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WORK PLAN FOR TREATABILITY STUDY AT OPERABLE UNIT 3 (OU 3) STUDY AREA 9
NTC ORLANDO FL
3/1/2000
TETRA TECH

Rev. 1
03/12/02

WORK PLAN
for
TREATABILITY STUDY AT OPERABLE UNIT 3 STUDY AREA 9

Naval Training Center
Orlando, Florida

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0180

MARCH 2002

Rev. 1
03/12/02

WORK PLAN
FOR
TREATABILITY STUDY AT OPERABLE UNIT 3
STUDY AREA 9

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:

Department of the Navy, Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:

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CONTRACT NO. N62467-94-D-0888
CONTRACT TASK ORDER 0180

MARCH 2002

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PROFESSIONAL ENGINEER CERTIFICATION

I hereby certify that this document, *Work Plan for Treatability Study at Operable Unit 3, Study Area 9, Naval Training Center, Orlando, Florida,* was prepared under my direct supervision in accordance with acceptable standards of engineering practice.

Steven B. McCoy 3/12/02

Steven B. McCoy, P.E. / Date
License No. PE-0041511
Tetra Tech NUS, Inc.
Certificate of Authorization No. 7988

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ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
bgs	below ground surface
DO	dissolved oxygen
DET	Environmental Detachment, Charleston
DPT	direct push technology
FDEP	Florida Department of Environmental Protection
FL SOPs	Florida Standard Operating Procedures
FOL	Field Operations Leader
GCTL	Groundwater Cleanup Target Goal
HASP	Health and Safety Plan
HLA	Harding Lawson Associates
IDW	investigation-derived waste
IRA	Interim Remedial Action
MCL	maximum contaminant level
MCPA	(4-chloro-2-methylphenoxy) acetic acid
MCPP	potassium (2-methyl-4-chlorophenoxy) propionate
MS	matrix spike
MSD	matrix spike duplicate
MSDS	Material Safety Data Sheet
μg/L	microgram(s) per liter
mg/L	milligram(s) per liter
mL/min	milliliters per minute
mV	millivolt(s)
NTC	Naval Training Center
NTU	Nephelometric Turbidity Unit
OPS	operating properly and successfully
OPT	Orlando Partnering Team
ORP	oxidation reduction potential
OU	Operable Unit
POP	Project Operations Plan
PPE	personal protective equipment
PVC	polyvinyl chloride
QC	quality control
SA	Study Area
SOP	Standard Operating Procedure
SOUTHDIV	Southern Division
SU	Standard Unit (pH)
TtNUS	Tetra Tech NUS, Inc.
USEPA	U.S. Environmental Protection Agency

1.0 INTRODUCTION

A site screening investigation and two and a half years of quarterly sampling have been completed at Operable Unit (OU) 3 of the former Naval Training Center (NTC), Orlando, Florida. During the investigation, arsenic was detected in groundwater at concentrations exceeding Federal and State regulatory limits. The Orlando Partnering Team (OPT) has decided to perform a Treatability Study at Study Area (SA) 9 to test activated alumina for in situ removal of arsenic and to reestablish compliance with the Federal and State groundwater criteria. This Work Plan presents the objectives for the Treatability Study and the technical approach by which the study will be performed.

1.1 SITE DESCRIPTION

Operable Unit 3. Two sites, SA 8 and SA 9, comprise OU 3. SA 8 and SA 9 lie about 600 feet apart on the southeast shore of Lake Baldwin, as shown on Figure 1-1. SA 8, known as the Greenskeeper's Storage Area, is the northernmost of the two SAs. SA 9 is known as the Former Pesticide Handling and Storage Area. The OPT agreed to treat the two sites as a single OU because the following criteria were met:

- The sites are close together.
- The sites have similar contaminant exposure histories.
- Remedial action, if required, would be similar for the two sites.

As part of the base closure for the NTC, environmental investigations and studies were conducted to evaluate the soil and groundwater conditions at OU 3 from past chemical handling, storage, and disposal practices. The investigation of OU 3 found that several pesticide-related chemicals, particularly arsenic, were present in the shallow soil and groundwater. Direct spillage or disposal of pesticides and herbicides on the ground surface at both SAs and via a sump at SA 9 were determined to be the most likely mechanisms for introducing the contaminants to the environment (HLA, 1999). The groundwater contamination is attributed to the leaching of contaminants from the soil. As a result, the contaminated soil was excavated and removed during two Interim Remedial Actions (IRAs) in 1997 and 1999.

