electrical ratings are approximate, and may vary because of motor brand. Actual ratings are on motor nameplate.

PNEUMATIC MOTOR & FAN DATA

Model	CFM	Fan Speed (RPM)	Air Consumption CFM (Free Air) @100 PSIG	Air Consumption (CFM) at Min. Oper. Pressure	Min. Oper. Pressure (PSI)	Weight (LBS)
ACA-15x-P	1015	1725	48	17	30	92
ACA-20x-P	1220	1725	48	17	30	115
ACA-25x-P	2240	1140	36	17	40	133
ACA-30x-P	2990	1140	36	17	40	156
ACA-35x-P	4370	1140	36	24	60	221
ACA-40x-P	5450	1140	36	24	60	221
ACA/ACH-50x-P	5921	1725	125	100	70	322
ACA/ACH-60x-P	9609	1725	125	100	70	322
ACA//ACH-70x-P	16000	1200	180	150	78	667
ACA/ACH-80x-P	21000	1200	180	150	78	819
ACA/ACH-90x-P	26000	1200	◇	◇	◇	1288
ACA/ACH-100x-P	26000	1200	◇	◇	◇	1288
ACA/ACH-110x-P	39000	870	◇	◇	◇	1702
ACA/ACH-120x-P	39000	870	◇	◇	◇	1702
ACA/ACH-130x-P	39000	870	◇	◇	◇	1702

◇ Information Available At Request.

Standard Construction Materials

Tubes .... Copper
Fins .... Aluminum
Turbulators .... Steel
Cabinet .... Steel

Manifolds .... Steel
Connection Pipes .... Steel
Fan Blade .... Aluminum With Steel Hub

Fan Guard .... Zinc Plated Steel
Mounting Legs .... Steel

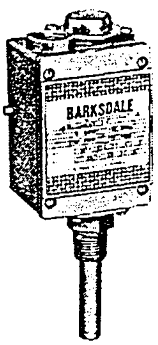
3905 Route 173 Zion, Illinois 60099
Telephone: (800) 338-5959 or (847) 731-1000
FAX: (847) 731-1010

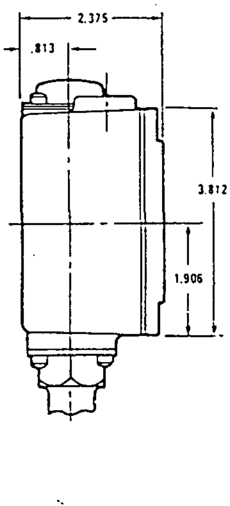
American Industrial Heat Transfer Inc.
Manufacturers of Quality Heat Exchangers

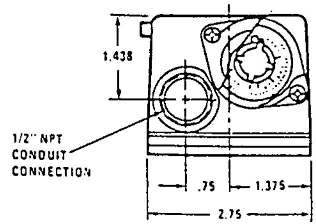
Barksdale Temperature Switches

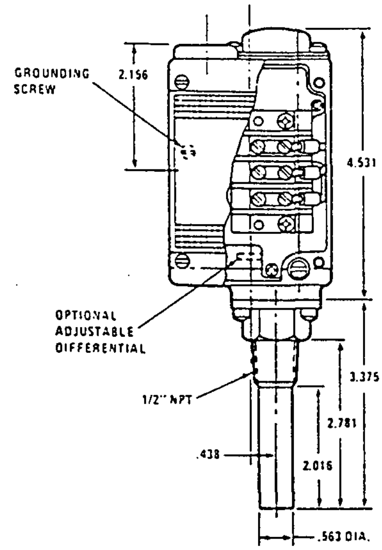
ML1H Description:

Single Setting
Local Mount
Watertight and Dusttight—
Indoor and Outdoor (NEMA 4)
Oiltight and Dusttight—
Indoor (NEMA 13)
Enclosed Terminal Strip
Tamperproof External Adjustment

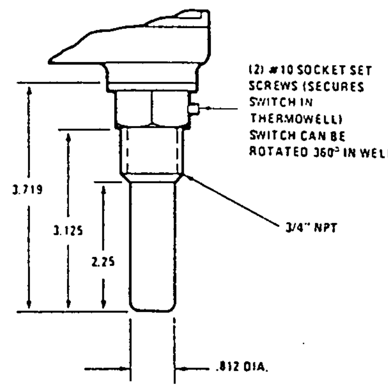








THERMOWELL MODELS ONLY
(See -WS Designation)



Operating Characteristics • Ordering Data • Items in Stock

	Media Temperature Limits (Proof)				Adjustable Range				Differential (Approx.) Liquid*		Catalog Numbers		
Calibrated Dial Adjustment	°F Low	°F High	°C Low	°C High	°F Low	°F High	°C Low	°C High	°F	°C	Brass Sensor (These do not have thermowells and cannot be field adapted for use with thermowells.)	304 Stainless Steel Sensor	304 Stainless Steel Sensor W/316SS Thermowell
Calibrated 2° Subdivision 125° Span	-100	+250	-73	+121	-50	+75	-45	+24	1 to 3	.5 to 1.6	ML1H-H201	ML1H-H201S	ML1H-H201S-WS
	-100	+250	-73	+121	+15	+140	-9	+60	1 to 3	.5 to 1.6	ML1H-H202	ML1H-H202S	ML1H-H202S-WS
	-100	+250	-73	+121	+75	+200	+24	+93	1 to 3	.5 to 1.6	ML1H-H203	ML1H-H203S	ML1H-H203S-WS
	-100	+400	-73	+205	+100	+225	+38	+107	1 to 3	.5 to 1.6	ML1H-H351	ML1H-H351S	ML1H-H351S-WS
	-100	+400	-73	+205	+165	+290	+74	+143	1 to 3	.5 to 1.6	ML1H-H352	ML1H-H352S	ML1H-H352S-WS
	-100	+400	-73	+205	+225	+350	+107	+177	1 to 3	.5 to 1.6	ML1H-H353	ML1H-H353S	ML1H-H353S-WS
Calibrated 5° Subdivision 250° Span	-100	+250	-73	+121	-50	+200	-45	+93	1 to 3	.5 to 1.6	ML1H-H204	ML1H-H204S	ML1H-H204S-WS
	-100	+400	-73	+205	+100	+350	+38	+177	1 to 3	.5 to 1.6	ML1H-H354	ML1H-H354S	ML1H-H354S-WS
Calibrated 5° Subdivision 150° Span	0	+500	-18	+260	+150	+300	+66	+149	3 to 6	1.6 to 3.3	ML1H-H451	ML1H-H451S	ML1H-H451S-WS
	0	+500	-18	+260	+230	+380	+110	+193	3 to 6	1.6 to 3.3	ML1H-H452	ML1H-H452S	ML1H-H452S-WS
	0	+500	-18	+260	+300	+450	+149	+232	3 to 6	1.6 to 3.3	ML1H-H453	ML1H-H453S	ML1H-H453S-WS
Calibrated 10° Subdivision 300° Span	0	+500	-18	+260	+150	+450	+66	+232	3 to 6	1.6 to 3.3	ML1H-H454	ML1H-H454S	ML1H-H454S-WS

*Test conditions and media used could affect differential.

Approx. Shipping Weight 1½ lbs.

Detail Data

Electrical Characteristics: All models incorporate Underwriters' Laboratories, Inc. listed single pole double throw snap-action switching elements. Electrical rating (continuous inductive) 10 amps 125 or 250 volts AC, 3 amps 480 volts AC. Automatically reset by snap-action of switch. For more details and other switch classes, see page 14.

Electrical Connection: Screw terminals on covered terminal strip through ½" npt conduit connection.

Terminals Identified: C (Common), N.C. (Normally Closed), N.O. (Normally Open).

Wire Coding: Purple (Common), Blue (Normally Closed), Red (Normally Open).

Adjustment Instructions: Turn adjustment knob clockwise to increase actuation point (switch setting).

Optional Modifications

MANUAL RESET AVAILABLE. Consult factory for price and delivery.

Green epoxy paint available on exterior surfaces of completely assembled and tested housed models.

All models on this page have the following U.L. and C.S.A. listings:

Underwriters' Laboratories, Inc.
Temperature indicating and regulating equipment. File No. E56247, Guide No. XAPX.

Canadian Standards Association listed for temperature indicating and regulating equipment. File No. LR34555, Guide NO. 400-E-0. Class 4813.

Measurement
cessories

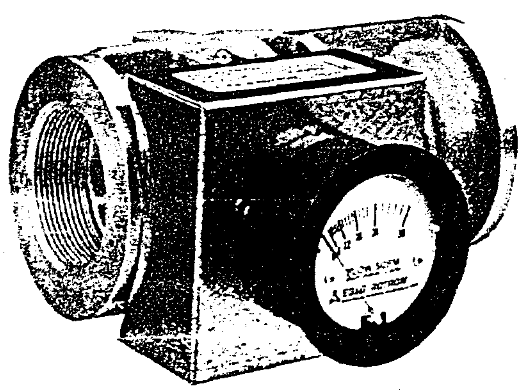
Blower Connection Key
NPT – American National Standard Taper Pipe Thread (Male)
NPSC – American National Standard Straight Pipe Thread for Coupling (Female)
SO – Slip On (Smooth – No Threads)

Air Flow Meter

FEATURES
- Direct reading in SCFM
- Low pressure drop (2-4" typical) across the flow meter
- Non-clogging, low impedance air stream
- Light weight aluminum
- No moving parts
- Large easy-to-read dial
- Accurate within 2% at standard conditions
- Good repeatability
- Available in 2", 3" and 4" sizes
- Factory configured for quick installation
- .048" Allen key supplied for gauge adjustment

OPTIONS
- For 4-20 mA outputs and digital readouts see page G-9
- High temperature version (above 140°F)
- Corrosion-resistant version with Chem-Tough™ or in stainless steel
- A-approved Food Tough™ surface conversion
- pressure version (100 PSI)

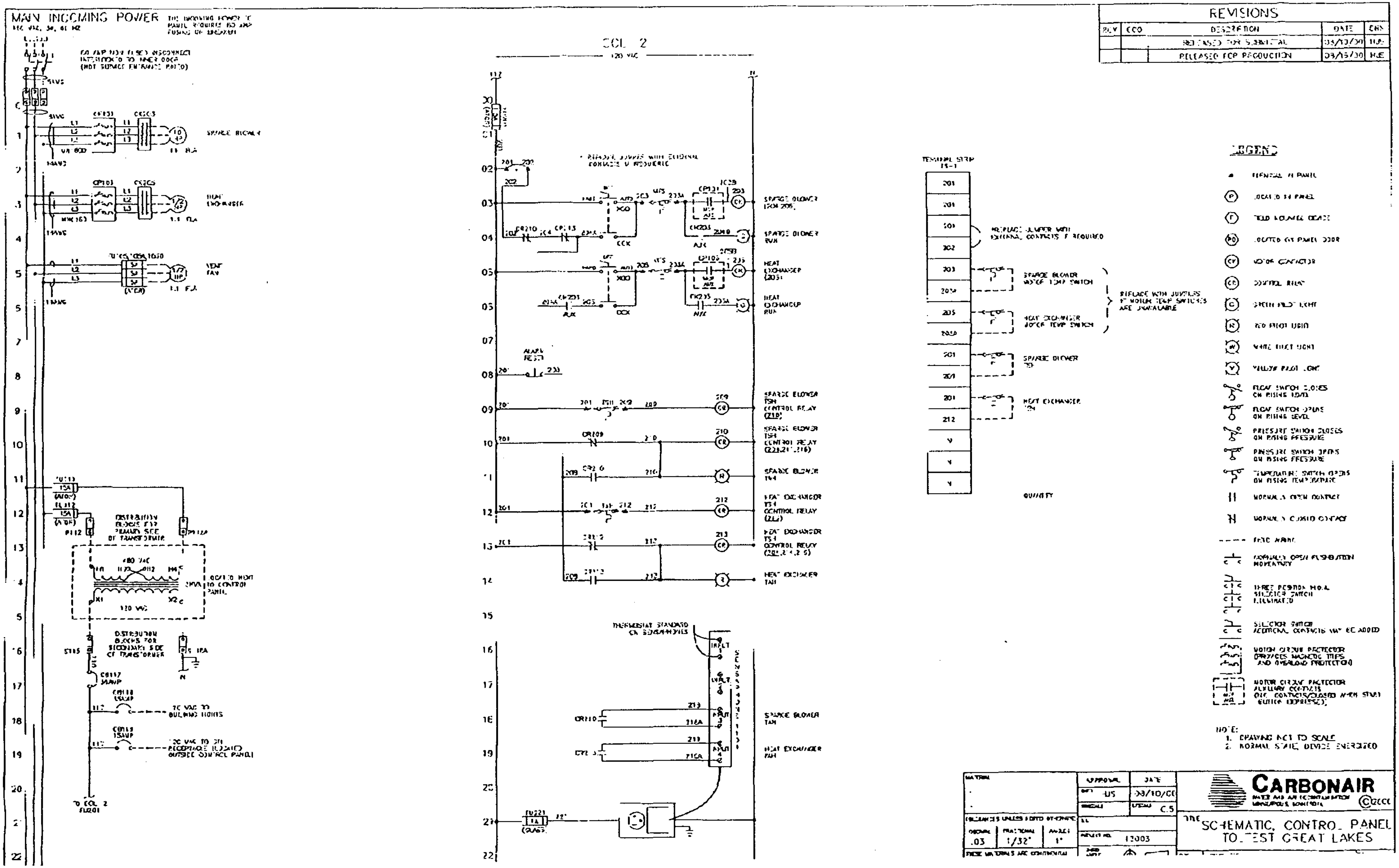
BENEFITS
- OPTIMIZE SYSTEM EFFICIENCY
  Measuring the correct air flow can assist you in fine-tuning to your system's optimal efficiency.
- BALANCE MULTI-PIPING SYSTEMS
  When evacuating CFM from more than one pipe, different run lengths or end system impedance can cause one pipe to handle more CFM than the other. With an accurate CFM reading, piping can be balanced by bleeding air in/out or by creating an extra impedance.
- DETECT CHANNELING OR PLUGGING
  For systems in which channeling or plugging can occur, a change in the CFM measured can help indicate the unseen changes in your system.



Current Models		Flow Range	B	C	D	E	F	Replaces	
Model	Part #	(SCFM)	Threads	Length	Width			Model	Part #
FM20C030Q	550599	6-30	2" - 11.5 NPSC	7.18"	7.0"	2.0"	3.75"	FM20A030Q	550312
FM20C045Q	550600	9-45						FM20A045Q	550313
FM20C065Q	550601	13-65						FM20A065Q	550314
FM20C125Q	550602	25-125			5.6"			FM20A125Q	550256
FM20C175Q	550603	35-175						FM20A175Q	550255
FM20C225Q	550604	45-225						FM20A225Q	550254
FM30C250Q	550605	50-250	3" - 8 NPSC	7.52"	7.4"	2.5"	4.43"	FM30A250Q	550259
FM30C350Q	550606	70-350						FM30A350Q	550258
FM30C475Q	550607	95-475						FM30A475Q	550257
0C450Q	550608	90-450	4" - 8 NPSC	8.00"	7.7"	2.7"	5.43"	FM40A450Q	550262
0C600Q	550609	120-600						FM40A600Q	550261
FM40C850Q	550610	170-850						FM40A850Q	550260

Section C: Carbonair Control System Schematic

The control schematic will follow as soon as it is done. I did not want to hold up the rest of the submittal because of it. I will send you 3 copies for your review / approval, when they are completed.


MAIN INCOMING POWER
COL 2
120 VAC
REVISIONS
DESCRIPTION
DATE
RELEASED FOR PRODUCTION
SPARGE BLOWER
HEAT EXCHANGER
VENT FAN
SPARGE BLOWER RUN
HEAT EXCHANGER RUN
ALARM RESET
SPARGE BLOWER TSH CONTROL RELAY
HEAT EXCHANGER TSH CONTROL RELAY
HEAT EXCHANGER FAN
SPARGE BLOWER FAN
DISTRIBUTION BLOCKS FOR PRIMARY SIDE OF TRANSFORMER
480 VAC
120 VAC
DISTRIBUTION BLOCKS FOR SECONDARY SIDE OF TRANSFORMER
120 VAC TO BUILDING LIGHTS
TO COL 2
THERMOSTAT STANDARD ON SENSORS
TERMINAL STRIP TS-1
SPARGE BLOWER MOTOR TEMP SWITCH
HEAT EXCHANGER MOTOR TEMP SWITCH
REPLACE WITH JUMPERS IF MOTOR TEMP SWITCHES ARE UNAVAILABLE
REPLACE JUMPER WITH EXTERNAL CONTACTS IF REQUIRED
LEGEND
MOTOR CONTACTOR
CONTROL RELAY
FLOAT SWITCH CLOSES ON RISING LEVEL
FLOAT SWITCH OPENS ON RISING LEVEL
PRESSURE SWITCH CLOSES ON RISING PRESSURE
PRESSURE SWITCH OPENS ON RISING PRESSURE
TEMPERATURE SWITCH OPENS ON RISING TEMPERATURE
NORMALLY OPEN CONTACT
NORMALLY CLOSED CONTACT
FIELD WIRING
NORMALLY OPEN PUSHBUTTON MOMENTARY
THREE POSITION H-O-A SELECTOR SWITCH ILLUMINATED
SELECTOR SWITCH ADDITIONAL CONTACTS MAY BE ADDED
MOTOR CIRCUIT PROTECTOR (PROVIDES MAGNETIC TRIPS AND OVERLOAD PROTECTION)
NOTE:
1. DRAWING NOT TO SCALE
2. NORMAL STATE, DEVICE DE-ENERGIZED
CARBONAIR
SCHEMATIC, CONTROL PANEL
TO TEST GREAT LAKES
03/10/00
.03
1/32"
1°
12003

APPENDIX D

ANALYTICAL RESULTS FROM
HERITAGE ENVIRONMENTAL SERVICES REPORT

Table 1
Summary of Soil Sample Results (ppm)
Field PID Readings

Boring Location	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18
Sample Depth	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.
PID	157	84	1	1	2000	2000	853	6	370	5	467	2000	35	240	0	0	30	3
Sample Depth	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.
PID	65	207	1	2	2000	2000	2000	0	59	3	2000	1800	7	2000	501	2000	2000	4
Sample Depth	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.		8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.
PID	0	12	0	3	121	17	128		0	0	140	51	0	110	0	0	991	86
Sample Depth	12-16 ft.				12-16 ft.		12-16 ft.				12-16 ft.	12-16 ft.	12-16 ft.					
PID	0				22		0				4	20	0					
Sample Depth												16-20 ft.						
PID												0						

Boring Location	B19	B20	B21	B22	B23	B24	B25	B26	B27	B28	B29	B30	B31	B32	B33	B34	B35
Sample Depth	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.	0-4 ft.
PID	0	2	0	0	0	0	89	3	6	9	1	0	4	3	2	0	0
Sample Depth	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.		4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.	4-8 ft.
PID	0	1200	60	2000	0	370		8	7	380	1	0	3	4	2	0	0
Sample Depth	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.		8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.	8-12 ft.
PID	0	772	3	127	0	1		6	2000	20	0	1	4	95	65	0	1
Sample Depth		12-16 ft.								12-16 ft.		12-16 ft.	12-16 ft.	12-16 ft.		12-16 ft.	12-16 ft.
PID		119								8		0	0	76		0	0

Comments:
ppm = parts per million.
(blank) = No sample collected.