Groundwater Contamination. Despite the IRAs at the two SAs, the groundwater remains contaminated with arsenic and other chemicals. Arsenic is the most prevalent contaminant with 13 of 32 wells at OU 3 containing arsenic above the current Federal Maximum Contaminant Level (MCL) and the current Florida Groundwater Cleanup Target Level (GCTL) of 50 micrograms per liter (μg/L). The U.S. Environmental Protection Agency (USEPA) has approved a change to the regulation to reduce the public health risks

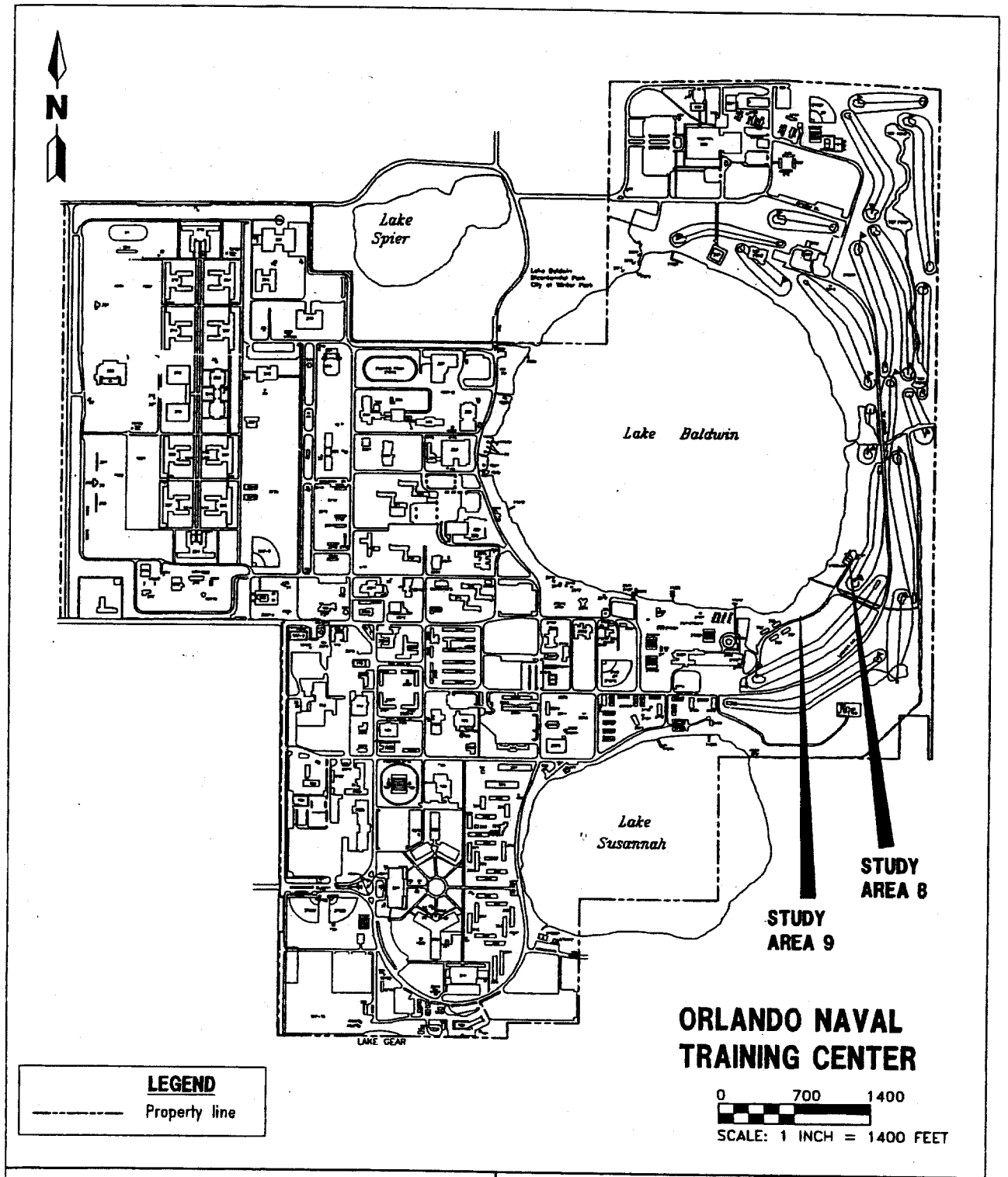

FIGURE 1-1

SITE LOCATION MAP

OPERABLE UNIT 3

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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from arsenic in drinking water. The new regulation will revise the current drinking water standard for arsenic from 50 to 10 μg/L effective in January 2006 (USEPA, 2001). The State of Florida is expected to change the GCTL to 10 μg/L as well, likely before the USEPA's January 2006 time frame. In the samples collected in July 2001, the arsenic exceedances at OU 3 of the new 10 μg/L standard ranged from 25.3 to 2230 μg/L (TtNUS, 2001c).

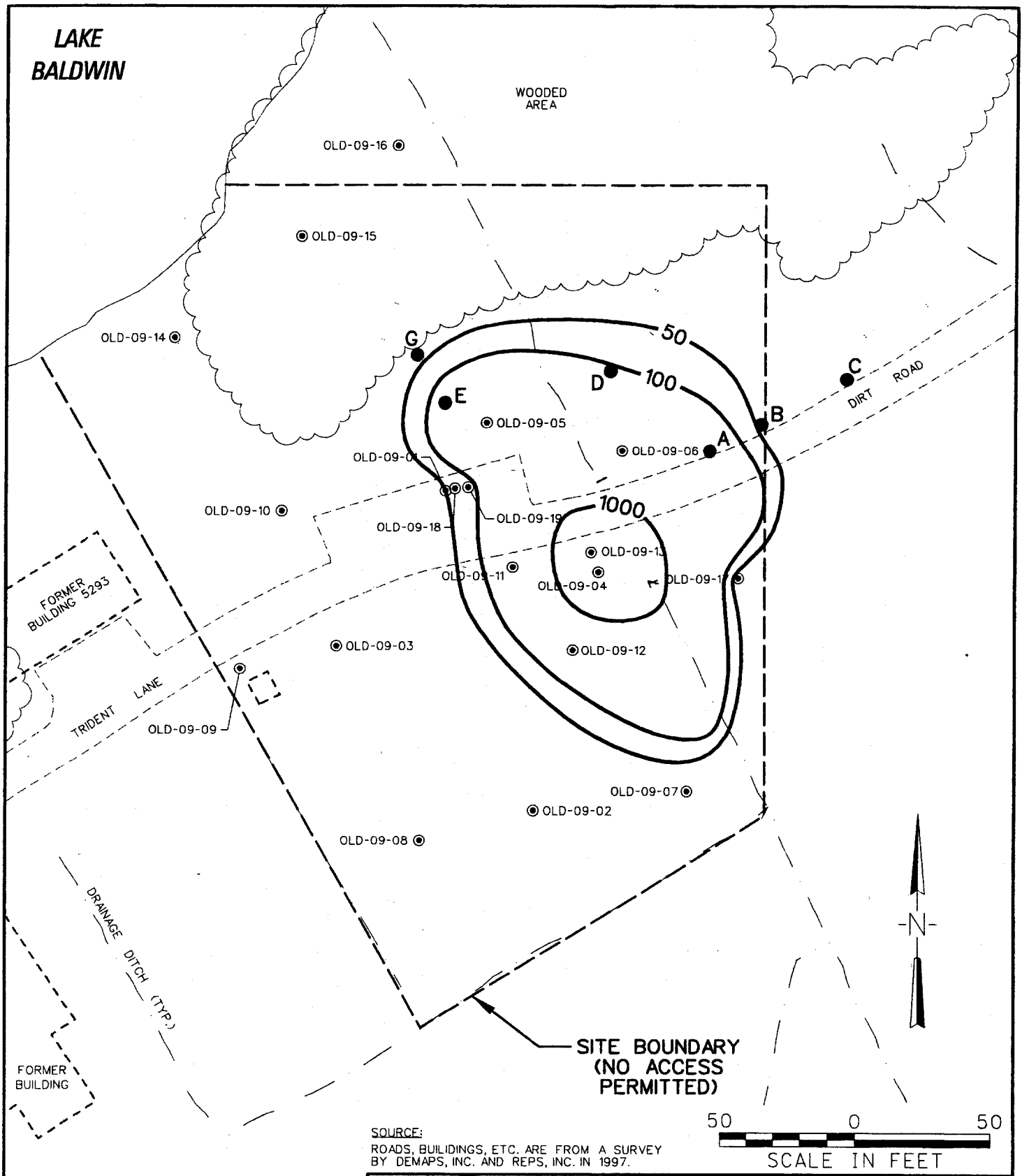
The groundwater from both SAs flows generally in a northwesterly direction into Lake Baldwin, although localized flow patterns exist at SA 9. Measurements of the depth to the groundwater during ten monitoring events from 1999 to 2001 show that the water table ranged between 0.45 and 7.41 feet below ground surface (bgs) depending upon the well location and the time of year (TtNUS, 2001c).