Table 2
Summary of Soil Sample Results (ppm)
IPS Field Screening

Boring Location	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19
Sample Depth	3-4 ft.	7-8 ft.	5-6 ft.	6-7 ft.	6-7 ft.	7-8 ft.	11-12 ft.		7-8 ft.	6-7 ft.		15-16 ft.	6-7 ft.	7-8 ft.		9-10 ft.			9-10 ft.
Benzene	–	–	–	–	–	–	–		–	–		–	–	10.348		0.348			–
Ethylbenzene	–	–	–	–	3.62	1.45	0.132		–	–		–	–	–		–			–
Toluene	–	–	–	–	13.872	0.471	0.034		–	–		–	–	17.462		0.054			–
Xylenes	–	–	–	–	63.594	0.766	0.186		–	–		–	–	72.083		0.038			–
TVH	1.425	1.48	0.064	2.001	796.051	62.129	7.042		0.711	0.209		0.017	0.853	994.302		1.355			–
Sample Depth	8-9 ft.	10-11 ft.																	
Benzene	–	–																	
Ethylbenzene	–	–																	
Toluene	–	–																	
Xylenes	–	–																	
TVH	0.349	0.129																	

Boring Location	B20	B21	B22	B23	B24	B25	B26	B27	B28	B29	B30	B31	B32	B33	B34	B35
Sample Depth	7-8 ft.	7-8 ft.	7-8 ft.	7-8 ft.	7-8 ft.	3-4 ft.	7-8 ft.	7-8 ft.	7-8 ft.	9-10 ft.	7-8 ft.	7-8 ft.	7-8 ft.	7-8 ft.	7-8 ft.	7-8 ft.
Benzene	0.324	–	–	–	0.51	–	–	–	0.221	–	–	–	–	–	–	–
Ethylbenzene	0.072	–	–	–	0.034	–	–	–	0.12	–	–	–	–	–	–	–
Toluene	0.39	–	–	–	0.272	–	–	–	0.311	–	–	–	–	–	–	–
Xylenes	1.68	–	–	–	0.26	–	–	–	0.661	–	–	–	–	–	–	–
TVH	8.199	0.016	–	–	1.406	0.43	0.026	–	3.395	–	–	–	–	–	–	–
Sample Depth	11-12 ft.	9-10 ft.	10-11 ft.					10-11 ft.	11-12 ft.	11-12 ft.	11-12 ft.	11-12 ft.	11-12 ft.	11-12 ft.	11-12 ft.	11-12 ft.
Benzene	0.538	0.122	–					–	0.287	–	–	–	1.782	0.202	–	–
Ethylbenzene	0.718	–	–					–	0.46	–	–	–	–	–	–	–
Toluene	0.476	0.046	–					–	0.194	–	–	–	–	–	–	–
Xylenes	2.062	–	–					–	0.11	–	–	–	–	–	–	–
TVH	7.728	0.623	8.169					–	4.658	–	–	–	1.852	0.401	–	–
Sample Depth	13-14 ft.								15-16 ft.				15-16 ft.		16-17 ft.	
Benzene	1.22								–				0.855		–	
Ethylbenzene	0.34								–				–		–	
Toluene	0.208								–				–		–	
Xylenes	0.072								–				–		–	
TVH	3.553								–				0.903		–	

Comments:
(–) = Below Method Detection Limit
ppm = parts per million (mg/kg or mg/L)
(blank) = Sample not collected or not analyzed

Table 3
Summary of Soil Sample Results (ppm)
Heritage Laboratory

Boring Location / Sample Depth	Cleanup Criteria (a) Inhalation	Cleanup Criteria (a) Migration	Cleanup Criteria (b) Inhalation	Cleanup Criteria (b) Migration	B1 7-8 ft.	B2 10-11 ft.	B3 5-6 ft.	B4	B5	B6 11-12 ft.	B7	B8 6-7 ft.	B9 7.5-8.5ft.	B10 5.5-6.5ft.	B11	B12 14-15 ft.	B13 6-7 ft.	B14 9.5-10.5ft.	B15	B16	B17 7-8 ft.
BETX Constituents																					
Benzene	0.8	0.03	1.5	0.17	–	–	–			0.003		–	–	–		–	–	0.013			
Ethylbenzene	400	13	400	19	–	–	–			0.008		–	–	–		–	–	0.046			
Toluene	650	12	650	29	–	–	–			0.029		–	–	–		–	–	0.058			
Xylenes	410	150	410	150	–	–	–			0.04		–	–	–		0.025	–	0.19			
PNA Constituents																					
Naphthalene	-c-	84	-c-	420	–	–	–			–		–	–	–		0.0074	–	0.058			
Acenaphthylene	NL	NL	NL	NL	–	–	–			–		–	–	–		–	–	–			
Acenaphthene	-c-	570	-c-	2,900	–	–	–			–		–	–	–		–	–	–			
Fluorene	-c-	560	-c-	2,800	–	–	–			–		–	–	–		–	–	–			
Phenanthrene	NL	NL	NL	NL	–	–	–			0.0087		–	–	–		–	–	–			
Anthracene	-c-	12,000	-c-	59,000	–	–	–			–		–	–	–		–	–	–			
Fluoranthene	-c-	4,300	-c-	21,000	–	–	–			0.0072		–	0.026	0.033		–	–	–			
Pyrene	-c-	4,200	-c-	21,000	–	–	–			–		–	0.016	0.03		–	–	–			
Benzo(a)Anthracene	-c-	2	-c-	8	–	–	–			–		–	0.005	0.0062		–	–	–			
Chrysene	-c-	160	-c-	800	–	–	–			–		–	0.0084	0.0099		–	–	–			
Benzo(b)Fluoranthene	-c-	5	-c-	25	–	–	–			–		–	0.016	0.018		–	–	–			
Benzo(k)Fluoranthene	-c-	49	-c-	250	–	–	–			–		–	0.0054	0.0089		–	0.0035	–			
Benzo(a)Pyrene	-c-	8	-c-	82	–	–	–			–		–	0.014	0.018		–	–	–			
Dibenzo(a,h)Anthracene	-c-	2	-c-	7.6	–	–	–			–		–	–	–		–	–	–			
Benzo(g,h,i)Perylene	-c-	NL	NL	NL	–	–	–			0.0094		–	0.014	0.014		0.0075	0.0079	0.0092			
Indeno(1,2,3-cd)Pyrene	-c-	14	-c-	69	–	–	–			–		–	0.012	0.011		–	0.0044	–			
Metal Constituents																					
Total Lead	-c-		-c-																		15
TCLP Lead		0.0075		0.1																	–

Boring Location / Sample Depth	B18 8-9 ft.	B19 6-7 ft.	B20 11-12 ft.	B21	B22	B23 7-8 ft.	B24	B25 3-4 ft.	B26 7-8 ft.	B27 10-11 ft.	B28 11-12 ft.	B29 9-10 ft.	B30 7-8 ft.	B31 6-7 ft.	B32	B33	B34 7-8 ft.	B35 11-12 ft.
BETX Constituents																		
Benzene	–	–	0.15			–		–	–	–	–	–	–	–			–	–
Ethylbenzene	0.005	–	5.5			–		–	–	–	–	–	–	–			–	–
Toluene	–	–	3.3			–		–	–	–	–	–	–	–		–	–	–
Xylenes	0.007	–	23			–		–	–	–	–	–	–	–			–	–
PNA Constituents																		
Naphthalene		–				–		–	–	–								
Acenaphthylene		–				–		–	–	–								
Acenaphthene		–				–		–	–	–								
Fluorene		–				–		–	–	–								
Phenanthrene		–				–		–	0.0097	–								
Anthracene		–				–		–	–	–								
Fluoranthene		–				–		–	0.013	–								
Pyrene		–				–		–	–	–								
Benzo(a)Anthracene		–				–		–	0.0038	–								
Chrysene		–				–		–	–	–								
Benzo(b)Fluoranthene		–				–		–	0.0058	–								
Benzo(k)Fluoranthene		–				–		–	–	–								
Benzo(a)Pyrene		–				–		–	–	–								
Dibenzo(a,h)Anthracene		–				–		–	–	–								
Benzo(g,h,i)Perylene		–				–		–	–	–								
Indeno(1,2,3-cd)Pyrene		–				–		–	0.005	–								
Metal Constituents																		
Total Lead																		
TCLP Lead																		

Comments:
(–) = Below Method Detection Limit
ppm = parts per million (mg/kg or mg/L)
(blank) = Sample not collected or not analyzed

NL = Not Listed
-c- = No toxicity criteria available for this route of exposure.
(a) = Inhalation and Migration values for Tier 1 Residential Properties.
(b) = Inhalation and Migration values for Tier 1 Industrial-Comercial Properties

Table 4
Summary of Groundwater Results (ppm)
Heritage Laboratory

	Class II Groundwater Criteria (a)	Piezometer Location			
		P1	P2	P3	P4
BETX Constituents					
Benzene	0.025	--	--	0.3	0.009
Ethylbenzene	1	--	--	0.041	--
Toluene	2.5	--	--	0.43	--
Xylenes	10	--	--	0.19	--
PNA Constituents					
Naphthalene	0.039		--	0.006	
Acenaphthylene	NL		--	--	
Acenaphthene	2.1		--	--	
Fluorene	1.4		--	--	
Phenanthrene	NL		--	--	
Anthracene	10.5		--	--	
Fluoranthene	1.4		--	--	
Pyrene	1.05		--	--	
Benzo(a)Anthracene	0.00065		--	--	
Chrysene	0.0075		--	--	
Benzo(b)Fluoranthene	0.0009		--	--	
Benzo(k)Fluoranthene	0.00085		--	--	
Benzo(a)Pyrene	0.002		--	--	
Dibenzo(a,h)Anthracene	0.0015		--	--	
Benzo(g,h,i)Perylene	NL		--	--	
Indeno(1,2,3-cd)Pyrene	0.00215		--	--	

Comments:

-- = Below Method Detection Limit
ppm = parts per million (mg/L)
(blank) = Sample not collected or not analyzed
(a) = Tier 1 Industrial-Comerical Properties
NL = Not Listed

APPENDIX E

LABORATORY TEST REPORTS

The Agency is authorized to require this information under Section 4 and Title XVI of the Environmental Protection Act (415 ILCS 5/4, 5/57 - 57.17). Failure to disclose this information may result in a civil penalty of not to exceed $50,000.00 for the violation and an additional civil penalty of not to exceed $10,000.00 for each day during which the violation continues (415 ILCS 5/42). Any person who knowingly makes a false material statement or representation in any label, manifest, record, report, permit, or license, or other document filed, maintained or used for the purpose of compliance with Title XVI commits a Class 4 felony. Any second or subsequent offense after conviction hereunder is a Class 3 felony (415 ILCS 5/57.17). This form has been approved by the Forms Management Center.

Illinois Environmental Protection Agency
Leaking Underground Storage Tank Program
Laboratory Certification for Chemical Analysis

A. Site Identification

IEMA Incident # (6 digit): 971739 IEPA Generator # (10 digit): 0971255004

Site Name: United States Navy, Great Lakes Training Center

Site Address (Not a P.O. Box): Building 1600A, Ray Street

City: Great Lakes County: Lake

B. Sample Collector

I certify that:

1. Appropriate sampling equipment/methods were utilized to obtain representative samples. TAB (initial)
2. Chain of custody procedures were followed in the field. TAB (initial)
3. Sample integrity was maintained by proper preservation. TAB (initial)
4. All samples were properly labeled. TAB (initial)

C. Laboratory Representative

I certify that:

1. Proper chain of custody procedures were followed as documented on the chain of custody forms. (initial)
2. Sample integrity was maintained by proper preservation. (initial)
3. All samples were properly labeled. (initial)
4. Quality assurance/quality control procedures were established and carried out. (initial)

IL 532 2293
LPC 509 Rev. Dec-96

5. Sample holding times were not exceeded. (initial)

6. SW-846 Analytical Laboratory Procedure (USEPA) methods were used for the analyses. (initial)

D. Signatures

I hereby affirm that all information contained in this form is true and accurate to the best of my knowledge and belief. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sample Collector	**Laboratory Representative**
Name: Timothy A. Boos	Name: Jeffrey J. Fesko
Title: Project Geologist	Title: Manager, Analytical Services
Company: TolTest, Inc.	Company: TolTest, Inc.
Address: 2104 Buckley Road Great Lakes, IL 60088	Address: 1915 N. 12th Street Toledo, Ohio 43603
Phone: (847) 689-0697	Phone: (419) 241-7175
Signature: Timothy A. Boos	Signature:
Date: 20 JAN 00	Date: 20 JAN 2000

TOLTEST, INC.
Founded in 1927
Toledo, Ohio • Detroit, Michigan • Plymouth, Michigan • Pittsburgh, Pennsylvania

TEST REPORT

CLIENT: TolTest, Inc.
4200 Coral Berry Path #103
Gurnee, Illinois 60031

DATE: November 24, 1999

ATTN: Mr. Khushwant Mander

REVISED

Project No.: 37755.01

Lab Receiving No.: 9910000088

Date Received: October 25, 1999

Date Sampled: October 19-20, 1999

Project Location: Building 1600 A
Great Lakes, Illinois

Sample Point(s): MW-1-03, MW-3-04, MW-2-03, MW-4-05, MW-5-05

Analysis Performed: General Chemistry, SPLP Metals, Total Metals, BTEX, PNAs (8270)

Reviewed and Approved by: ______________________ Date: 11/24/99

Jeffrey J. Fesko
Manager, Analytical Services

ANALYTICAL NARRATIVE

The note(s) below pertain to the sample(s) and analytical data reported herein:

The sample(s) received by the laboratory under chain of custody met EPA guidelines for container type, labeling and preservation technique.

This report contains data produced by a subcontracted laboratory accredited for the test method(s) performed. Subcontract Laboratory: Specialized Assays, Inc. U.S. Army Corps of Engineers Accredited.

The BTEX surrogate for sample point MW-2-03 could not be determined due to matrix interferences and therefore is not reported.

The report was revised to include results for MTBE.

The laboratory is accredited or approved by the following agencies:

State of Ohio; Certification No.: 7016
State of Tennessee; Division of UST
U.S. Army Corps of Engineers
City of Toledo
AIHA; Certification No.: 384
NVLAP; Certification No.: 101594-0

REPORT KEY

ASTM	=	American Society of Testing and Materials
EP TOX	=	Extraction Procedure Toxicity
EPA/CE-81-1	=	Technical Report: Procedures for Handling and Chemical Analysis of Sediment and Water Samples
GC	=	Gas Chromatograph Instrument
GC/MS	=	Gas Chromatography/Mass Spectrometer Instrument
HPLC	=	High Performance Liquid Chromatography
IR	=	Infrared Instrument
mE/100grams	=	milliequivalent/100 grams soil
mg/m^3	=	milligram per cubic meter
mg/kg	=	milligram per kilogram (ppm)
mg/L	=	milligram per liter (ppm)
mg/W	=	milligram per wipe
mV	=	milliVolts
n/a	=	not applicable
PCBs	=	Polychlorinated Biphenyls
pCi/L	=	picocurie per liter
ppb	=	parts per billion
ppm	=	parts per million
RCRA	=	Resource Conservation and Recovery Act
SM	=	Standard Method, 19^{th} Edition
std	=	result is relative to standard pH units
TCLP	=	Toxicity Characteristic Leaching Procedure
SPLP	=	Synthetic Precipitation Leaching Procedure
µg/kg	=	microgram per kilogram (ppb)
µg/L	=	microgram per liter (ppb)
µg/S	=	microgram per sample
µg/W	=	microgram per wipe
>	=	greater than
<	=	less than
%	=	percent
ACZ	=	ACZ Laboratories, Inc.
BEC	=	BEC Laboratories, Inc.
DLZ	=	DLZ Laboratories, Inc.
SAI	=	Specialized Assays, Inc.
JHL	=	Jones & Henry Laboratories, Inc.
JF	=	Jeff Fesko
EA	=	Elaine Ault
BD	=	Barb Dusseau
SP	=	Susan Pellitieri
LW	=	Lorene Watts
JK	=	Julie Konieczny
DG	=	Diann Gillette
RW	=	Rebecca Williamson
MR	=	Margaret Russell

GENERAL CHEMISTRY
ANALYTICAL RESULTS

PROJECT No.:	37755.01	**UNITS:**	see below
METHOD No.:	see below	**BATCH No.:**	9814

SAMPLE ID:	**METHOD NUMBER**	**UNITS**	**METHOD BLANK**	MW-1-03	MW-3-04	MW-2-03	MW-4-05	MW-5-05
SAMPLE No.:				85282	85283	85284	85285	85286
Total Organic Carbon	9060M	mg/kg	<30.0	**43700.**	**21200.**	**30600.**	**54900.**	**35600.**

TOTAL METALS
ANALYTICAL RESULTS

PROJECT No.:	37755.01	**UNITS:**	mg/kg
METHOD No.:	6010B	**BATCH No.:**	2AAI021399

SAMPLE ID:	**METHOD BLANK**	MW-1-03	MW-3-04	MW-2-03				
SAMPLE No.:		85282	85283	85284				
Lead	<2.50	**6.60**	**15.2**	**7.38**				

SPL[illegible]TALS
ANALYTICAL RESULTS

PROJECT No.:	37755.01	**UNITS:**	mg/L
METHOD No.:	1312/7421	**BATCH No.:**	8AAG020899

SAMPLE ID:	**METHOD BLANK**	**MW-1-03**	**MW-3-04**	**MW-2-03**				
SAMPLE No.:		85282	85283	85284				
Lead	<0.001	**0.020**	**0.027**	**0.038**				

AROMATIC VOLA[illegible] ORGANICS by GC
ANALYTICAL RESULTS

PROJECT No.:	37755.01	**UNITS:**	mg/kg
METHOD No.:	5035/8021B	**BATCH No.:**	2GCV015799

SAMPLE ID:	**METHOD BLANK**	**MW-1-03**	**MW-3-04**	**MW-2-03**	**MW-4-05**	**MW-5-05**		
SAMPLE No.:		85282	85283	85284	85285	85286		
Benzene	<0.005	<0.005	<0.005	**0.116**	**0.023**	**0.039**		
Toluene	<0.005	<0.005	<0.005	<0.010	**0.044**	<0.005		
Ethylbenzene	<0.005	<0.005	<0.005	<0.010	**0.031**	<0.005		
Total Xylenes	<0.015	<0.015	<0.015	<0.030	**0.969**	<0.015		
MTBE	<0.005	<0.005	<0.005	<0.010	<0.005	<0.005		

POLYNUCLEAR ARC. .TIC HYDROCARBONS
ANALYTICAL RESULTS

PROJECT No.:	37755.01	**UNITS:**	mg/kg
METHOD No.:	8270C	**BATCH No.:**	2MSS013699

SAMPLE ID:	**METHOD BLANK**	**MW-1-03**	**MW-3-04**	**MW-2-03**	**MW-4-05**	**MW-5-05**		
SAMPLE No.:		85282	85283	85284	85285	85286		
Acenaphthene	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300		
Acenaphthylene	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250		
Anthracene	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250		
Benzo(a)anthracene	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150		
Benzo(b)fluoranthene	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150		
Benzo(k)fluoranthene	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300		
Benzo(g,h,i)perylene	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100		
Benzo(a)pyrene	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150		
Chrysene	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100		
Dibenz(a,h)anthracene	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100		
Fluoranthene	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300		
Fluorene	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250		
Indeno(1,2,3-c,d)pyrene	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250		
Naphthalene	<0.300	<0.300	<0.300	**6.99**	<0.300	<0.300		
Phenanthrene	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250		
Pyrene	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300		
2-Methylnaphthalene	<0.250	<0.250	<0.250	**8.29**	<0.250	<0.250		

SURROG… SUMMARY

	PCBs Method 8082 Batch No.	PESTICIDES Method 8081A Batch No.	HERBICIDES Method 8151A Batch No.	PNAs Method 8100 Batch No.	BTEX Method 5035/8021B Batch No. 2GCV015799
Surrogate:	Tetrachloro-m-xylene	Decachlorobiphenyl	DCAA	2-Fluorobiphenyl	α,α,α-Trifluorotoluene
METHOD BLANK					103
METHOD SPIKE					103
MATRIX SPIKE					104
MATRIX SPIKE DUPLICATE					105
85282					98
85283					105
85284					---
85285					98
85286					101
SURROGATE CONTROL LIMITS:	30-130%	30-130%	30-130%	50-115%	70-120%

SURROGATE SUMMARY

	SEMI-VOLATILES Method 8270C Batch No. 2MSS013699						VOLATILES Method 8260B Batch No.		
Surrogates:	Phenol-d_5	2-Fluorophenol	2,4,6-Tribromophenol	Nitrobenzene-d_5	2-Fluorobiphenyl	p-Terphenyl	Dibromofluoromethane	4-Bromofluorobenzene	Toluene-d_8
METHOD BLANK	n/a	n/a	n/a	80	82	88			
METHOD SPIKE	n/a	n/a	n/a	76	82	89			
MATRIX SPIKE	n/a	n/a	n/a	67	74	83			
MATRIX SPIKE DUP	n/a	n/a	n/a	67	76	77			
85282	n/a	n/a	n/a	70	77	85			
85283	n/a	n/a	n/a	77	78	77			
85284	n/a	n/a	n/a	67	88	75			
85285	n/a	n/a	n/a	73	74	87			
85286	n/a	n/a	n/a	75	77	72			
SURROGATE CONTROL LIMITS:	50-120%	35-110%	55-125%	50-120%	55-120%	60-130%	80-120%	65-115%	75-115%

BATCH ( )UMMARY

BATCH No.	DATE EXTRACTED	DATE ANALYZED	ANALYST	GENERAL CHEMISTRY PARAMETERS	% Recovery METHOD SPIKE	% Recovery MATRIX SPIKE	% Recovery MATRIX DUPLICATE	% RPD
9814	--------	10/31/99	SAI	Total Organic Carbon (TOC)	93	n/a	n/a	n/a

BATCH No.	DATE EXTRACTED	DATE ANALYZED	ANALYST	TOTAL METALS PARAMETERS	% Recovery METHOD SPIKE	% Recovery MATRIX SPIKE	% Recovery MATRIX DUPLICATE	% RPD
2AAI021399	11/02/99	11/02/99	RW	Lead	81	64	79	21

BATCH No.	DATE EXTRACTED	DATE ANALYZED	ANALYST	SPLP METALS PARAMETERS	% Recovery METHOD SPIKE	% Recovery MATRIX SPIKE	% Recovery MATRIX DUPLICATE	% RPD
8AAG020899	10/29/99	11/04/99	RW	Lead	87	92	99	7

BATCH [illegible] SUMMARY

BATCH No.	DATE EXTRACTED	DATE ANALYZED	ANALYST	BTEX PARAMETERS	% Recovery METHOD SPIKE	% Recovery MATRIX SPIKE	% Recovery MATRIX DUPLICATE	% RPD
2GCV015799	--------	10/25/99	RW	Benzene	79	73	79	8
				Toluene	81	77	80	4
				Ethylbenzene	83	75	81	8
				Total Xylenes	84	75	81	8
				MTBE	63	65	71	9

BATCH No.	DATE EXTRACTED	DATE ANALYZED	ANALYST	SEMI-VOLATILES PARAMETERS	% Recovery METHOD SPIKE	% Recovery MATRIX SPIKE	% Recovery MATRIX DUPLICATE	% RPD
2MSS013699	10/27-28/99	10/28-29/99	EA	Acenaphthene	84	73	73	0
				1,4-Dichlorobenzene	70	60	57	5
				2,4-Dinitrotoluene	65	54	54	0
				N-Nitrosodi-n-propylamine	88	80	77	4
				Pyrene	97	86	84	2
				1,2,4-Trichlorobenzene	85	75	73	3

TOLTEST, INC. 1915 N. 12th St., P.O. Box 2186, Toledo, OH 43603-2186; Voice (419) 241-7175, Fax (419) 321-6259
Ship To Address: ATTN: RECEIVING LAB, 1810 N. 12th St., Toledo, OH 43624-1304; Voice (419) 241-7175, Fax (419) 241-1808
Sent From: ☐ Corporate ☐ Plymouth ☐ Monroe ☐ Pittsburgh ☒ Other Great Lakes

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Chain of C

23223 Page 1 of

Project No.: 37755.01	Client: US NAVY, EJOC
P.O. No.:	Project/Location: Bldg 1600A, Great Lakes, IL
Project Mgr.: Khush Mander/Bob Beckwith	Sampler's Name: Timothy A. Boos
Phone No.	Sampler's Signature: Timothy A. Boos

Parameters

Item No.	Sample I.D.	Date Sampled	Time Sampled	Type	Matrix	Sample Location	Total No. of Containers	SPLP lead 1312	Total Lead 7421	BTEX 5035	PNAs 8100	TOC 9060	Penetrometer			Preserved Yes/No	LAB USE ONLY Lab #
1	MW-1-03	10/19/99	10:23	S	Soil	Monitoring well 1, sample 3, 4-6ft	2	X	X	X	X	X	X			N	85282
2	MW-3-04	10/19/99	13:31	S	Soil	Monitoring well 3, sample 4, 6-8ft	2	X	X	X	X	X	X			↓	85283
3	MW-2-03	10/19/99	15:40	S	Soil	monitoring well 2, sample 3, 4-6ft	2	X	X	X	X	X	X			↓	85284
4	MW-4-05	10/20/99	10:50	S	Soil	monitoring well 4, sample 5, 8-10ft	~~2~~ 3			X	X	X	X			↓	85285
5	MW-5-05	10/20/99	14:50	S	Soil	monitoring well 5, sample 5, 8-10ft	~~2~~ 3			X	X	X	X			↓	85286
6																	
7																	
8																	
9																	
10																	

Item No.	Relinquished By:	Date / Time	Received By:	Date / Time
1-5	Timothy A. Boos	10/22/99	Fed Ex 813529224968	10/22/99
1-5	Fed Ex 813529224968	10/25/99 1015	[signature]	10/25/99 1015

LAB USE ONLY

Were samples delivered ☐ in person ☒ by courier
Were samples preserved ☐ in field ☐ in lab ☒ N/A
Temp of samples 4 °C
Did samples arrive intact and sealed? ☒ yes ☐ no ☐ N/A
Were proper containers used? ☒ yes ☐ no
Was container labeled properly for contents? ☒ yes ☐ no
Were samples packaged properly for type of material? ☒ yes ☐ no
Was shipping label completed properly per regulations? (49 CFR 170, etc.) ☐ yes ☒ no
Comments:

TAT 10

TOLTEST, INC.

Founded in 1927
Toledo, Ohio • Detroit, Michigan • Plymouth, Michigan • Pittsburgh, Pennsylvania

TEST REPORT

CLIENT: TolTest, Inc.
1915 N. 12th Street
Toledo, Ohio 43624-1305

DATE: December 17, 1999

ATTN: Mr. Bob Beckwith

Project No.: 37755.01

Lab Receiving No.: 9912000027

Date Received: December 9, 1999

Date Sampled: December 7, 1999

Project Location: Building 1600 A
Great Lakes, Illinois

Sample Point(s): MW-6-06

Analysis Performed: BTEX, MTBE, PNAs (8270)

Reviewed and Approved by: ______________________ Date: 12/17/99

Jeffrey J. Fesko
Manager, Analytical Services

ANALYTICAL NARRATIVE

The note(s) below pertain to the sample(s) and analytical data reported herein:

The sample(s) received by the laboratory under chain of custody met EPA guidelines for container type, labeling and preservation technique.

The laboratory is accredited or approved by the following agencies:

State of Ohio; Certification No.: 7016
State of Tennessee; Division of UST
U.S. Army Corps of Engineers
City of Toledo
AIHA; Certification No.: 384
NVLAP; Certification No.: 101594-0

REPORT KEY

ASTM	=	American Society of Testing and Materials
EP TOX	=	Extraction Procedure Toxicity
EPA/CE-81-1	=	Technical Report: Procedures for Handling and Chemical Analysis of Sediment and Water Samples
GC	=	Gas Chromatograph Instrument
GC/MS	=	Gas Chromatography/Mass Spectrometer Instrument
HPLC	=	High Performance Liquid Chromatography
IR	=	Infrared Instrument
mE/100grams	=	milliequivalent/100 grams soil
mg/m^3	=	milligram per cubic meter
mg/kg	=	milligram per kilogram (ppm)
mg/L	=	milligram per liter (ppm)
mg/W	=	milligram per wipe
mV	=	milliVolts
n/a	=	not applicable
PCBs	=	Polychlorinated Biphenyls
pCi/L	=	picocurie per liter
ppb	=	parts per billion
ppm	=	parts per million
RCRA	=	Resource Conservation and Recovery Act
SM	=	Standard Method, 19th Edition
std	=	result is relative to standard pH units
TCLP	=	Toxicity Characteristic Leaching Procedure
SPLP	=	Synthetic Precipitation Leaching Procedure
µg/kg	=	microgram per kilogram (ppb)
µg/L	=	microgram per liter (ppb)
µg/S	=	microgram per sample
µg/W	=	microgram per wipe
>	=	greater than
<	=	less than
%	=	percent
ACZ	=	ACZ Laboratories, Inc.
BEC	=	BEC Laboratories, Inc.
DLZ	=	DLZ Laboratories, Inc.
SAI	=	Specialized Assays, Inc.
JHL	=	Jones & Henry Laboratories, Inc.
JF	=	Jeff Fesko
EA	=	Elaine Ault
BD	=	Barb Dusseau
SP	=	Susan Pellitieri
LW	=	Lorene Watts
JK	=	Julie Konieczny
DG	=	Diann Gillette
RW	=	Rebecca Williamson
MR	=	Margaret Russell

AROMATIC VOLA_ ORGANICS by GC
ANALYTICAL RESULTS

PROJECT No.:	37755.01	**UNITS:**	mg/kg
METHOD No.:	5035/8021B	**BATCH No.:**	2GCV017599

SAMPLE ID:	**METHOD BLANK**	MW-6-06						
SAMPLE No.:		86558						
Benzene	<0.005	<0.005						
Toluene	<0.005	**0.031**						
Ethylbenzene	<0.005	<0.005						
Total Xylenes	<0.015	<0.015						
MTBE	<0.005	<0.005						

POLYNUCLEAR ARC. .TIC HYDROCARBONS
ANALYTICAL RESULTS

PROJECT No.:	37755.01	**UNITS:**	mg/kg
METHOD No.:	8270C	**BATCH No.:**	2MSS014999

SAMPLE ID:	METHOD BLANK	MW-6-06							
SAMPLE No.:		86558							
Acenaphthene	<0.300	<0.300							
Acenaphthylene	<0.250	<0.250							
Anthracene	<0.250	<0.250							
Benzo(a)anthracene	<0.150	<0.150							
Benzo(b)fluoranthene	<0.150	<0.150							
Benzo(k)fluoranthene	<0.300	<0.300							
Benzo(g,h,i)perylene	<0.100	<0.100							
Benzo(a)pyrene	<0.150	<0.150							
Chrysene	<0.100	<0.100							
Dibenz(a,h)anthracene	<0.100	<0.100							
Fluoranthene	<0.300	<0.300							
Fluorene	<0.250	<0.250							
Indeno(1,2,3-c,d)pyrene	<0.250	<0.250							
Naphthalene	<0.300	<0.300							
Phenanthrene	<0.250	<0.250							
Pyrene	<0.300	<0.300							
2-Methylnaphthalene	<0.250	<0.250							

SURROGATE SUMMARY

	PCBs Method 8082 Batch No.	PESTICIDES Method 8081A Batch No.	HERBICIDES Method 8151A Batch No.	PNAs Method 8100 Batch No.	BTEX Method 5035/8021B Batch No. 2GCV017599
Surrogate:	Tetrachloro-m-xylene	Decachlorobiphenyl	DCAA	2-Fluorobiphenyl	α,α,α-Trifluorotoluene
METHOD BLANK					98
METHOD SPIKE					99
MATRIX SPIKE					108
MATRIX SPIKE DUPLICATE					109
86558					104
SURROGATE CONTROL LIMITS:	30-130%	30-130%	30-130%	50-115%	70-120%

SURROGATE SUMMARY

	SEMI-VOLATILES Method 8270C Batch No. 2MSS014999						VOLATILES Method 8260B Batch No.		
Surrogates:	Phenol-d_5	2-Fluorophenol	2,4,6-Tribromophenol	Nitrobenzene-d_5	2-Fluorobiphenyl	p-Terphenyl	Dibromofluoromethane	4-Bromofluorobenzene	Toluene-d_8
METHOD BLANK	n/a	n/a	n/a	67	71	85			
METHOD SPIKE	n/a	n/a	n/a	65	70	82			
MATRIX SPIKE	n/a	n/a	n/a	81	76	79			
MATRIX SPIKE DUP	n/a	n/a	n/a	82	77	76			
86558	n/a	n/a	n/a	74	74	77			
SURROGATE CONTROL LIMITS:	50-120%	35-110%	55-125%	50-120%	55-120%	60-130%	80-120%	65-115%	75-115%

BATCH QC SUMMARY

BATCH No.	DATE EXTRACTED	DATE ANALYZED	ANALYST	BTEX PARAMETERS	% Recovery METHOD SPIKE	MATRIX SPIKE	MATRIX DUPLICATE	% RPD
2GCV017599	--------	12/10/99	RW	Benzene	93	106	114	7
				Toluene	88	83	89	7
				Ethylbenzene	90	92	99	7
				Total Xylenes	91	94	101	7
				MTBE	89	115	127	10

BATCH No.	DATE EXTRACTED	DATE ANALYZED	ANALYST	SEMI-VOLATILES PARAMETERS	% Recovery METHOD SPIKE	MATRIX SPIKE	MATRIX DUPLICATE	% RPD
2MSS014999	12/09/99	12/10/99	EA	Acenaphthene	71	78	80	3
				1,4-Dichlorobenzene	66	67	71	6
				2,4-Dinitrotoluene	55	77	73	5
				N-Nitrosodi-n-propylamine	78	91	92	1
				Pyrene	89	90	88	2
				1,2,4-Trichlorobenzene	75	74	73	1

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Ship To Address: ATTN: RECEIVING LAB, 1810 N. 12th St., Toledo, OH 43624-1304; Voice (419) 241-7175, Fax (419) 241-1808
Sent From: ☐ Corporate ☐ Plymouth ☐ Pittsburgh ☒ Other Fed Ser. - GLNTC

Chain of Cu y Record

26830 Page 1 of 1

Project No.: 37755.01	Client: US Navy / Fed Ser. - GLNTC
P.O. No.:	Project/Location: Bldg 1600A, Great Lakes, IL
Project Mgr.: Bob Beckwith	Sampler's Name: Timothy A. Boos
Phone No. (419) 241-7175	Sampler's Signature: Timothy A. Boos

Parameters

Item No.	Sample I.D.	Date Sampled	Time Sampled	Type	Matrix	Sample Location	Total No. of Containers	BTEX 5035/8021B	MTBE 5035/8021B	PNA 8270					Preserved Yes/No	LAB USE ONLY Lab #
1	MW-6-06	12/7/99	0807	S	Soil	MW-6 10 to 12 ft bgs	2	X	X	X						86558
2																
3																
4																
5																
6																
7																
8																
9																
10																

Item No.	Relinquished By:	Date	Time	Received By:	Date	Time
1	Timothy A. Boos	12/8/99	15:35	FedEx	12/8/99	1535
1-1	Fed Ex	12/9/99	1015	[signature]	12/9/99	1015

LAB USE ONLY

- Were samples delivered ☐ in person ☒ by courier
- Were samples preserved ☐ in field ☐ in lab ☒ N/A
- Temp of samples NA °C
- Did samples arrive intact and sealed? ☒ yes ☐ no ☐ N/A
- Were proper containers used? ☐ yes ☐ no
- Was container labeled properly for contents? ☒ yes ☐ no
- Were samples packaged properly for type of material? ☒ yes ☐ no
- Was shipping label completed properly per regulations? (49 CFR 170, etc.) ☐ yes ☒ no

Comments:

TAT 10

Distribution: Original plus one accompanies shipment (white and yellow); copy to coordinator field files (pink)

Rev. 4/99

TOLTEST, INC.

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TEST REPORT

CLIENT: TolTest, Inc.
1915 N. 12th Street
Toledo, Ohio 43624-1305

DATE: November 10, 1999

ATTN: Mr. Robert Beckwith

REVISED

Project No.: 37755.01

Lab Receiving No.: 9910000111

Date Received: October 29, 1999

Date Sampled: October 28, 1999

Project Location: Building 1600A
Great Lakes, Illinois

Sample Point(s): MW-1, MW-2, MW-3, MW-4, MW-5

Analysis Performed: Total Lead, BTEX, MTBE, PNAs (8270)

Reviewed and Approved by: [signature] Date: 11/10/99

Jeffrey J. Fesko
Manager, Analytical Services

ANALYTICAL NARRATIVE

The note(s) below pertain to the sample(s) and analytical data reported herein:

The sample(s) received by the laboratory under chain of custody met EPA guidelines for container type, labeling and preservation technique.

The BTEX surrogate for sample point MW-4 could not be determined due to matrix interferences and therefore is not reported.

The report was revised, per client request, to include results for MTBE.