1.2 SITE INVESTIGATION AND REMOVAL ACTION SUMMARY

Surface Soil. Investigations conducted between August 1994 and March 1998 detected arsenic and organic compounds in surface soils at concentrations that exceeded regulatory criteria. The other chemicals included benzo(a)pyrene and 4,4'-DDD.

Investigators recommended removing contaminated surface soil to prevent human exposure and minimize the likelihood of additional contaminants being washed downward into the surficial aquifer. The Environmental Detachment, Charleston (DET) completed an IRA for the removal of 3,000 tons of contaminated soil from SA 9 in September 1997 and backfilled the excavation with clean soil. An additional IRA removed 32 tons of contaminated soil from SA 9 in May 1999. The OPT recommended changing the site classification from residential to recreational, and no further action is anticipated for soils.

Groundwater. Investigations detected inorganics and several pesticides and herbicides in groundwater in the surficial aquifer, with arsenic, MCPA [(4-chloro-2-methylphenoxy) acetic acid], and MCPP [potassium (2-methyl-4-chlorophenoxy) propionate] being the principal contaminants of concern at concentrations exceeding regulatory criteria in the surficial aquifer. Groundwater from selected monitoring wells at OU 3 is sampled and analyzed on a quarterly basis. The arsenic isoconcentration map for SA 9 based on the July 2001 sampling event [and modified by the October 2001 direct push technology (DPT) event] is shown on Figure 1-2.



SOURCE:
ROADS, BUILIDINGS, ETC. ARE FROM A SURVEY BY DEMAPS, INC. AND REPS, INC. IN 1997.

LEGEND

MONITORING WELL ⊙

DPT POINT ● A

ARSENIC CONTOUR[1] ——

1-CONCENTRATION IN MICROGRAMS PER LITER (ug/L)

NOTE:
DPT LOCATIONS ARE APPROXIMATE.

FIGURE 1-2
ARSENIC IN GROUNDWATER
DATA FROM JULY AND OCTOBER 2001
OPERABLE UNIT 3 - STUDY AREA 9

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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1.3 BENCH-SCALE STUDY

Arsenic is a primary contaminant at both SA 8 and SA 9. Arsenic in groundwater is typically present as either the oxidized arsenate or the slightly reduced arsenite form. Under normal pH conditions observed in groundwater (i.e., slightly acidic to slightly basic), arsenate will be present as an anion $(AsO_4)^{3-}$, and arsenite will be present as an uncharged complex (As_2O_3). In either case, the in situ removal of arsenic from groundwater requires a medium capable of anion exchange and/or neutral species sorption at ambient conditions.

From May to November 2000, a bench-scale treatability study was performed on arsenic-contaminated groundwater from OU 3. The purpose of the study was to evaluate the effectiveness of three sorbent materials in removing arsenic from groundwater. Based on the results of that study, one of the tested sorbents, activated alumina, was clearly superior in the amount of arsenic it removed from the groundwater and in achieving effluent concentrations below the target concentration of 5 μg/L. The adsorptive capacity of the activated alumina determined during the bench-scale treatability study was 2,520 μg arsenic per gram of activated alumina. The activated alumina was stable with no increase in aluminum concentrations observed in the effluent of the test column. The alumina had little effect on alkalinity, chloride, or nitrate, but decreased sulfate and slightly increased pH. Separate testing with site soils indicated that the retardation factor for the movement of the arsenic in the groundwater ranged from 14 to 21 in the saturated soil from OU 3. Further details of the bench-scale study can be found in *Bench-Scale Treatability Studies – Operable Unit 3* (TtNUS, 2001a). The material safety data sheet (MSDS) for activated alumina is provided in Appendix A.

1.4 OBJECTIVES

During this treatability study, a permeable adsorptive barrier will be installed at SA 9 to allow the arsenic-contaminated groundwater to flow through a treatment zone of activated alumina. This permeable adsorptive barrier configuration is different than the original plan to install a funnel and gate, which uses impermeable funnel walls to direct the groundwater flow through a zone of activated alumina, the “gate.” The change to a permeable adsorptive barrier occurred based largely on the findings from soil borings installed in August 2001 which indicated that there is no confining layer in which to key the bottom of the funnel walls. Subsequent groundwater flow modeling indicated that a significant component of flow would go underneath the funnel walls unless a pumping well was used to influence the flow. A permeable adsorptive barrier was selected because there is little change to the subsurface hydraulics and groundwater flow and pumping wells are not required.

The objectives of this treatability study are as follows.

- To confirm the capability of activated alumina to remove arsenic from groundwater in situ to meet future MCLs (10 μg/L).
- To prevent elevated concentrations of arsenic from entering Lake Baldwin.
- To demonstrate arsenic concentration reduction in groundwater at the site to meet requirements for an operating properly and successfully (OPS) determination.
- To confirm activated alumina exchange capacity for prediction of replacement frequency.

Additional preferences are that the system be passive in operation (e.g., no pumps) and that the system design be flexible and can be modified if required at a later date to enhance performance (volume of groundwater treated or rate of cleanup).

Data collected to evaluate these objectives include field measurements and fixed-base laboratory analyses collected over the treatment period from new and existing wells within and near the source area.

Four quarters of groundwater samples will be collected from existing monitoring wells as well as 10 new microwells to be installed. Quarterly performance monitoring letter reports will be prepared, and a final treatability study report will be submitted after the first year of sampling.

2.0 PROJECT SCHEDULE

MILESTONE SCHEDULE

TASK	START DATE	FINISH DATE	DURATION (days)
Notice to Proceed		09 May 01	
Submit Draft Work Plan		20 Jun 01	
Submit Final Work Plan		12 Mar 02	
Submit HASP Addendum		12 Mar 02	
Utility Clearance / Site Clearing	27 Mar 02	28 Mar 02	1
Permeable Adsorptive Barrier Installation	02 Apr 02	05 Apr 02	4
Microwell Installation	08 Apr 02	12 Apr 02	5
Surveying	15 Apr 02	16 Apr 02	2
Baseline Sampling	15 Apr 02	19 Apr 02	5
1st Quarter Sampling	17 Jul 02	21 Jul 02	5
Submit Baseline/1st Quarter Report		30 Oct 02	
2nd Quarter Sampling	16 Oct 02	20 Oct 02	5
Submit 2nd Quarter Report		29 Jan 03	
3rd Quarter Sampling	16 Jan 03	20 Jan 03	5
Submit 3rd Quarter Report		28 Apr 03	
4th Quarter Sampling	17 Apr 03	21 Apr 03	5
Submit Treatablility Study Report		30 Jul 03	
End Project		06 Aug 03	

3.0 PERMEABLE ADSORPTIVE BARRIER – DESIGN CONSIDERATIONS

3.1 SELECTION OF TREATABILITY STUDY LOCATION

OU 3 consists of SAs 8 and 9, both of which contain arsenic plumes in the groundwater. This treatability study will be performed at SA 9, which was originally selected over SA 8 mainly due to the location of the plumes in relation to Lake Baldwin.