The laboratory is accredited or approved by the following agencies:

State of Ohio; Certification No.: 7016
State of Tennessee; Division of UST
U.S. Army Corps of Engineers
City of Toledo
AIHA; Certification No.: 384
NVLAP; Certification No.: 101594-0

REPORT KEY

ASTM	=	American Society of Testing and Materials
EP TOX	=	Extraction Procedure Toxicity
EPA/CE-81-1	=	Technical Report: Procedures for Handling and Chemical Analysis of Sediment and Water Samples
GC	=	Gas Chromatograph Instrument
GC/MS	=	Gas Chromatography/Mass Spectrometer Instrument
HPLC	=	High Performance Liquid Chromatography
IR	=	Infrared Instrument
mE/100grams	=	milliequivalent/100 grams soil
mg/m^3	=	milligram per cubic meter
mg/kg	=	milligram per kilogram (ppm)
mg/L	=	milligram per liter (ppm)
mg/W	=	milligram per wipe
mV	=	milliVolts
n/a	=	not applicable
PCBs	=	Polychlorinated Biphenyls
pCi/L	=	picocurie per liter
ppb	=	parts per billion
ppm	=	parts per million
RCRA	=	Resource Conservation and Recovery Act
SM	=	Standard Method, 19^{th} Edition
std	=	result is relative to standard pH units
TCLP	=	Toxicity Characteristic Leaching Procedure
SPLP	=	Synthetic Precipitation Leaching Procedure
µg/kg	=	microgram per kilogram (ppb)
µg/L	=	microgram per liter (ppb)
µg/S	=	microgram per sample
µg/W	=	microgram per wipe
>	=	greater than
<	=	less than
%	=	percent
ACZ	=	ACZ Laboratories, Inc.
BEC	=	BEC Laboratories, Inc.
DLZ	=	DLZ Laboratories, Inc.
SAI	=	Specialized Assays, Inc.
JHL	=	Jones & Henry Laboratories, Inc.
JF	=	Jeff Fesko
EA	=	Elaine Ault
BD	=	Barb Dusseau
SP	=	Susan Pellitieri
LW	=	Lorene Watts
JK	=	Julie Konieczny
DG	=	Diann Gillette
RW	=	Rebecca Williamson
MR	=	Margaret Russell

TOTA ETALS
ANALYTICAL RESULTS

PROJECT No.:	37755.01	**UNITS:**	mg/L
METHOD No.:	7421	**BATCH No.:**	1AAG021199

SAMPLE ID:	**METHOD BLANK**	**MW-1**	**MW-2**	**MW-3**				
SAMPLE No.:		85384	85385	85386				
Lead	<0.001	**0.020**	<0.001	**0.002**				

AROMATIC VOLA[illegible] ORGANICS by GC
ANALYTICAL RESULTS

PROJECT No.:	37755.01	**UNITS:**	µg/L
METHOD No.:	5035/8021B	**BATCH No.:**	1GCV016299

SAMPLE ID:	**METHOD BLANK**	MW-1	MW-2	MW-3	MW-4	MW-5		
SAMPLE No.:		85384	85385	85386	85387	85388		
Benzene	<1.00	<1.00	**453.**	<1.00	**691.**	**24.8**		
Toluene	<1.00	<1.00	**1320.**	<1.00	**243.**	<1.00		
Ethylbenzene	<1.00	<1.00	**407.**	<1.00	**761.**	**7.79**		
Total Xylenes	<3.00	<3.00	**1100.**	<3.00	**1680.**	**5.75**		
MTBE	<1.00	<1.00	<2.00	<1.00	<1.00	**19.2**		

POLYNUCLEAR ARC. TIC HYDROCARBONS
ANALYTICAL RESULTS

PROJECT No.:	37755.01	**UNITS:**	µg/L
METHOD NO.:	8270C	**BATCH NO.:**	1MSS014099

SAMPLE ID:	**METHOD BLANK**	**MW-1**	**MW-2**	**MW-3**	**MW-4**	**MW-5**		
SAMPLE No.:		85384	85385	85386	85387	85388		
Acenaphthene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Acenaphthylene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Anthracene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Benzo(a)anthracene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Benzo(b)fluoranthene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Benzo(k)fluoranthene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Benzo(g,h,i)perylene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Benzo(a)pyrene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Chrysene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Dibenz(a,h)anthracene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Fluoranthene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Fluorene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Indeno(1,2,3-c,d)pyrene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Naphthalene	<5.00	<5.00	**56.2**	<5.00	<5.00	<5.00		
Phenanthrene	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00		
Pyrene	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50		
2-Methylnaphthalene	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50		

SURROG. SUMMARY

Surrogate:	PCBs Method 8082 Batch No. Tetrachloro-m-xylene	PESTICIDES Method 8081A Batch No. Decachlorobiphenyl	HERBICIDES Method 8151A Batch No. DCAA	PNAs Method 8100 Batch No. 2-Fluorobiphenyl	BTEX Method 5035/8021B Batch No. 1GCV016299 α,α,α-Trifluorotoluene
METHOD BLANK					102
METHOD SPIKE					107
MATRIX SPIKE					106
MATRIX SPIKE DUPLICATE					107
85384					99
85385					126
85386					92
85387					---
85388					93
SURROGATE CONTROL LIMITS:	30-130%	30-130%	30-130%	50-115%	70-120%

SURROG… SUMMARY

	SEMI-VOLATILES Method 8270C Batch No. 1MSS014099						VOLATILES Method 8260B Batch No.		
Surrogates:	Phenol-d_5	2-Fluorophenol	2,4,6-Tribromophenol	Nitrobenzene-d_5	2-Fluorobiphenyl	p-Terphenyl	Dibromofluoromethane	4-Bromofluorobenzene	Toluene-d_8
METHOD BLANK	n/a	n/a	n/a	76	79	97			
METHOD SPIKE	n/a	n/a	n/a	65	70	73			
MATRIX SPIKE	n/a	n/a	n/a	65	67	88			
MATRIX SPIKE DUP	n/a	n/a	n/a	65	72	92			
85384	n/a	n/a	n/a	69	68	75			
85385	n/a	n/a	n/a	59	62	80			
85386	n/a	n/a	n/a	65	66	65			
85387	n/a	n/a	n/a	64	64	74			
85388	n/a	n/a	n/a	57	56	88			
SURROGATE CONTROL LIMITS:	10-110%	10-110%	55-120%	45-115%	55-115%	50-130%	80-115%	70-120%	80-115%

BATCH QC SUMMARY

BATCH No.	DATE EXTRACTED	DATE ANALYZED	ANALYST	TOTAL METALS PARAMETERS	% Recovery METHOD SPIKE	MATRIX SPIKE	MATRIX DUPLICATE	% RPD
1AAG021199	11/01/99	11/02/99	RW	Lead	105	95	90	5

BATCH No.	DATE EXTRACTED	DATE ANALYZED	ANALYST	BTEX PARAMETERS	% Recovery METHOD SPIKE	MATRIX SPIKE	MATRIX DUPLICATE	% RPD
1GCV016299	--------	11/02/99	EA	Benzene	106	102	105	3
				Toluene	100	95	97	2
				Ethylbenzene	99	99	101	2
				Total Xylenes	100	99	101	2
				MTBE	94	97	100	3

BATCH No.	DATE EXTRACTED	DATE ANALYZED	ANALYST	SEMI-VOLATILES PARAMETERS	% Recovery METHOD SPIKE	MATRIX SPIKE	MATRIX DUPLICATE	% RPD
1MSS014099	11/02/99	11/02/99	EA	Acenaphthene	64	60	66	10
				1,4-Dichlorobenzene	48	53	49	8
				2,4-Dinitrotoluene	53	51	53	4
				N-Nitrosodi-n-propylamine	71	69	71	3
				Pyrene	87	88	91	3
				1,2,4-Trichlorobenzene	59	60	59	2

30 10/29/99 111

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Ship To Address: ATTN: RECEIVING LAB, 1810 N. 12th St., Toledo, OH 43624-1304; Voice (419) 241-7175, Fax (419) 241-1808
Sent From: ☐ Corporate ☐ Plymouth ☐ Monroe ☐ Pittsburgh ☑ Other Fed - Great Lakes

Chain of Custody

23229

Page 1 of 1

Project No.: 37755.01
Client: US Navy
P.O. No.:
Project/Location: EJOC, Bldg 1600A, Great Lakes, IL
Project Mgr.: B. Beckwith
Sampler's Name: Timothy A. Boos
Phone No. (419) 241-7175
Sampler's Signature: Timothy A. Boos

Item No.	Sample I.D.	Date Sampled	Time Sampled	Type	Matrix	Sample Location	Total No. of Containers	SPLP lead 1312	Total lead 7421	BTEX 5035	PNAs 8100					Preserved Yes/No	LAB USE ONLY Lab #
1	MW-1	10/28/99	13:26	G	liquid	Bldg 1600A MW-1	4 3	X	X	X	X						85384
2	MW-2	↓	13:38	↓	↓	Bldg 1600A MW-2	4 3	X	X	X	X						85385
3	MW-3	↓	13:49	↓	↓	Bldg 1600A MW-3	4	X	X	X	X						85386
4	MW-4	↓	13:13	↓	↓	Bldg 1600A MW-4	3			X	X						85387
5	MW-5	↓	12:58	↓	↓	Bldg 1600A MW-5	3			X	X						85388
6																	
7																	
8																	
9																	
10																	

Item No.	Relinquished By:	Date / Time	Received By:	Date / Time
1-5	Timothy A. Boos	10/29/99 13:15	[signature]	10/29/99 1323

LAB USE ONLY

Were samples delivered ☑ in person ☐ by courier
Were samples preserved ☐ in field ☑ in lab ☐ N/A
Temp of samples 4 °C
Did samples arrive intact and sealed? ☑ yes ☐ no ☐ N/A
Were proper containers used? ☑ yes ☐ no
Was container labeled properly for contents? ☑ yes ☐ no
Were samples packaged properly for type of material? ☑ yes ☐ no
Was shipping label completed properly per regulations? (49 CFR 170, etc.) ☐ yes ☑ no

Comments:

TAT 10

TOLTEST, INC.

Founded in 1927
Toledo, Ohio • Detroit, Michigan • Plymouth, Michigan • Pittsburgh, Pennsylvania

TEST REPORT

CLIENT: TolTest, Inc.
1915 N. 12th Street
Toledo, Ohio 43624-1305

DATE: December 22, 1999

ATTN: Mr. Robert Beckwith

Project No.: 37755.01

Lab Receiving No.: 9912000066

Date Received: December 17, 1999

Date Sampled: December 16, 1999

Project Location: Building 1600A
Great Lakes, Illinois

Sample Point(s): MW-6

Analysis Performed: BTEX, MTBE, PNAs (8270)

Reviewed and Approved by: [signature] Date: 12/22/99

Jeffrey J. Fesko
Manager, Analytical Services

ANALYTICAL NARRATIVE

The note(s) below pertain to the sample(s) and analytical data reported herein:

The sample(s) received by the laboratory under chain of custody met EPA guidelines for container type, labeling and preservation technique.

The laboratory is accredited or approved by the following agencies:

State of Ohio; Certification No.: 7016
State of Tennessee; Division of UST
U.S. Army Corps of Engineers
City of Toledo
AIHA; Certification No.: 384
NVLAP; Certification No.: 101594-0

REPORT KEY

ASTM	=	American Society of Testing and Materials
EP TOX	=	Extraction Procedure Toxicity
EPA/CE-81-1	=	Technical Report: Procedures for Handling and Chemical Analysis of Sediment and Water Samples
GC	=	Gas Chromatograph Instrument
GC/MS	=	Gas Chromatography/Mass Spectrometer Instrument
HPLC	=	High Performance Liquid Chromatography
IR	=	Infrared Instrument
mE/100grams	=	milliequivalent/100 grams soil
mg/m^3	=	milligram per cubic meter
mg/kg	=	milligram per kilogram (ppm)
mg/L	=	milligram per liter (ppm)
mg/W	=	milligram per wipe
mV	=	milliVolts
n/a	=	not applicable
PCBs	=	Polychlorinated Biphenyls
pCi/L	=	picocurie per liter
ppb	=	parts per billion
ppm	=	parts per million
RCRA	=	Resource Conservation and Recovery Act
SM	=	Standard Method, 19th Edition
std	=	result is relative to standard pH units
TCLP	=	Toxicity Characteristic Leaching Procedure
SPLP	=	Synthetic Precipitation Leaching Procedure
µg/kg	=	microgram per kilogram (ppb)
µg/L	=	microgram per liter (ppb)
µg/S	=	microgram per sample
µg/W	=	microgram per wipe
>	=	greater than
<	=	less than
%	=	percent
ACZ	=	ACZ Laboratories, Inc.
BEC	=	BEC Laboratories, Inc.
DLZ	=	DLZ Laboratories, Inc.
SAI	=	Specialized Assays, Inc.
JHL	=	Jones & Henry Laboratories, Inc.
JF	=	Jeff Fesko
EA	=	Elaine Ault
BD	=	Barb Dusseau
SP	=	Susan Pellitieri
LW	=	Lorene Watts
JK	=	Julie Konieczny
DG	=	Diann Gillette
RW	=	Rebecca Williamson
MR	=	Margaret Russell

AROMATIC VOLA[illegible]E ORGANICS by GC
ANALYTICAL RESULTS

PROJECT No.:	37755.01	**UNITS:**	µg/L
METHOD No.:	5035/8021B	**BATCH No.:**	1GCV018099

SAMPLE ID:	**METHOD BLANK**	**MW-6**						
SAMPLE No.:		86878						
Benzene	<1.00	<1.00						
Toluene	<1.00	<1.00						
Ethylbenzene	<1.00	<1.00						
Total Xylenes	<3.00	<3.00						
MTBE	<1.00	<1.00						

POLYNUCLEAR AR[illegible]TIC HYDROCARBONS
ANALYTICAL RESULTS

PROJECT No.:	37755.01	**UNITS:**	µg/L
METHOD NO.:	8270C	**BATCH NO.:**	1MSS015099

SAMPLE ID:	**METHOD BLANK**	**MW-6**							
SAMPLE No.:		86878							
Acenaphthene	<5.00	<5.00							
Acenaphthylene	<5.00	<5.00							
Anthracene	<5.00	<5.00							
Benzo(a)anthracene	<5.00	<5.00							
Benzo(b)fluoranthene	<5.00	<5.00							
Benzo(k)fluoranthene	<5.00	<5.00							
Benzo(g,h,i)perylene	<5.00	<5.00							
Benzo(a)pyrene	<5.00	<5.00							
Chrysene	<5.00	<5.00							
Dibenz(a,h)anthracene	<5.00	<5.00							
Fluoranthene	<5.00	<5.00							
Fluorene	<5.00	<5.00							
Indeno(1,2,3-c,d)pyrene	<5.00	<5.00							
Naphthalene	<5.00	<5.00							
Phenanthrene	<5.00	<5.00							
Pyrene	<2.50	<2.50							
2-Methylnaphthalene	<2.50	<2.50							

SURROG SUMMARY

Surrogate:	PCBs Method 8082 Batch No. Tetrachloro-m-xylene	PESTICIDES Method 8081A Batch No. Decachlorobiphenyl	HERBICIDES Method 8151A Batch No. DCAA	PNAs Method 8100 Batch No. 2-Fluorobiphenyl	BTEX Method 5035/8021B Batch No. 1GCV018099 α,α,α-Trifluorotoluene
METHOD BLANK					96
METHOD SPIKE					97
MATRIX SPIKE					108
MATRIX SPIKE DUPLICATE					106
86878					98
SURROGATE CONTROL LIMITS:	30-130%	30-130%	30-130%	50-115%	70-120%

SURROGA SUMMARY

	SEMI-VOLATILES Method 8270C Batch No. 1MSS015099						VOLATILES Method 8260B Batch No.		
Surrogates:	Phenol-d_5	2-Fluorophenol	2,4,6-Tribromophenol	Nitrobenzene-d_5	2-Fluorobiphenyl	p-Terphenyl	Dibromofluoromethane	4-Bromofluorobenzene	Toluene-d_8
METHOD BLANK	n/a	n/a	n/a	60	52	50			
METHOD SPIKE	n/a	n/a	n/a	59	56	57			
MATRIX SPIKE	n/a	n/a	n/a	60	60	80			
MATRIX SPIKE DUP	n/a	n/a	n/a	63	67	80			
86878	n/a	n/a	n/a	60	61	56			
SURROGATE CONTROL LIMITS:	10-110%	10-110%	55-120%	45-115%	55-115%	50-130%	80-115%	70-120%	80-115%

BATCH (,UMMARY

BATCH No.	DATE EXTRACTED	DATE ANALYZED	ANALYST	BTEX PARAMETERS	% Recovery METHOD SPIKE	% Recovery MATRIX SPIKE	% Recovery MATRIX DUPLICATE	% RPD
1GCV018099	--------	12/20/99	EA	Benzene	106	108	99	9
				Toluene	101	102	93	9
				Ethylbenzene	102	120	95	23
				Total Xylenes	105	109	96	13
				MTBE	109	110	101	9

BATCH No.	DATE EXTRACTED	DATE ANALYZED	ANALYST	SEMI-VOLATILES PARAMETERS	% Recovery METHOD SPIKE	% Recovery MATRIX SPIKE	% Recovery MATRIX DUPLICATE	% RPD
1MSS015099	12/20/99	12/20/99	EA	Acenaphthene	57	61	64	5
				1,4-Dichlorobenzene	49	54	52	4
				2,4-Dinitrotoluene	53	56	60	7
				N-Nitrosodi-n-propylamine	65	67	68	1
				Pyrene	74	80	85	6
				1,2,4-Trichlorobenzene	52	57	59	3

TOLTEST INC. 1915 N. 12th St., P.O. Box 2186, Toledo, OH 43603-2186; Voice (419) 241-7[illegible] (419) 321-6259
Ship To Address: ATTN: RECEIVING LAB, 1810 N. 12th St., Toledo, OH 43624-1304; Voice (419) 241-7175, Fax (419) 241-1808
Sent From: ☐ Corporate ☐ Plymouth ☐ Pittsburgh ☒ Other TolTest - GLNTC

Chain of Custody Record

26560

Page 1 of 1

Project No.: 37755.01	Client: US Navy, EJOC
P.O. No.:	Project/Location: Bldg 1600A
Project Mgr.: Bob Beckwith	Sampler's Name: Timothy A. Boos
Phone No. (419) 241-7175	Sampler's Signature: Timothy A. Boos

Parameters

Item No.	Sample I.D.	Date Sampled	Time Sampled	Type	Matrix	Sample Location	Total No. of Containers	BTEX 5035/8020B	MTBE 5035/8021B	PNA 8270						Preserved Yes/No	LAB USE ONLY Lab #
1	MW-6	12/16/99	10:50	G	Liquid	Bldg 1600A, MW-6	3	X	X	X							56578
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Item No.	Relinquished By:	Date / Time	Received By:	Date / Time
1	Timothy A. Boos	12/16/99 17:00	FedEx 813131157226	12/16/99 1700
1-1	FedEx 813131157226	12/17/99 0900	[signature]	12/17/99 0900

LAB USE ONLY

Were samples delivered ☐ in person ☑ by courier
Were samples preserved ☐ in field ☑ in lab ☐ N/A
Temp of samples 4 °C
Did samples arrive intact and sealed? ☑ yes ☐ no ☐ N/A
Were proper containers used? ☑ yes ☐ no
Was container labeled properly for contents? ☑ yes ☐ no
Were samples packaged properly for type of material? ☑ yes ☐ no
Was shipping label completed properly per regulations? (49 CFR 170, etc.) ☐ yes ☑ no
Comments:

TAT 5

Distribution: Original plus one accompanies shipment (white and yellow); copy to coordinator field files (pink)

Rev. 4/99

APPENDIX F

BORING LOGS

LUST Incident No.: 971739	Boring Number: MW-1	Page: 1 of 1
Site Name: Naval Training Center Address: Building 1600A, Ray Street Great Lakes Illinois	Boring Location: 160' NE of Bldg 1600A	Date: Start 10/19/99 Finish 10/19/99

Sample Number	Sample Device	Sample Recovery	Lithology Symbol	Depth (feet)	Detailed Soil and Rock Description	Natural Moisture Content %	Qu Hand Penetrometer	OVA/PID/FID/OVM	Remarks
				0	FILL, topsoil with glass fragments				
S-1	SPT	1.0	ML	1–2	FILL, stiff, light brn, silty clay with trace sand, damp — becomes brown with some red bricks at 2.0 ft.			0.1	
S-2	SPT	2.0		3–4				0	
S-3	SPT	1.5		5–6	2-inch wet coarse-grained sand layer at 5.0 ft.			0.1	
S-4	SPT	1.5	SP	7–8	SAND, medium dense, brn, coarse-grained with silt, wet			0	
S-5	SPT	1.5		9–10	becomes gray and fine-grained at 8.5 ft.			0	
S-6	SPT	2.0	ML	11–12	SILT, very stiff, gray with trace sand, moist			0	End of boring at 13.0 ft.
				13–15					

Note: Stratification lines are approximate; in-situ transition between soil types may be gradual.

Groundwater Data		
▼ Depth While Drilling: 6.0	Auger Depth 13.0	Rig CME 75
▽ Depth After Drilling: 4.61	Rotary Depth	Geologist Timothy A. Boos
	Driller/Co. TolTest, Inc.	
	Note: Boring backfilled unless otherwise noted.	