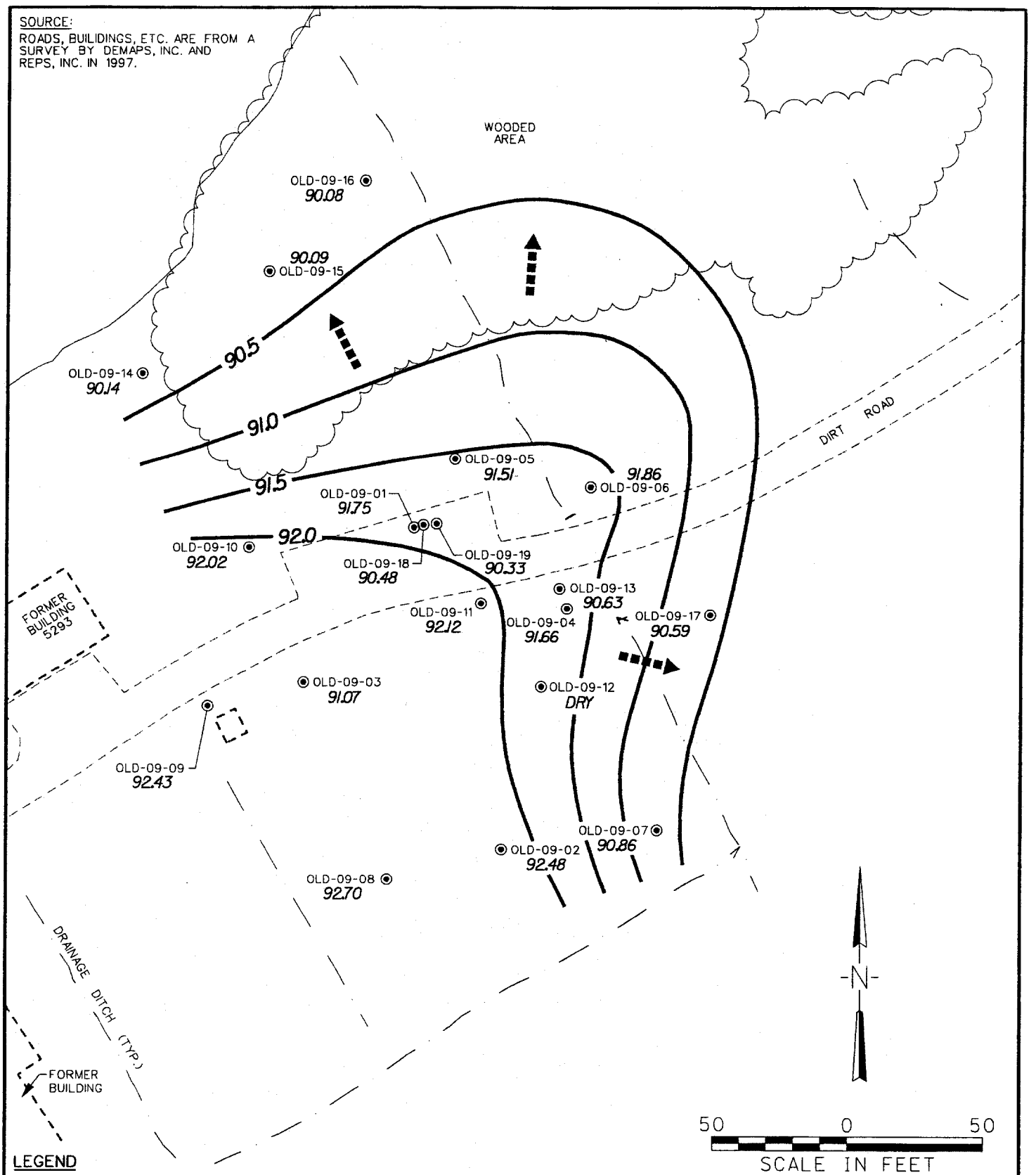
3.2 CONFIGURATION OF BARRIER

As mentioned in Section 1.0, this treatability study will use a permeable adsorptive barrier instead of the originally proposed funnel and gate configuration. This change comes primarily from the lack of a confining layer in the site stratigraphy (as discovered based on August 2001 soil borings) and groundwater modeling results that indicated there would be underflow of impermeable funnel walls not keyed into a confining layer. Any significant contaminant underflow of the walls would not meet the treatability study objectives and would make the performance of the activated alumina difficult to assess.

Additional groundwater flow modeling, using a 3-dimensional model in BOSS GMS software, indicated that a pumping well downgradient of the treatment zone of the funnel and gate would provide enough hydraulic control to prevent the underflow of the impermeable funnel walls. However, that is not consistent with the preference to use a passive system. By using a permeable adsorptive barrier instead of the funnel and gate, there is little impact to the groundwater flow, and no significant vertical flow components are introduced in the subsurface since there is no impermeable barrier to back up flow. Therefore, the passive permeable adsorptive barrier was chosen for the treatability study.

3.3 SELECTION OF BARRIER LOCATION

The choice of location for the permeable adsorptive barrier is based on the groundwater flow patterns and the extent of the arsenic groundwater plume. Based on the quarterly groundwater elevation measurements at SA 9, there are westerly, northerly, and easterly components of flow caused by a groundwater high in the area of wells OLD-09-11 and OLD 09-13. Recent survey data on other parts of NTC Orlando have indicated problems with the accuracy of past surveys. To ensure that the unusual flow pattern at SA 9 is correct and not a result of inaccurate survey data, all wells at SA 9 were resurveyed in December 2001. While all well top elevations were indeed inaccurate (ranging from 1.07 to 1.36 feet in error), there was little change in the replotted flow patterns, indicating that the westerly, northerly, and easterly components of flow are correct. The groundwater flow patterns at SA 9 are presented on Figure 3-1.