Illinois Environmental Protection Agency

LUST Incident No.: 971739

Boring Number: MW-2

Site Name: Naval Training Center

Address: Building 1600A, Ray Street Great Lakes Illinois

Boring Location: 90' NNE of Bldg 1600A

Date: Start 10/19/99 Finish 10/19/99

Sample Number	Sample Device	Sample Recovery	Lithology Symbol	Depth (feet)	Detailed Soil and Rock Description	Natural Moisture Content %	Qu Hand Penetrometer	OVA/PID/FID/OVM	Remarks
S-1	SPT	1.0	ML	0–1	Topsoil, very loose and dry			0	
S-2	SPT	0	CL	2–3	CLAY, stiff, brn, silty, and dry becomes medium stiff at 2.0 ft				
S-3	SPT	1.5	SP	4–5	SAND, loose, brn, coarse-grained and wet			1900	
S-4	SPT	1.5		6–8	becomes medium dense, greenish gray at 6.0 ft			728	
S-5	SPT	1.75	CL	9–10	CLAY, stiff, gray, silty, and moist			18	
S-6	SPT	2.0		11–12				9.4	End of boring at 13.0 ft

Note: Stratification lines are approximate; in-situ transition between soil types may be gradual.

Groundwater Data

▼ Depth While Drilling 4.0

▽ Depth After Drilling 6.08

Auger Depth 13.0 Rig CME 75

Rotary Depth ______ Geologist Timothy A. Boos

Driller/Co. TolTest, Inc.

Note: Boring backfilled unless otherwise noted.

Illinois Environmental Protection Agency

LUST Incident No.: 971739	Boring Number: MW-3	Page: 1 of 1
Site Name: Naval Training Center Address: Building 1600A, Ray Street Great Lakes Illinois	Boring Location: 40' NE of Bldg 1600A	Date: Start 10/19/99 Finish 10/19/99

Sample Number	Sample Device	Sample Recovery	Lithology Symbol	Depth (feet)	Detailed Soil and Rock Description	Natural Moisture Content %	Qu Hand Penetrometer	OVA/PID/FID/OVM	Remarks
S-1	SPT	0.5	ML	0–2	Topsoil, medium dense and dry			0	
S-2	SPT	1.0	ML	2–6	FILL, stiff brn, silty clay with trace sand, and dry becomes loose with red brick fragments at 4.0 ft			0	
S-3	SPT	1.5						0.3	
S-4	SPT	1.5	SP	6–12	SAND, very loose, brn, coarse-grained with some silt, wet becomes gray and medium to coarse-grained at 8.0 ft becomes medium dense at 10.0 ft			2.7	
S-5	SPT	1.5						0.1	
S-6	SPT	0.5						0.8	
S-7	SPT	1.75	ML	12–14	SILT, stiff, gray			0.2	End of boring at 14.0 ft

Note: Stratification lines are approximate; in-situ transition between soil types may be gradual.

Groundwater Data		
▼ Depth While Drilling 6.0	Auger Depth 14.0	Rig CME 75
▽ Depth After Drilling 6.11	Rotary Depth	Geologist Timothy A. Boos
	Driller/Co. TolTest, Inc.	
	Note: Boring backfilled unless otherwise noted.	

Illinois Environmental Protection Agency

LUST Incident No.: 971739	Boring Number: MW-4	Page: 1 of 1
Site Name: Naval Training Center Address: Building 1600A, Ray Street Great Lakes Illinois	Boring Location: 170' NE of Bldg 1600A adjacent Spaulding Street	Date: Start 10/20/99 Finish 10/20/99

Sample Number	Sample Device	Sample Recovery	Lithology Symbol	Depth (feet)	Detailed Soil and Rock Description	Natural Moisture Content %	Qu Hand Penetrometer	OVA/PID/FID/OVM	Remarks
			ML	0	Topsoil, medium dense, and dry				
S-1	SPT	1.0	SP	1	SAND, medium dense, brn, silty, and dry			1.2	
				2					
S-2	SPT	0		3					
				4					
S-3	SPT	1.5	CL	5	CLAY, stiff, dark grayish brn, silty, and moist			2.1	
				6	becomes light brownish gray at 6.0 ft				
S-4	SPT	1.0		7				3.5	
				8					
S-5	SPT	1.25	SP	9	SAND, medium dense, brn, coarse-grained, and wet			80.1	
				10					
S-6	SPT	1.0		11				49	
				12					
				13					End of boring at 13.0 ft
				14					
				15					

Note: Stratification lines are approximate; in-situ transition between soil types may be gradual.

Groundwater Data		
▼ Depth While Drilling 8.0 ▽ Depth After Drilling 5.38	Auger Depth 13.0 Rig CME 75 Rotary Depth ______ Geologist Timothy A. Boos Driller/Co. TolTest, Inc. Note: Boring backfilled unless otherwise noted.	Illinois Environmental Protection Agency

The Agen... is authorized to require this information under 415 ILCS 5/4 and 21. Disclosure of this information is required. Failur... to so may result in a civil penalty up to $25,000.00 fo... day the failure continues, a fine up to $50,000.00 and im...ment up to five years. This form has been approved by th... ms Management Center.

IL 532-2275
LPC 501 Dec-96

LUST Incident No.: 971739	Boring Number: MW-5	Page: 1 of 1
Site Name: Naval Training Center Address: Building 1600A, Ray Street Great Lakes Illinois	Boring Location: 230' E of Bldg 1600A inside entrance to Bldg 1506	Date: Start 10/20/99 Finish 10/20/99

Sample Number	Sample Device	Sample Recovery	Lithology Symbol	Depth (feet)	Detailed Soil and Rock Description	Natural Moisture Content %	Qu Hand Penetrometer	OVA/PID/FID/OVM	Remarks
			ML	0	Topsoil				
S-1	SPT	1.0	GC	1–2	FILL, medium dense, crushed stone with some clay			0.4	
S-2	SPT	1.5	CL	3–4	CLAY, stiff, dark grayish brn, and silty			0.1	
S-3	SPT	1.0		5–6	becomes medium stiff at 6.0 ft			0.4	
S-4	SPT	1.5		7				2.0	
S-5	SPT	1.0	SP	8–9	SAND, loose, dark gray, silty, and wet			3.3	
S-6	SPT	1.5	CL	10–11	CLAY, stiff, gray, and silty with trace sand			1.3	
S-7	SPT	1.5		12–13	6" gray silty sand layer at 12.0 ft			0.6	
				14					End of boring at 14.0 ft

Note: Stratification lines are approximate; in-situ transition between soil types may be gradual.

Groundwater Data		
▼ Depth While Drilling 8.0	Auger Depth 14.0 Rig CME 75	Illinois Environmental Protection Agency
▽ Depth After Drilling 4.91	Rotary Depth ____ Geologist Timothy A. Boos	
	Driller/Co. TolTest, Inc.	
	Note: Boring backfilled unless otherwise noted.	

IL 532-2275
LPC 501 Dec-96

LUST Incident No.: 971739	Boring Number: MW-6	Page: 1 of 1
Site Name: Naval Training Center Address: Building 1600A, Ray Street Great Lakes Illinois	Boring Location: 10' W of Bldg 1506	Date: Start 12/7/99 Finish 12/7/99

Sample Number	Sample Device	Sample Recovery	Lithology Symbol	Depth (feet)	Detailed Soil and Rock Description	Natural Moisture Content %	Qu Hand Penetrometer	OVA/PID/FID/OVM	Remarks
				0	Asphalt Pavement				
			GC	1	FILL, dense, crushed stone				
				2	becomes stiff, gray to dark green				
S-1	SPT	2.0		3	gray with some glass at 2.5 ft			0.7	
				4					
S-2	SPT	2.0		5				0.4	
			CL	6	CLAY, stiff yellow brn, silty and moist				
S-3	SPT	0.8	SP	7	SAND, medium dense, black and white, medium-grained, wet			0.3	
				8					
S-4	SPT	2.0	CL	9	CLAY, very stiff, gray, silty with trace sand, moist			0.2	
				10					
S-5	SPT	2.0	ML	11	SILT, medium stiff, gray with sand, wet			0.6	
				12	becomes stiff at 12.0 ft				
S-6	SPT	2.0		13				0.2	
				14					End of boring at 14.0 ft
				15					

Note: Stratification lines are approximate; in-situ transition between soil types may be gradual.

Groundwater Data		
▼ Depth While Drilling 6.0	Auger Depth 14.0	Rig CME 75
	Rotary Depth	Geologist Timothy A. Boos
▽ Depth After Drilling 4.14	Driller/Co. TolTest, Inc.	
	Note: Boring backfilled unless otherwise noted.	

Illinois Environmental Protection Agency

Project No: 37755.01

Location: Building #1600A

City, County: Great Lakes

Log of Borehole: MW-1

Geologist: T. Boos

TOLTEST, INC.

Depth (ft)	Elevation	Sample Number	Description	Recovery (ft)	SPT Blows	PID Readings (ppm)
0	0		Ground Surface			
0–0.8	-0.8	S-1	*FILL (ML)* topsoil with slug and glass	1.0	3 5 6 5	0.1
0.8–6			*FILL (ML)* stiff, light brown, silty clay with trace sand, and damp			
		S-2	-becomes brown with some red bricks at 2.0 ft	2.0	5 5 6 7	0
	-6	S-3*	-2" wet coarse-grained sand layer at 5.0 ft	1.5	3 6 4 7	0.1
6–11		S-4	*SAND (SP)* medium dense, brown, coarse-grained with silt, wet	1.5	7 8 10 10	0
		S-5	-becomes gray and fine-grained at 8.5 ft	1.5	5 7 7 8	0
11–12	-11 / -12	S-6	*SILT (ML)* very stiff, gray with trace sand, moist	2.0	6 8 10 11	0
12			End of Borehole			

* Designates sample submitted for laboratory analysis

Drilling Method: 4.25" Hollow Stem Auger

Drilling Date: 10-19-1999

Drilling Company: TolTest, Inc.

Total Depth: 13.0 ft

Initial Water Elevation (ft)/date: 5.0/10-19-1999

Water Elevation (ft)/date: 4.61/12-16-1999

Datum: Ground surface

Checked by: RRB

Sheet: 1 of 1

Project No: 37755.01

Log of Borehole: MW-2

Location: Building #1600A

Geologist: T. Boos

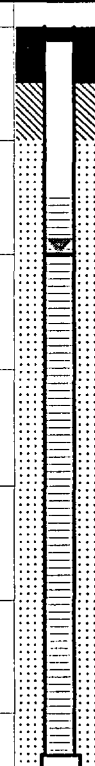
City, County: Great Lakes

TOLTEST, INC.

Depth (ft)	Elevation	Sample Number	Description	Recovery (ft)	SPT Blows	PID Readings (ppm)
0	0		Ground Surface			
0–1	-1	S-1	***TOPSOIL (ML)*** very loose and dry	1.0	2 3 5 4	0
1–4	-4		***CLAY (CL)*** stiff, 10 YR 5/3, brown, silty, and dry -becomes medium stiff at 2.0 ft			
2–4		S-2		0	2 2 4 4	
4–6		S-3*	***SAND (SP)*** loose, brown, coarse-grained, and wet	1.5	4 4 4 4	1900
6–8	-8.5	S-4	-becomes medium dense, 5/106, greenish gray at 6.0 ft	1.5	5 6 7 8	728
8–10		S-5	***CLAY (CL)*** stiff, 10 YR 5/1, gray, silty, and moist	1.75	5 5 5 5	18
10–12	-12	S-6		2.0	5 5 5 6	9.4
12			End of Borehole			

PID Readings scale (ppm): 250, 750, 1250, 1750, 2250

Well Data



* Designates sample submitted for laboratory analysis

Drilling Method: 4.25" Hollow Stem Auger

Total Depth: 13.0 ft

Datum: Ground surface

Drilling Date: 10-19-1999

Initial Water Elevation (ft)/date: 4.0/10-19-1999

Checked by: RCB

Drilling Company: TolTest, Inc.

Water Elevation (ft)/date: 6.08/12-16-1999

Sheet: 1 of 1

Project No: 37755.01

Log of Borehole: MW-3

Location: Building #1600A

Geologist: T. Boos

City, County: Great Lakes

TOLTEST, INC.

Depth (ft)	Elevation	Sample Number	Description	Recovery (ft)	SPT Blows	PID Readings (ppm)
0	0		Ground Surface			
0–2	-2	S-1	*TOPSOIL (ML)* medium dense and dry	0.5	3, 6, 7, 3	0
2–4		S-2	*FILL (ML)* stiff, brown, silty clay with trace sand, and dry -becomes loose with red bricks at 4.0 ft	1.0	4, 5, 6, 8	0
4–6	-6	S-3		1.5	2, 2, 4, 3	0.3
6–8		S-4*	*SAND (SP)* very loose, brown, coarse-grained with some silt, and wet	1.5	1, 1, 1, 1	2.7
8–10		S-5	-becomes gray and medium- to coarse-grained at 8.0 ft	1.5	2, 1, 2, 5	0.1
10–12	-11.5	S-6	-becomes medium dense at 10.0 ft *SILT (ML)* (from 11.5 ft) stiff, 10 YR 5/1, gray	0.5	8, 11, 12, 14	0.8
12–14	-14	S-7		1.75	4, 6, 4, 5	0.2
14			End of Borehole			

* Designates sample submitted for laboratory analysis

Drilling Method: 4.25" Hollow Stem Auger

Total Depth: 14.0 ft

Datum: Ground surface

Drilling Date: 10-19-1999

Initial Water Elevation (ft)/date: 6.0/10-19-1999

Checked by: CCB

Drilling Company: TolTest, Inc.

Water Elevation (ft)/date: 6.11/12-16-1999

Sheet: 1 of 1

Project No: 37755.01

Location: Building #1600A

City, County: Great Lakes

Log of Borehole: MW-4

Geologist: T. Boos

TOLTEST, INC.

Depth (ft)	Elevation	Sample Number	Description	Recovery (ft)	SPT Blows	PID Readings (ppm)
0	0		Ground Surface			
0	-0.5		*TOPSOIL (ML)* medium dense and dry			
0.5–2		S-1	*SAND (SP)* medium dense, 10 YR 4/2, brown, silty, and dry	1.0	5 6 7 8	1.2
2–4	-4	S-2		0.0	5 6 9 12	
4–6		S-3	*CLAY (CL)* stiff, 10 YR 4/2, dark grayish brown, silty, and moist	1.5	4 4 5 6	2.1
6–8	-8	S-4	-becomes 10 YR 6/2, light brownish gray at 6.0 ft	1.0	4 5 6 6	3.5
8–10		S-5*	*SAND (SP)* medium dense, 10 YR 4/3, brown, coarse-grained, and wet	1.25	5 6 8 9	80.1
10–12	-12	S-6		1.0	8 6 7 9	49
12			End of Borehole			

* Designates sample submitted for laboratory analysis

Drilling Method: 4.25" Hollow Stem Auger

Drilling Date: 10-20-1999

Drilling Company: TolTest, Inc.

Total Depth: 13.0 ft

Initial Water Elevation (ft)/date: 8.0/10-20-1999

Water Elevation (ft)/date: 5.38/12-16-1999

Datum: Ground surface

Checked by: LCS

Sheet: 1 of 1

Project No: 37755.01

Log of Borehole: MW-5

Location: Building #1600A

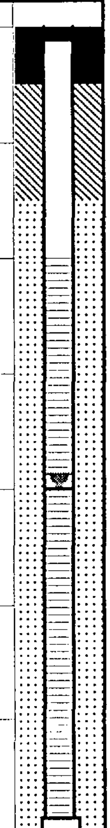
Geologist: T. Boos

City, County: Great Lakes

TOLTEST, INC.

Depth (ft)	Elevation	Sample Number	Description	Recovery (ft)	SPT Blows	PID Readings (ppm)
0	0		Ground Surface			
0–0.6	-0.6		***TOPSOIL (ML)***			
0.6–2.5		S-1	***FILL (GC)*** medium dense, crushed stone with some clay	1.0	5 7 7 10	0.4
2.5–8	-2.5	S-2	***CLAY (CL)*** stiff, 10 YR 4/2, dark grayish brown, and silty	1.5	5 5 5 5	0.1
		S-3		1.0	3 4 5 7	0.4
		S-4	-becomes medium stiff at 6.0 ft	1.5	3 3 4 4	2
8–10	-8	S-5*	***SAND (SP)*** loose, 10 YR 4/1, dark gray, silty, and wet	1.0	2 3 3	3.3
10–14	-10	S-6	***CLAY (CL)*** stiff, 10 YR 5/1, gray, and silty with trace sand	1.5	7 5 4 3	1.3
		S-7	-6" gray silty sand layer at 12.0 ft	1.5	4 6 5 6	0.6
14	-14		End of Borehole			

Well Data:



* Designates sample submitted for laboratory analysis

Drilling Method: 4.25" Hollow Stem Auger	Total Depth: 14.0 ft	Datum: Ground surface
Drilling Date: 10-20-1999	Initial Water Elevation (ft)/date: 8.0/10-20-1999	Checked by: [signature]
Drilling Company: TolTest, Inc.	Water Elevation (ft)/date: 4.91/12-16-1999	Sheet: 1 of 1

Project No: 37755.01

Log of Borehole: MW-6

Location: Building #1506

Geologist: T. Boos

City, County: Great Lakes

TOLTEST, INC.

Depth (ft)	Elevation	Sample Number	Description	Recovery (ft)	SPT Blows	PID Readings (ppm)
0	0		Ground Surface			
0–0.5	-0.5		***PAVEMENT*** asphalt			
0.5–5.5			***FILL (GC)*** dense, crushed stone			
2–4		S-1	-becomes stiff, 4/10 Y, gray to dark greenish gray with some glass at 2.5 ft	2.0	25 36 9 10	0.7
4–6	-5.5	S-2		2.0	4 5 5 5	0.4
5.5–6	-6		***CLAY (CL)*** stiff, 10 YR 5/4, yellowish brown, silty, and moist			
6–9		S-3	***SAND (SP)*** medium dense, black and white, medium-grained, wet	0.8	6 8 11 12	0.3
8–10	-9	S-4		2.0	4 6 9 9	0.2
9–10	-10		***CLAY (CL)*** very stiff, 10 YR 5/1, gray, silty with trace sand, moist			
10–12		S-5*	***SILT (ML)*** medium stiff, 10 YR 5/1, gray with sand, wet	2.0	2 3 4 4	0.6
12–14	-14	S-6	-becomes stiff at 12.0 ft	2.0	3 7 9 10	0.2
14			End of Borehole			

* Designates sample submitted for laboratory analysis

Drilling Method: 4.25" Hollow Stem Auger

Total Depth: 14.0 ft

Datum: Ground surface

Drilling Date: 12-7-1999

Initial Water Elevation (ft)/date: 6.0/12-7-1999

Checked by: [illegible]

Drilling Company: TolTest, Inc.

Water Elevation (ft)/date: 4.14/12-16-1999

Sheet: 1 of 1

ATTACHMENT 7-1B

TOLTEST, INC.
PID FIELD SCREENING LOG

Project No.: 37755.01	Date: 10/19/99	Page 1 of 2
Project Name & Location: Bldg 1600A Great Lakes, IL	Geologist: T. Boos	
Disposition of Headspace Media: Drum		

Borehole No.	Sample Interval (ft bgs)	Time	PID Reading (ppm)	Duplicate Reading (ppm)
MW-1	0-2	9:30	0.0	0.1
	2-4	9:45	0.0	0.0
	4-6	10:23	0.1	0.0
	6-8	10:31	0.0	0.0
	8-10	10:36	0.0	0.0
MW-1	10-12	10:44	0.0	0.0
~~MW-3~~	~~0-2~~	—	~~1.7~~	~~4.5~~
	~~2-4~~	—	~~4.4~~	~~1.8~~
	~~4-6~~	—	~~9.3~~	~~19.4~~
	~~6-8~~	—	~~2.9~~	~~13.0~~
	~~8-10~~	—	—	—
	~~10-12~~	—	—	—
MW-3	0-2	13:06	0.0	0.0
	2-4	13:14	0.0	0.0
	4-6	13:21	0.3	0.2
	6-8	13:31	~~[illegible]~~	2.7
	8-12		0.1	
MW-3	12-14	13:44	0.8	

moved boring due to PID readings?

ATTACHMENT 7-1B

TOLTEST, INC.
PID FIELD SCREENING LOG

Project No.: 37755.01	Date: 10/19/99	Page 2 of 2
Project Name & Location: Bldg 1600 A, Great Lakes, IL	Geologist: Tim Boos	
Disposition of Headspace Media: Drummed w/ soil cuttings		

Borehole No.	Sample Interval (ft bgs)	Time	PID Reading (ppm)	Duplicate Reading (ppm)
MW-2	4-6	15:40	2000	1800
|	6-8	15:45	885.5	869.5
|	8-10	16:00	14.5	22.0
MW-2	10-12	16:07	8.9	9.8

ATTACHMENT 7-1B

TOLTEST, INC.
PID FIELD SCREENING LOG

Project No.: 37755.01	Date: 10/20/99	Page 1 of 1
Project Name & Location: Bldg 1600A, Great Lakes, IL	Geologist: Tim Boos	
Disposition of Headspace Media: Drummed with soil cuttings.		

Borehole No.	Sample Interval (ft bgs)	Time	PID Reading (ppm)	Duplicate Reading (ppm)
MW-4	0-2	10:22	0.8	1.5
	2-4	—	No Recovery	—
	4-6	10:31	1.8	2.3
	6-8	10:42	2.9	4.0
	8-10	10:50	96.7	63.5
MW-4	10-12	10:56	60.2	39.8
—	—	—	—	—
MW-5	0-2	14:39	0.5	0.2
	2-4	14:42	0.1	0.1
	4-6	14:46	0.3	0.5
	6-8	14:50	2.1	2.0
	8-10	14:54	1.8	4.8
	10-12	14:56	1.6	0.9
MW-5	12-14	15:00	0.6	0.5

ATTACHMENT 7-1B

TOLTEST, INC.
PID FIELD SCREENING LOG

Project No.: 37755.01	Date: 12/7/99	Page 1 of 1
Project Name & Location: Bldg 1600 A, Great Lakes, IL	Geologist: Tim Boos	
Disposition of Headspace Media: Drummed w/ soil cuttings		

Borehole No.	Sample Interval (ft bgs)	Time	PID Reading (ppm)	Duplicate Reading (ppm)
MW-6	2-4	07:30	0.7	0.6
	4-6	07:42	0.4	0.3
	6-8	07:51	0.4	0.2
	8-10	08:00	0.1	0.2
	10-12	08:07	0.5	0.7
MW-6	12-14	08:17	0.2	0.1

APPENDIX G

MONITORING WELL LOGS

Illinois Environmental Protection Agency

LUST Well Completion Report

Incident No.: 971739
Well No.: MW-1
Site Name: Naval Training Center, Bldg 1600A
Date Drilled Start: 10/19/99
Drilling Contractor: TolTest, Inc.
Date Completed: 10/19/99
Driller: Neil Wiktor
Geologist: Timothy A. Boos
Drilling Method: 4 1/4-inch Hollow Stem Auger
Drilling Fluids (type): None

Annular Space Details

Type of Surface Seal: Concrete
Type of Annular Sealant: Bentonite chips
Type of Bentonite Seal (Granular, Pellet): Granular

Type of Sand Pack: #5 silica sand

Well Construction Materials

	Stainless Steel Specify Type	PVC 2" Specify Type Sch 40	Other Specify Type
Riser coupling joint		threaded	
Riser pipe above w.t.		3.0	
Riser pipe below w.t.			
Screen		10.0	
Coupling joint screen to riser		threaded	
Protective casing	Steel		

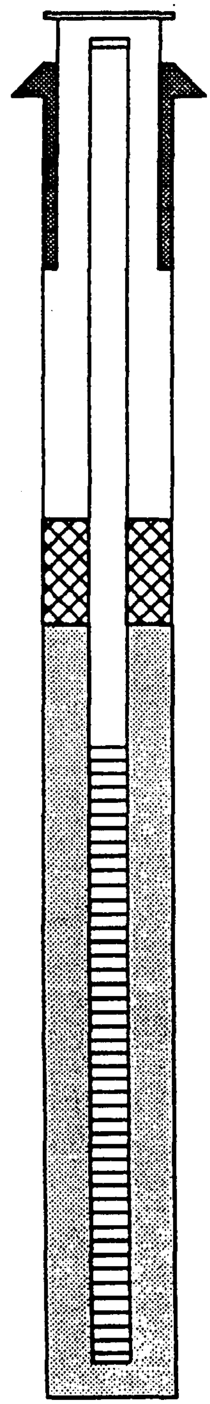
Measurements

to .01 ft (where applicable)

Riser pipe length	3.0
Screen length	10.0
Screen slot size	0.010
Protective casing length	1.5
Depth to water	4.61
Elevation of water	658.61
Free Product thickness	NA
Gallons removed (develop)	8
Gallons removed (purge)	
Other	

Completed by: Robert R Beckwith, PG

Elevations - .01 ft.



663.61 Top of Protective Casing
663.22 Top of Riser Pipe
____ Ground Surface
662.97 Top of Annular Sealant
0.0 Casing Stickup
662.72 Top of Seal
1.0 Total Seal Interval
661.72 Top of Sand
660.22 Top of Screen
10.0 Total Screen Interval
650.22 Bottom of Screen
650.22 Bottom of Borehole

For Groundwater Monitoring Wells installed due to a release of petroleum subject to 35 Ill. Adm. Code Section 731, Subpart F.

IL 532-2274

Illinois Environmental Protection Agency

LUST Well Completion Report

Incident No.: 971739
Site Name: Naval Training Center, Bldg 1600A
Drilling Contractor: TolTest, Inc
Driller: Neil Wiktor
Drilling Method: 4 1/4-inch Hollow Stem Auger

Well No.: MW-2
Date Drilled Start: 10/19/99
Date Completed: 10/19/99
Geologist: Timothy A. Boos
Drilling Fluids (type): None

Annular Space Details

Type of Surface Seal: Concrete
Type of Annular Sealant: Bentonite chips
Type of Bentonite Seal (Granular, Pellet): Granular

Type of Sand Pack: #5 silica sand

Well Construction Materials

	Stainless Steel Specify Type	PVC 2" Specify Type Sch 40	Other Specify Type
Riser coupling joint		threaded	
Riser pipe above w.t.		3.0	
Riser pipe below w.t.			
Screen		10.0	
Coupling joint screen to riser		threaded	
Protective casing	Steel		

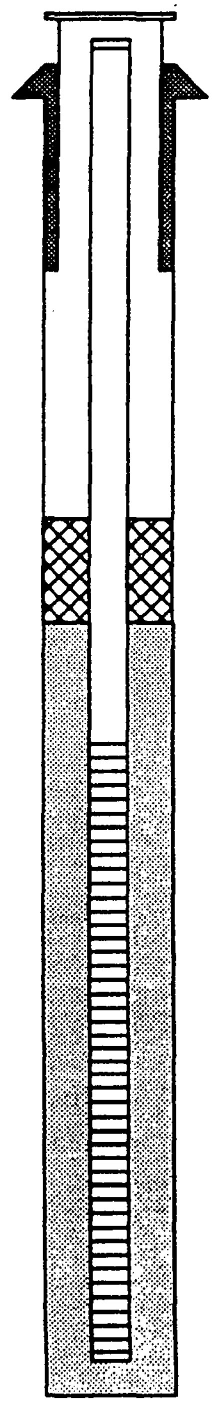
Measurements

to .01 ft (where applicable)

Riser pipe length	3.0
Screen length	10.0
Screen slot size	0.010
Protective casing length	1.5
Depth to water	6.08
Elevation of water	657.25
Free Product thickness	NA
Gallons removed (develop)	6
Gallons removed (purge)	
Other	

Completed by: Robert R Beckwith, PG

Elevations - .01 ft.



663.71 Top of Protective Casing
663.33 Top of Riser Pipe
Ground Surface
662.83 Top of Annular Sealant
0.0 Casing Stickup

662.33 Top of Seal
1.0 Total Seal Interval
661.33 Top of Sand
660.33 Top of Screen
10.0 Total Screen Interval
650.33 Bottom of Screen
650.33 Bottom of Borehole

For Groundwater Monitoring Wells installed due to a release of petroleum subject to 35 Ill. Adm. Code Section 731, Subpart F.

Illinois Environmental Protection Agency — **LUST Well Completion Report**

Incident No.: 971739
Site Name: Naval Training Center, Bldg 1600A
Drilling Contractor: TolTest, Inc
Driller: Neil Wiktor
Drilling Method: 4 1/4-inch Hollow Stem Auger

Well No.: MW-3
Date Drilled Start: 10/19/99
Date Completed: 10/19/99
Geologist: Timothy A. Boos
Drilling Fluids (type): None

Annular Space Details

Type of Surface Seal: Concrete
Type of Annular Sealant: Bentonite chips
Type of Bentonite Seal (Granular, Pellet): Granular

Type of Sand Pack: #5 silica sand

Well Construction Materials

	Stainless Steel Specify Type	PVC 2" Specify Type Sch 40	Other Specify Type
Riser coupling joint		threaded	
Riser pipe above w.t.		4.0	
Riser pipe below w.t.			
Screen		10.0	
Coupling joint screen to riser		threaded	
Protective casing	Steel		

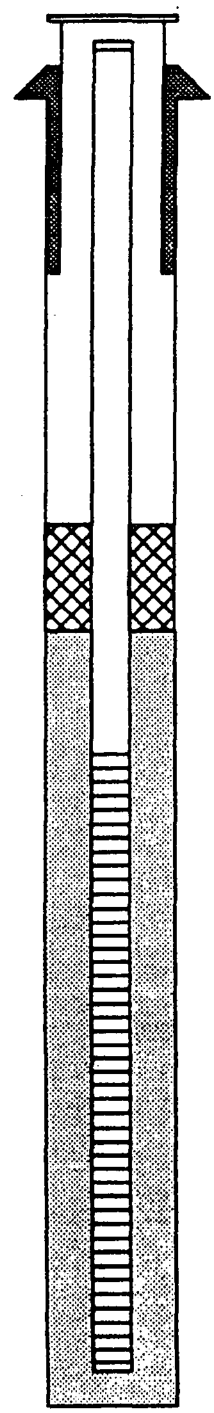
Measurements

to .01 ft (where applicable)

Riser pipe length	4.0
Screen length	10.0
Screen slot size	0.010
Protective casing length	1.5
Depth to water	6.11
Elevation of water	656.69
Free Product thickness	NA
Gallons removed (develop)	6
Gallons removed (purge)	
Other	

Completed by: Robert R Beckwith, P.G

Elevations - .01 ft.



663.26 Top of Protective Casing
662.80 Top of Riser Pipe
_____ Ground Surface
662.30 Top of Annular Sealant
0.0 Casing Stickup

661.80 Top of Seal
1.5 Total Seal Interval
660.30 Top of Sand

658.80 Top of Screen

10.0 Total Screen Interval

648.80 Bottom of Screen
648.80 Bottom of Borehole

For Groundwater Monitoring Wells installed due to a release of petroleum subject to 35 Ill. Adm. Code Section 731, Subpart F.

IL 532-2274

Illinois Environmental Protection Agency

LUST Well Completion Report

Incident No.:	971739	**Well No.:**	MW-4
Site Name:	Naval Training Center, Bldg 1600A	**Date Drilled Start:**	10/20/99
Drilling Contractor:	TolTest, Inc.	**Date Completed:**	10/20/99
Driller:	Neil Wiktor	**Geologist:**	Timothy A. Boos
Drilling Method:	4 1/4-inch Hollow Stem Auger	**Drilling Fluids (type):**	None

Annular Space Details

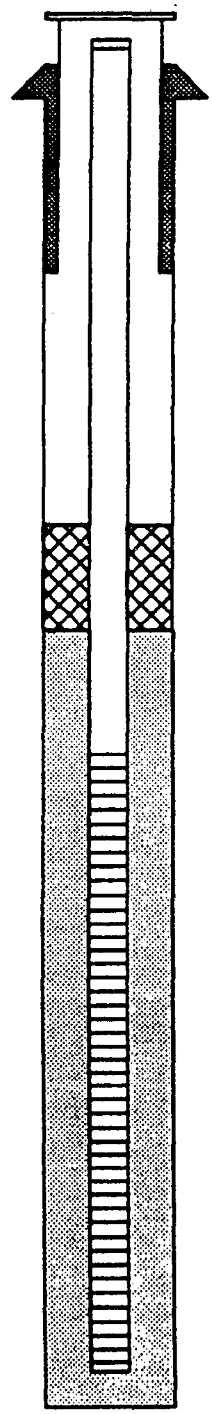
Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Type of Bentonite Seal (Granular, Pellet): Granular

Type of Sand Pack: #5 silica sand

Elevations - .01 ft.



661.17	Top of Protective Casing
660.73	Top of Riser Pipe
	Ground Surface
660.23	Top of Annular Sealant
0.0	Casing Stickup
659.73	Top of Seal
1.0	Total Seal Interval
658.73	Top of Sand
657.73	Top of Screen
10.0	Total Screen Interval
647.73	Bottom of Screen
647.73	Bottom of Borehole

Well Construction Materials

	Stainless Steel Specify Type	PVC 2" Specify Type Sch 40	Other Specify Type
Riser coupling joint		threaded	
Riser pipe above w.t.		3.0	
Riser pipe below w.t.			
Screen		10.0	
Coupling joint screen to riser		threaded	
Protective casing	Steel		

Measurements

to .01 ft (where applicable)

Riser pipe length	3.0
Screen length	10.0
Screen slot size	0.010
Protective casing length	1.5
Depth to water	5.38
Elevation of water	655.35
Free Product thickness	NA
Gallons removed (develop)	6
Gallons removed (purge)	
Other	

Completed by: Robert R Beckwith, PG

For Groundwater Monitoring Wells installed due to a release of petroleum subject to 35 Ill. Adm. Code Section 731, Subpart F.

Illinois Environmental Protection Agency

LUST Well Completion Report

Incident No.: 971739
Well No.: MW-5
Site Name: Naval Training Center, Bldg 1600A
Date Drilled Start: 10/20/99
Drilling Contractor: TolTest, Inc
Date Completed: 10/20/99
Driller: Neil Wiktor
Geologist: Timothy A. Boos
Drilling Method: 4 1/4-inch Hollow Stem Auger
Drilling Fluids (type): None

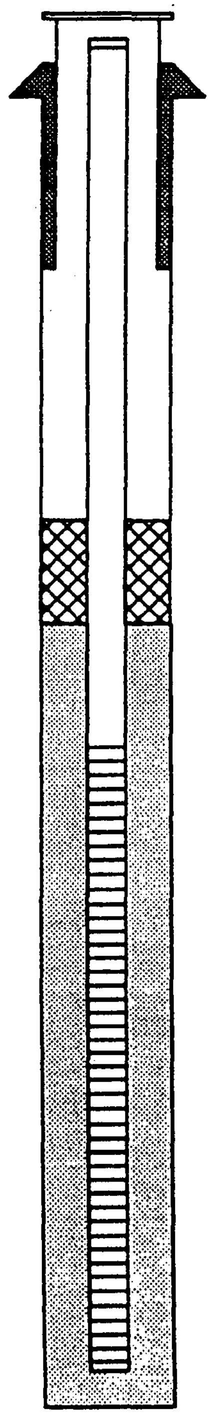
Annular Space Details

Type of Surface Seal: Concrete
Type of Annular Sealant: Bentonite chips
Type of Bentonite Seal (Granular, Pellet): Granular

Type of Sand Pack: #5 silica sand

Elevations - .01 ft.

660.07 Top of Protective Casing
659.51 Top of Riser Pipe
____ Ground Surface
660.23 Top of Annular Sealant
0.0 Casing Stickup



659.73 Top of Seal
1.5 Total Seal Interval
658.23 Top of Sand
656.73 Top of Screen
10.0 Total Screen Interval
646.73 Bottom of Screen
645.51 Bottom of Borehole

Well Construction Materials

	Stainless Steel Specify Type	PVC 2" Specify Type Sch 40	Other Specify Type
Riser coupling joint		threaded	
Riser pipe above w.t.		4.0	
Riser pipe below w.t.			
Screen		10.0	
Coupling joint screen to riser		threaded	
Protective casing	Steel		

Measurements

to .01 ft (where applicable)

Riser pipe length	4.0
Screen length	10.0
Screen slot size	0.010
Protective casing length	1.5
Depth to water	4.91
Elevation of water	654.60
Free Product thickness	NA
Gallons removed (develop)	8
Gallons removed (purge)	
Other	

Completed by: Robert R Beckwith, P.G.

For Groundwater Monitoring Wells installed due to a release of petroleum subject to 35 Ill. Adm. Code Section 731, Subpart F.

The Agency is authorized to require this information under 415 ILCS 5/4 and 21. Disclosure of this information is required. Failure to do so may result in a civil penalty up to $25,000.00 for each day the failure continues, a fine up to $50,000.00 and imprisonment up to five years. This form has been approved by the Forms Management Center.

Illinois Environmental Protection Agency — LUST Well Completion Report

Incident No.: 971739
Well No.: MW-6
Site Name: Naval Training Center, Bldg 1600A
Date Drilled Start: 12/7/99
Drilling Contractor: TolTest, Inc.
Date Completed: 12/7/99
Driller: Neil Wiktor
Geologist: Timothy A. Boos
Drilling Method: 4 1/4-inch Hollow Stem Auger
Drilling Fluids (type): None

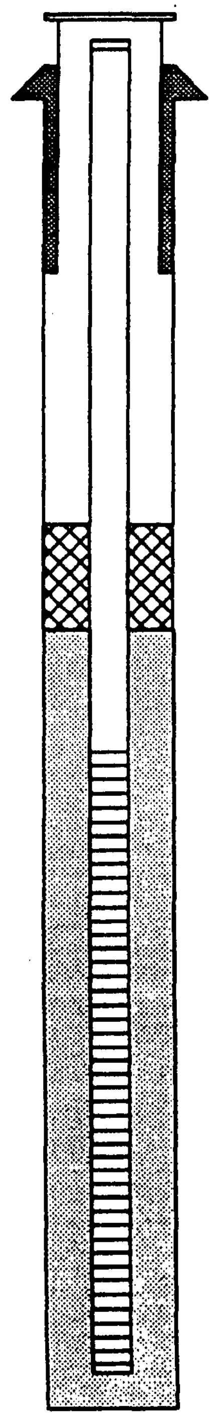
Annular Space Details

Type of Surface Seal: Concrete
Type of Annular Sealant: Bentonite chips
Type of Bentonite Seal (Granular, Pellet): Granular

Type of Sand Pack: #5 silica sand

Elevations - .01 ft.

659.18 Top of Protective Casing
658.73 Top of Riser Pipe
Ground Surface
658.23 Top of Annular Sealant
0.0 Casing Stickup



657.73 Top of Seal
1.5 Total Seal Interval
656.23 Top of Sand
654.73 Top of Screen
10.0 Total Screen Interval
644.73 Bottom of Screen
644.73 Bottom of Borehole

Well Construction Materials

	Stainless Steel Specify Type	PVC 2" Specify Type Sch 40	Other Specify Type
Riser coupling joint		threaded	
Riser pipe above w.t.		4.0	
Riser pipe below w.t.			
Screen		10.0	
Coupling joint screen to riser		threaded	
Protective casing	Steel		

Measurements

to .01 ft (where applicable)

Riser pipe length	4.0
Screen length	10.0
Screen slot size	0.010
Protective casing length	1.5
Depth to water	4.14
Elevation of water	654.59
Free Product thickness	NA
Gallons removed (develop)	6
Gallons removed (purge)	
Other	

Completed by: Robert R Beckwith, P.G.