LEGEND

MONITORING WELL

GROUNDWATER ELEVATION[1] 90.59

GROUNDWATER CONTOUR[1] (DASHED WHERE APPROX.)

GROUNDWATER FLOW DIRECTION (APPROX.)

1 - ELEVATION IN FEET ABOVE MEAN SEA LEVEL

NOTE:
WELLS OLD-09-13, OLD-09-18, AND OLD-09-19 ARE SCREENED IN LOWER PART OF AQUIFER AND NOT INCLUDED IN CONTOURING. WELL OLD-09-03 WAS ALSO EXCLUDED FROM CONTOURING.

FIGURE 3-1
GROUNDWATER ELEVATION MAP
JULY 13, 2001
OPERABLE UNIT 3 - STUDY AREA 9

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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The permeable adsorptive barrier at SA 9 will be located at the leading edge of the plume to ensure treatment of contaminated groundwater. However, due to the multi-direction flow of groundwater, the leading edge likely extends around the northern and eastern sides of the plume. Because this is such a great distance (approximately 250 to 300 feet), the permeable adsorptive barrier will be installed along the northern edge of the plume to address the treatability study objective of preventing arsenic from entering Lake Baldwin.

The exact location of the northern leading edge is unknown because there is about 100 feet between wells OLD-09-05 (with 363 μg/L arsenic) and OLD-09-15 (non-detect) and about 140 feet between wells OLD-09-06 (with 331 μg/L arsenic) and OLD-09-16 (non-detect). A DPT groundwater sampling campaign was completed in October 2001 to help delineate the leading edge. The additional DPT points are shown on Figure 1-2 and labeled with letters A through G. If the permeable adsorptive barrier is placed too far in front of the plume's leading edge, then little or no treatment of the contaminated groundwater will occur in the one-year time frame of the treatability study.

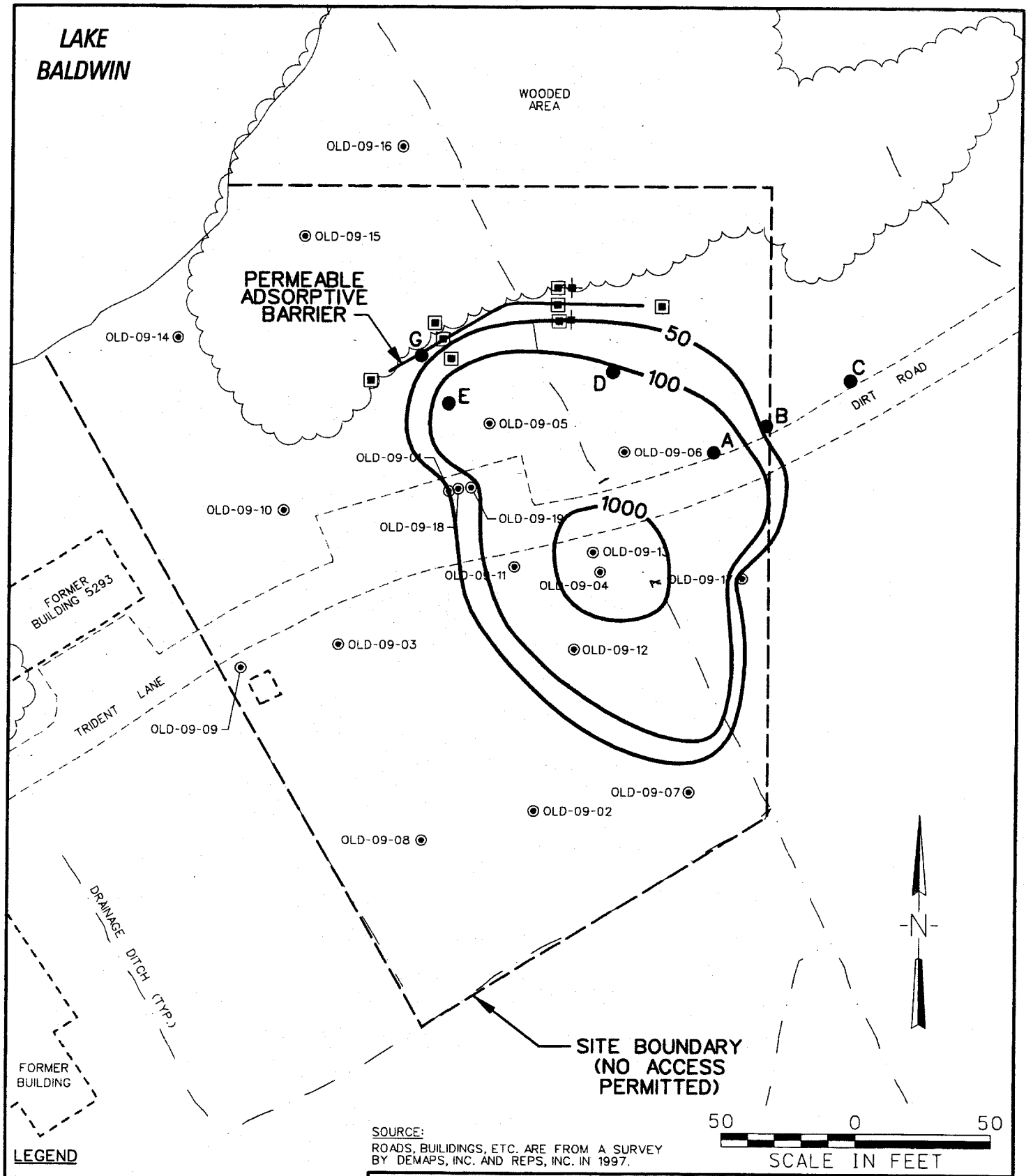
The proposed location of the permeable adsorptive barrier, shown on Figure 3-2, meets the treatability study objective of preventing flow of the arsenic plume into Lake Baldwin. The location represents a best effort to estimate the leading edge of the plume. Figure 3-2 also shows the permeable adsorptive barrier passing across a drainage swale. This swale is very shallow and almost not noticeable in photographs of the site. Little to no surface water flows through this ditch, and its presence should not pose a problem with the treatability study.