For Groundwater Monitoring Wells installed due to a r[illegible] of petroleum subject to 35 Ill. Adm. Code Section 731, Subpart F.

IL 532-2274

APPENDIX H

SITE MAPS

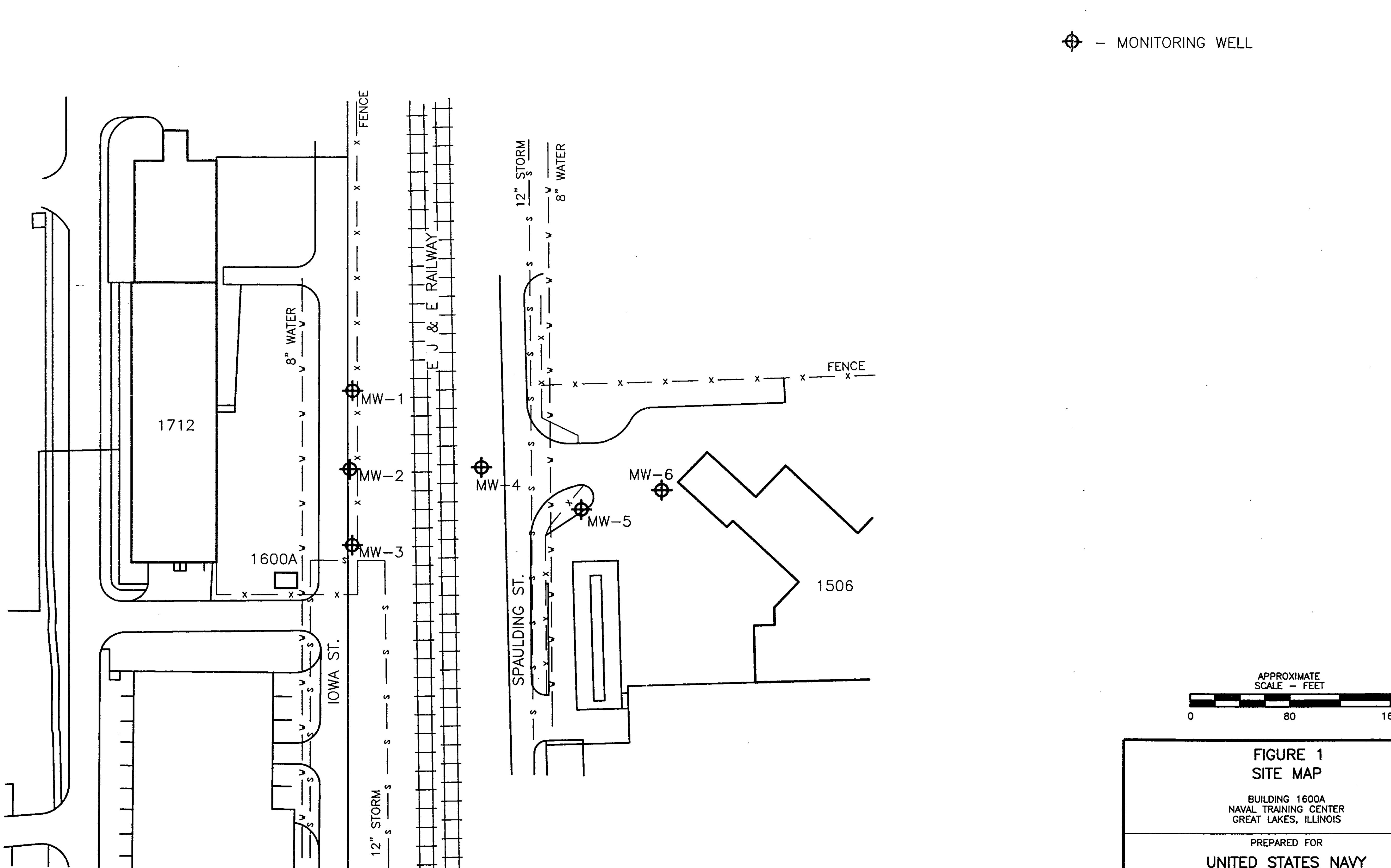


FIGURE 1
SITE MAP

BUILDING 1600A
NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS

PREPARED FOR

UNITED STATES NAVY
GREAT LAKES NAVAL TRAINING CENTER

DRAWN MRC\1-3-00	CHECKED
REVISED	APPROVED
JOB NO.: 37755.01	TOLTEST, INC.
DRAWING NUMBER 377551-2	

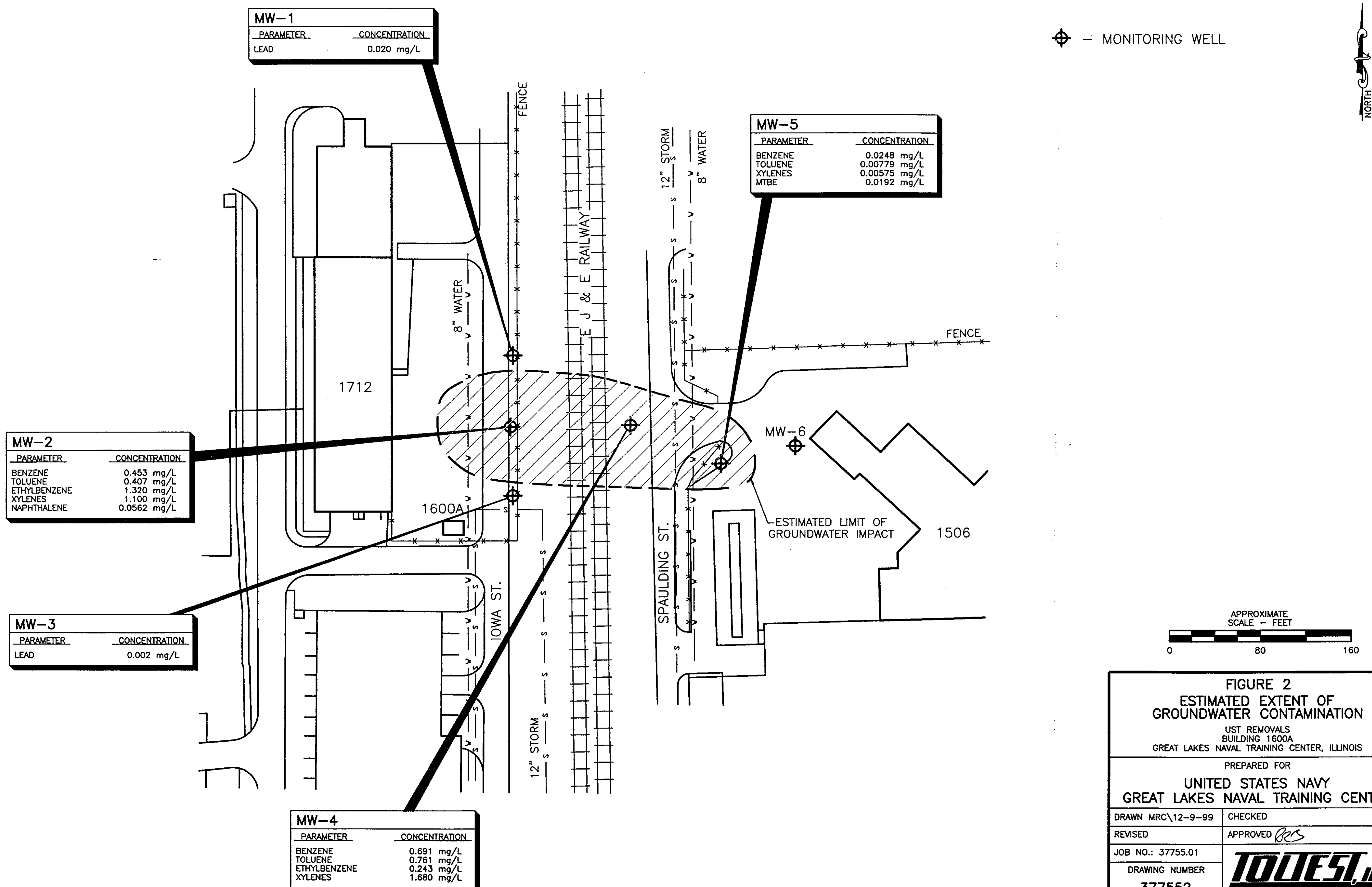
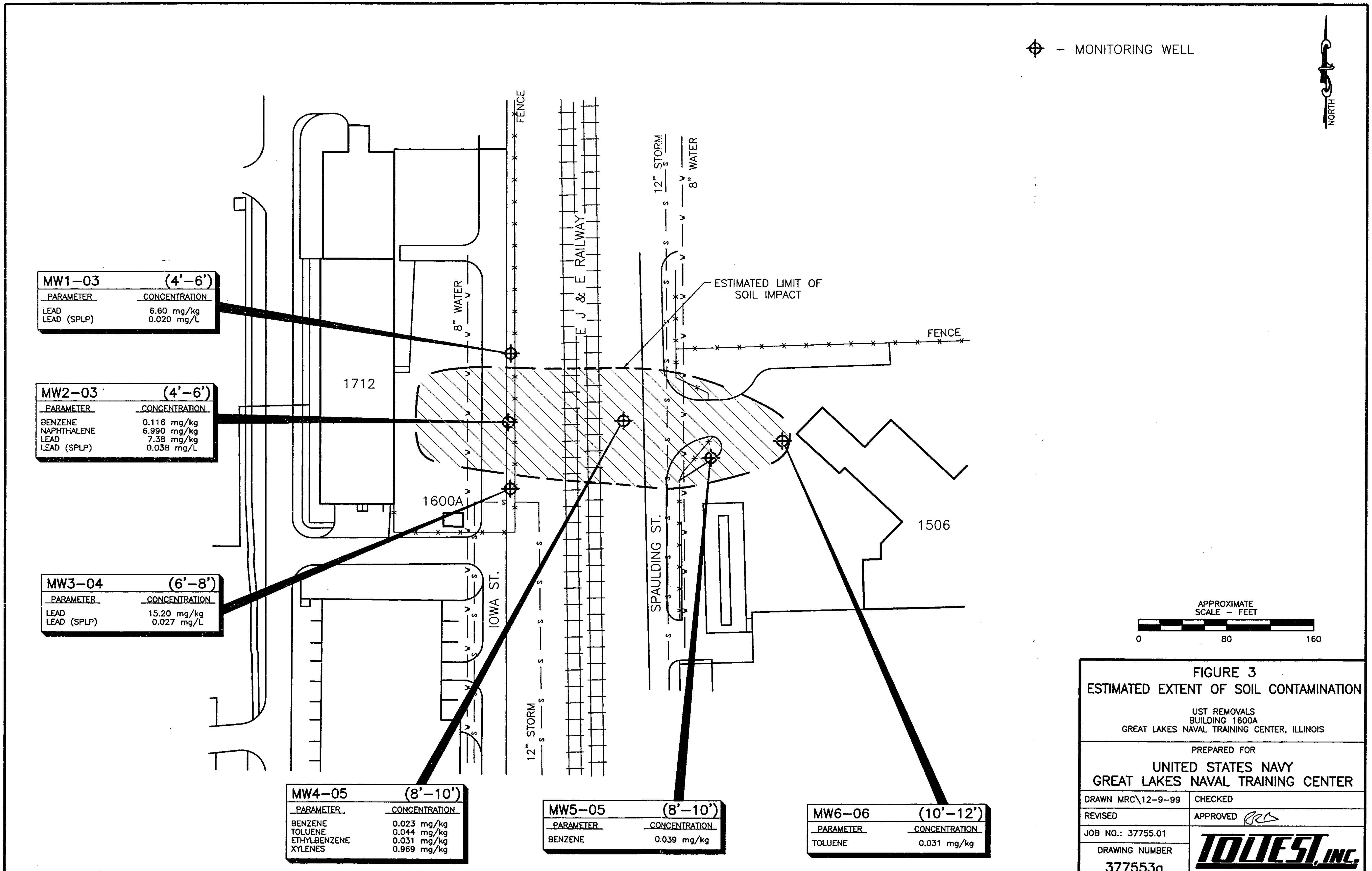


FIGURE 2
ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION
UST REMOVALS
BUILDING 1600A
GREAT LAKES NAVAL TRAINING CENTER, ILLINOIS

PREPARED FOR
UNITED STATES NAVY
GREAT LAKES NAVAL TRAINING CENTER

DRAWN MRC\12-9-99	CHECKED
REVISED	APPROVED
JOB NO.: 37755.01	TOLTEST, INC.
DRAWING NUMBER 377552	



MONITORING WELL
NORTH
FENCE
8" WATER
E J & E RAILWAY
12" STORM
8" WATER
ESTIMATED LIMIT OF SOIL IMPACT
FENCE
1712
1600A
1506
IOWA ST.
SPAULDING ST.
12" STORM
MW1-03 (4'-6')
PARAMETER CONCENTRATION
LEAD 6.60 mg/kg
LEAD (SPLP) 0.020 mg/L
MW2-03 (4'-6')
PARAMETER CONCENTRATION
BENZENE 0.116 mg/kg
NAPHTHALENE 6.990 mg/kg
LEAD 7.38 mg/kg
LEAD (SPLP) 0.038 mg/L
MW3-04 (6'-8')
PARAMETER CONCENTRATION
LEAD 15.20 mg/kg
LEAD (SPLP) 0.027 mg/L
MW4-05 (8'-10')
PARAMETER CONCENTRATION
BENZENE 0.023 mg/kg
TOLUENE 0.044 mg/kg
ETHYLBENZENE 0.031 mg/kg
XYLENES 0.969 mg/kg
MW5-05 (8'-10')
PARAMETER CONCENTRATION
BENZENE 0.039 mg/kg
MW6-06 (10'-12')
PARAMETER CONCENTRATION
TOLUENE 0.031 mg/kg
APPROXIMATE SCALE - FEET
0 80 160
FIGURE 3
ESTIMATED EXTENT OF SOIL CONTAMINATION
UST REMOVALS
BUILDING 1600A
GREAT LAKES NAVAL TRAINING CENTER, ILLINOIS
PREPARED FOR
UNITED STATES NAVY
GREAT LAKES NAVAL TRAINING CENTER
DRAWN MRC\12-9-99
CHECKED
REVISED
APPROVED
JOB NO.: 37755.01
DRAWING NUMBER
377553a
TOLTEST, INC.

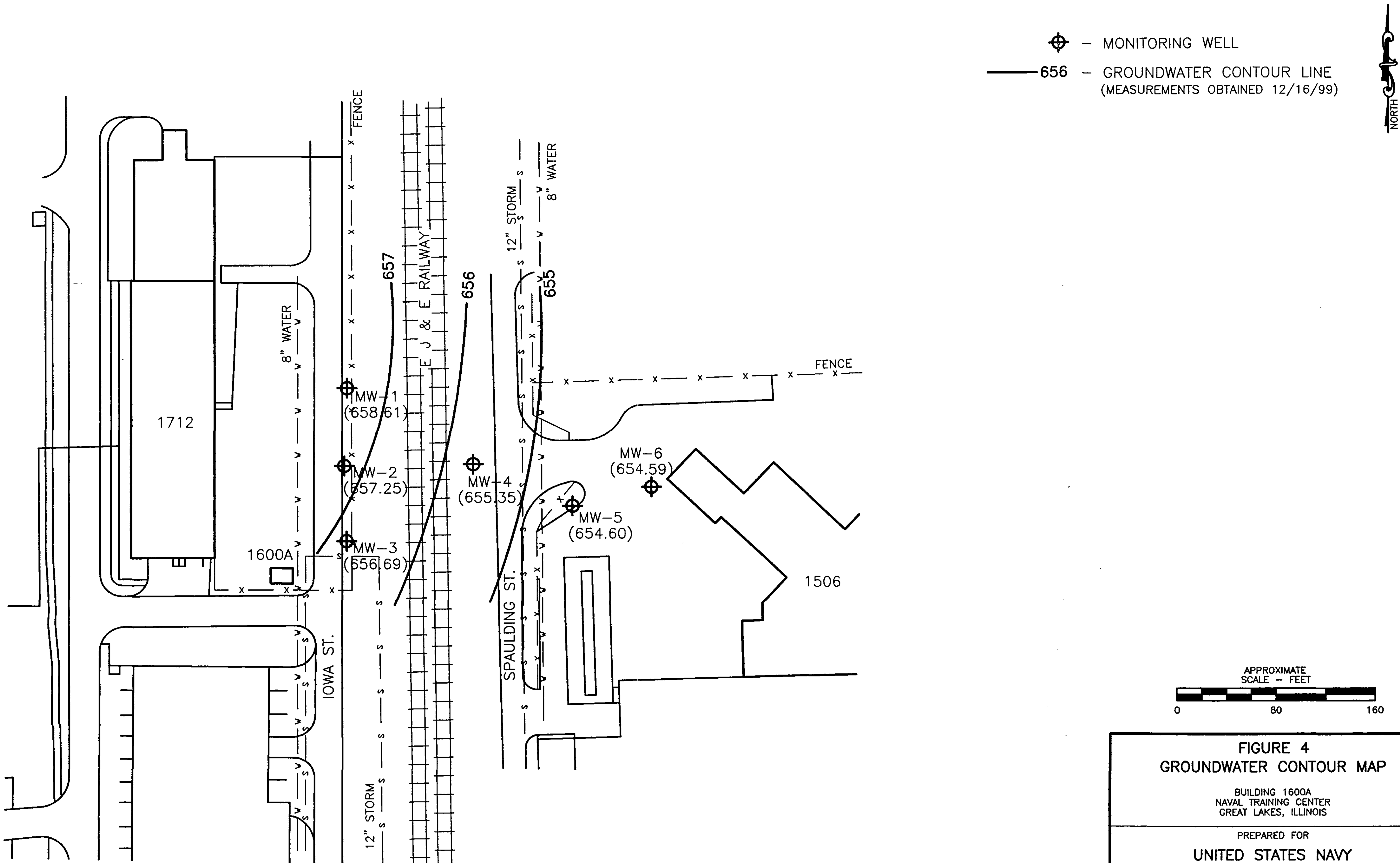


FIGURE 4
GROUNDWATER CONTOUR MAP

BUILDING 1600A
NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS

PREPARED FOR

UNITED STATES NAVY
GREAT LAKES NAVAL TRAINING CENTER

DRAWN MRC\1-6-00	CHECKED
REVISED	APPROVED
JOB NO.: 37755.01	TOLTEST, INC.
DRAWING NUMBER 377554	

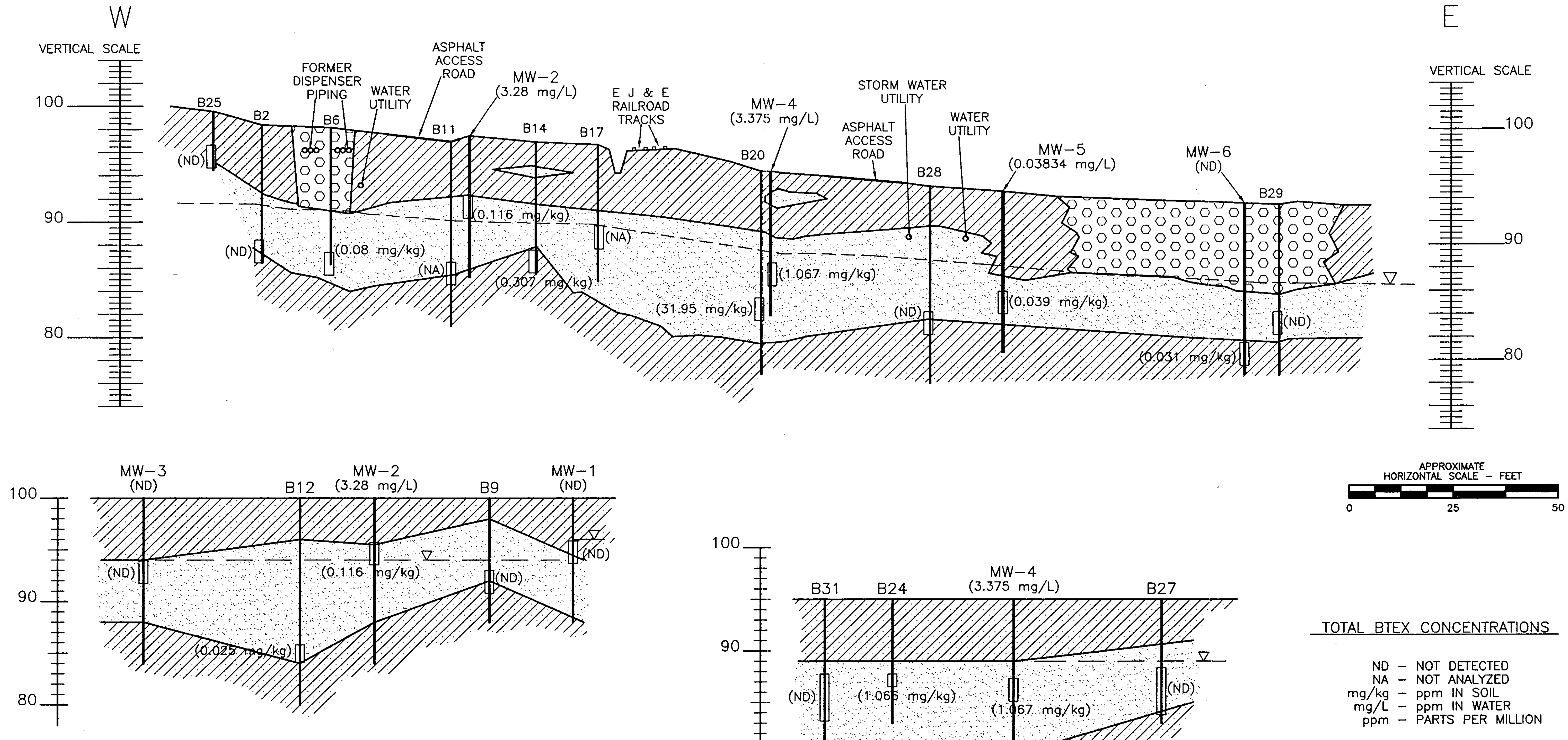


FIGURE 5
SITE CROSS-SECTION

BUILDING 1600A
NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS

PREPARED FOR
UNITED STATES NAVY
GREAT LAKES NAVAL TRAINING CENTER

DRAWN MRC\12-9-99	CHECKED
REVISED	APPROVED RRB
JOB NO.: 37755.01	
DRAWING NUMBER 377555	TOLTEST, INC.

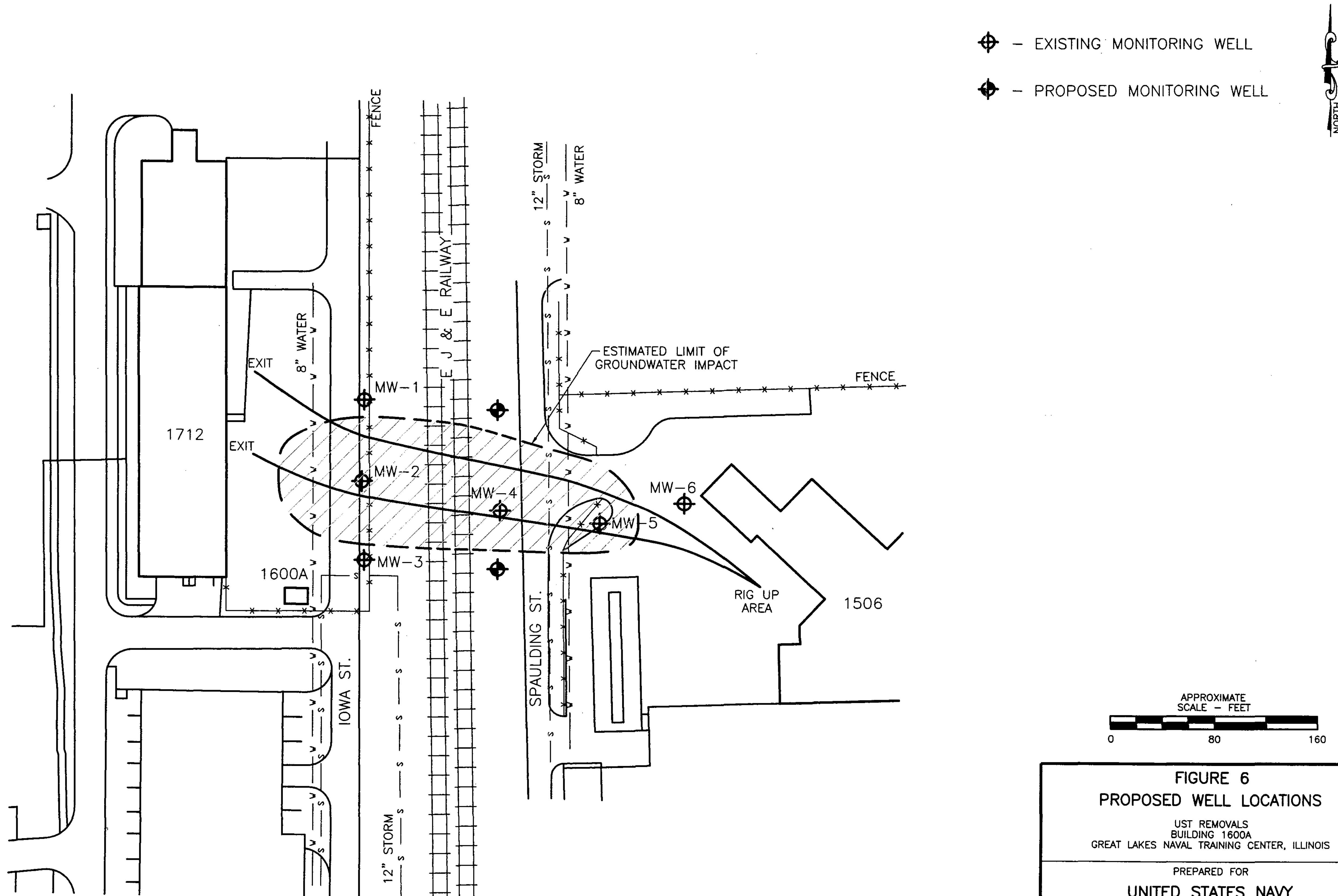


FIGURE 6

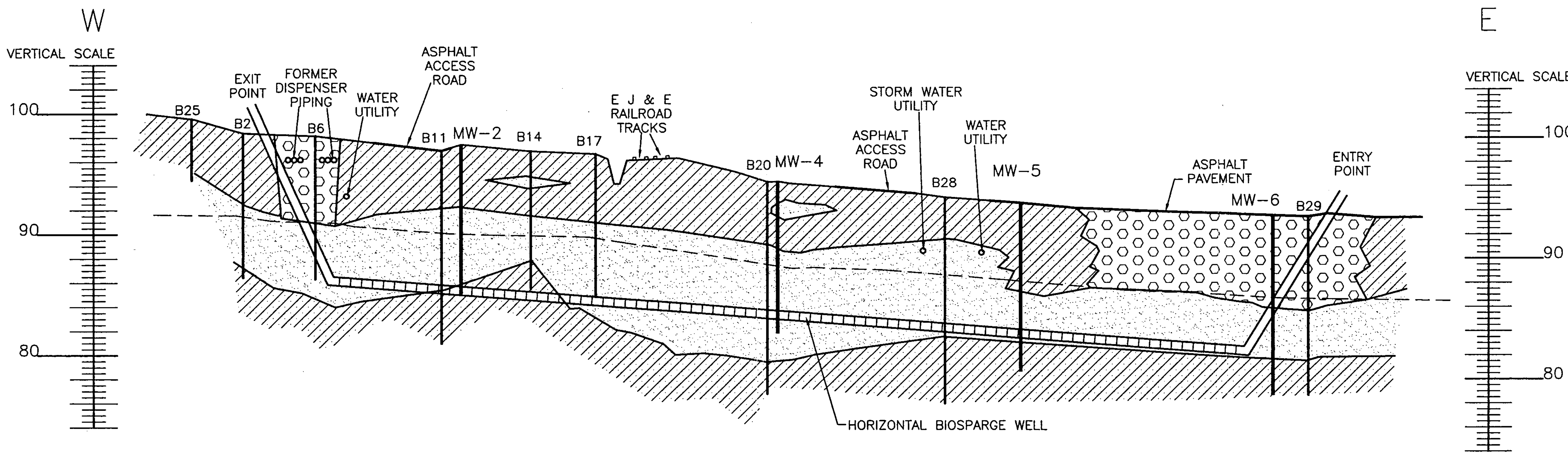
PROPOSED WELL LOCATIONS

UST REMOVALS
BUILDING 1600A
GREAT LAKES NAVAL TRAINING CENTER, ILLINOIS

PREPARED FOR

UNITED STATES NAVY
GREAT LAKES NAVAL TRAINING CENTER

DRAWN MRC\5–25–00	CHECKED
REVISED	APPROVED
JOB NO.: 37755.01	TOLTEST, INC.
DRAWING NUMBER 377556	



- CLAYEY SILTS & SILTY CLAYS
- SAND & SILTY SANDS
- PLACED FILL OR SLAG

FIGURE 7
PROPOSED HORIZONTAL WELL

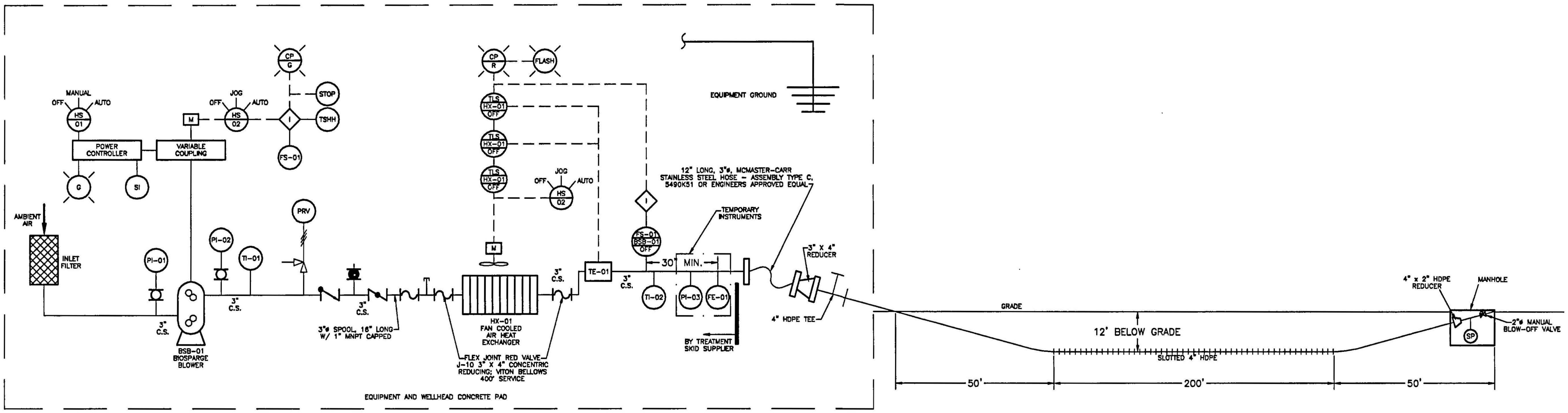
BUILDING 1600A
NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS

PREPARED FOR
UNITED STATES NAVY
GREAT LAKES NAVAL TRAINING CENTER

DRAWN MRC\12-9-99	CHECKED
REVISED	APPROVED
JOB NO.: 37755.01	
DRAWING NUMBER 377557	TOLTEST, INC.

APPENDIX I

CONCEPTUAL PROCESS DESIGN



TYPICAL HORIZONTAL WELL

NOT TO SCALE

PROCESS LEGEND

- CP/R – RED LIGHT AT CONTROL PANEL
- HS/01 – HAND SWITCH
- PI – PRESSURE INDICATOR
- TI – TEMPERATURE INDICATOR
- TSHH – TEMPERATURE SWITCH, HIGH HIGH
- TSH – TEMPERATURE SWITCH, HIGH
- TSL – TEMPERATURE SWITCH, LOW
- SI – SPEED INDICATOR
- STOP – EMERGENCY STOP
- TE – TEMPERATURE ELEMENT
- FE – FLOW ELEMENT
- FS – FLOW SWITCH
- A – ALARM
- G – PANEL LIGHT LOCAL
- FCV – FLOW CONTROL VALVE
- I – INTERLOCK
- SC – SPEED CONTROL
- SP – SAMPLE PORT
- – CAPPED TEE
- – FLEX CONNECTOR
- – BALL VALVE, NORMALLY OPEN
- – BALL VALVE, NORMALLY CLOSED
- – GATE VALVE, AUTOMATIC
- – GATE VALVE, MANUAL
- – CHECK VALVE
- – BUTTERFLY VALVE
- – REDUCER
- – ROTARY LOBE BLOWER
- PRV – PRESSURE REDUCING VALVE

SUBMITTED BY: TOLTEST, INC.	DATE: 09 FEB. 00
SCALE: NONE	
DESIGNED BY: R. BECKWITH	CHECKED BY:
DATE:	
DRAWN BY: M. CIESLEWSKI	APPROVED BY:
DATE: 2/6/00	
DELIVERY ORDER NO:	DWG NO: 37755-CD
SHEET NO: 1 of 1	

TITLE: BUILDING 1600A
PROCESS CONCEPTUAL DESIGN
NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS

Department of the Navy
Naval Facilities
Engineering Command

NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

TOLTEST, INC.

APPENDIX J

BIOREMEDIAL TECHNOLOGIES REPORT

BioRemedial Technologies, ncorporated

2700 Kirila Drive
Hermitage, Pennsylvania 16148

phone: (724) 981-1994
fax: (724) 981-9030
email: brt@pathway.net

Bioremediation Feasibility Study
BTEX and MTBE Contamination in Soil

Toltest, Inc.
Ref. Proposal No. Q1097GM
November 15, 1999

Background

Samples of soil, collected from the Great Lakes Naval Training Center, were shipped to BioRemedial Technologies, Incorporated (BRT) via overnight courier service. The specimens arrived on 10-26-99. Aliquots of the samples were used in tests designed to determine the feasibility of utilizing a biologically based technology for remediation of gasoline contamination. The major contaminants of interest are methyl *tert*-butyl ether (MTBE) and the volatile aromatics, benzene, toluene, ethylbenzene and xylene (BTEX).

Results

The heterotrophic plate count is a test that determines how many microorganisms are in a sample. The culture medium used in the test supplies a large variety of carbon sources to meet nutritional and energy requirements. As shown in Table I, heterotrophic plate counts ranged from 2.8×10^5 to 4.9×10^6 colony forming units (CFU) per gram (g) of soil.

Table I

Heterotrophic Plate Counts

	Sample	Matrix	Microbial Count (CFU/ml)
mw-1	85282	Soil	3.3×10^5
mw-3	85283	Soil	4.6×10^6
mw-2	85284	Soil	4.9×10^6
mw-4	85285	Soil	2.0×10^6
mw-5	85286	Soil	2.8×10^5

The results of the heterotrophic plate counts indicate that conditions at this site are suitable for bioremediation. In general, a count of 1 x 10^4 CFU/ml in any sample is evidence of the following:

- Microorganisms have adapted to the changes in site conditions that were brought about by the spill.
- The environment is not toxic to the adapted microbial population.
- Bioremediation is a potential option for addressing contamination at this site.

Subsequent to a hydrocarbon release, some of the intrinsic microorganisms in the soil respond by producing enzymes that enable them to degrade the environmental contaminants for use as food and energy sources. To test for these enzymes, samples of groundwater and soil were placed on media containing BTEX compounds or MTBE as the sole carbon sources. Only those organisms actively producing the enzymes involved in MTBE or BTEX degradation were able to grow on these selective media. The results of this study are shown in Table II. In general, bioremediation of the contaminant is feasible if one to ten per cent of the microbial population displays the appropriate enzyme activity.

Table II

Numbers of Contaminant-Degrading Microorganisms

Sample	**Number (CFU/ml) and Percentage of Contaminant-Degraders**			
	BTEX	**% Total**	**MTBE**	**% Total**
85282	1.4 x 10^6	100	2.4 x 10^6	100
85283	7.9 x 10^5	17	2.8 x 10^6	61
85284	4.9 x 10^8	100	1.4 x 10^7	100
85285	3.5 x 10^6	100	1.5 x 10^7	100
85286	2.8 x 10^4	10	5.5 x 10^4	20

Analysis of these results indicates the following:

- The percentage of organisms exhibiting the ability to degrade MTBE or BTEX compounds exceeds the minimum requirement for bioremediation.
- Some of the organisms prefer the contaminant as a food source to heterotrophic culture medium, as evidenced by microbial counts that were higher on MTBE or BTEX plates than standard plates.
- Microbial degradation of the contaminants of interest is a viable option for remediation at this site.

The samples were also analyzed for pH as shown in Table III. The optimal pH range for microbial growth is 6.5 to 8.0. The results of testing indicate that pH at the site is variable. Sample 85286 exhibited a pH that is outside the optimal range for bioremediation.

Table III

pH Testing

Site	pH
85282	7.2
85283	7.0
85284	7.2
85285	7.4
85286	8.5

Conclusions

The microbial populations at this site are capable of degrading the contaminants of issue and are present in sufficient numbers to accomplish bioremediation. Sample 85286 exhibited an elevated pH and the lowest microbial counts. This finding reflects the correlation that exists between pH and microbial growth. While an elevation of 0.5 pH units does not preclude bioremediation as a viable remedial option at this site, it dictates that the system design address heterogeneous conditions.

Sara J. Giordano — Date Nov 16, 1999

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Project No.: 37755.01	Client: TOLTEST INC		
P.O. No.: 26864	Project/Location: BLDG. 1600 A		
Project Mgr.: ROBERT BECKWITH		Sampler's Name	
Phone No. 419 241 7175		Sampler's Signature	

Parameters: Total No. of Containers; FEASIBILITY STUDY; Preserved Yes/No; LAB USE ONLY

Item No.	Sample I.D.	Date Sampled	Time Sampled	Type	Matrix	Sample Location	Total No. of Containers	FEASIBILITY STUDY								Preserved Yes/No	LAB USE ONLY	Lab #
1	85282	10/19/99	AM	G	SOIL		1	X								N		
2	85283	↓	↓	↓	↓		1	X								↓		
3	85284	↓	↓	↓	↓		1	X								↓		
4	85285	↓	↓	↓	↓		1	X								↓		
5	85286	↓	↓	↓	↓		1	X								↓		
6																		
7																		
8																		
9																		
10																		

Item No.	Relinquished By:	Date	Time	Received By:	Date	Time
1-5	[signature]	10/26/99	1500	FED EX 806972141522	10/26/99	1600
				[signature]	10/27/99	10:00

LAB USE ONLY

Were samples delivered ☐ in person ☐ by courier
Were samples preserved ☐ in field ☐ in lab ☐ N/A
Temp of samples ______°C
Did samples arrive intact and sealed? ☐ yes ☐ no ☐ N/A
Were proper containers used? ☐ yes ☐ no
Was container labeled properly for contents? ☐ yes ☐ no
Were samples packaged properly for type of material? ☐ yes ☐ no
Was shipping label completed properly per regulations? (49 CFR 170, etc.) ☐ yes ☐ no

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