3.4 PERMEABLE ADSORPTIVE BARRIER DIMENSIONS

The permeable adsorptive barrier will be 100 feet long, 1.5 feet wide, and will be installed to a depth of 25 feet bgs. The depth of the permeable adsorptive barrier was determined from the October 2001 DPT event. The depth of the permeable adsorptive barrier will extend below any known groundwater contamination. The width of the permeable adsorptive barrier was based on the minimum typical construction method width that met the technical requirements of contact time and available surface area. The length was determined to capture the portion of the groundwater plume moving toward Lake Baldwin.

3.5 SAND SPECIFICATIONS

The selected sand will be mixed 50/50 by volume with the 14x28 mesh activated alumina and used as backfill for the permeable adsorptive barrier. Grain-size analyses were conducted on soil samples from 2-foot depth intervals at soil boring NTC09ST01 between depths of 20 to 32 feet. These samples represent



SOURCE:
ROADS, BUILIDINGS, ETC. ARE FROM A SURVEY BY DEMAPS, INC. AND REPS, INC. IN 1997.

LEGEND

PROPOSED MICROWELL (SCREENED 7-12 ft bls)

PROPOSED MICROWELL (SCREENED 26-28 ft bls)

MONITORING WELL

DPT POINT ● A

ARSENIC CONTOUR[1]

1-CONCENTRATION IN MICROGRAMS PER LITER (ug/L)

NOTE:
DPT LOCATIONS ARE APPROXIMATE.

FIGURE 3-2
TREATABILITY STUDY LAYOUT

OPERABLE UNIT 3 - STUDY AREA 9
NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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the zone of excavation for the permeable adsorptive barrier. A review of the grain-size analyses indicates that the formation is predominantly fine sand (four of six samples) with very consistent size and gradation characteristics, and contained 5.5 to 13.2% fines. On the basis of the grain-size analyses, the formation was treated as a fine, well-sorted sand with 8% fines for selecting the appropriate sand backfill material.

The treatment media (i.e., sand and alumina) in the trench will act as a groundwater filter through which contaminated groundwater will flow.

The design of the backfill was based on standard engineering specifications published by Cedergren (1977). Using the size gradation specifications provided by the alumina supplier and from a commercial sand supplier in Florida, the size gradations for two backfills were calculated.

4.0 FIELD OPERATIONS

4.1 FIELD OPERATIONS SUMMARY

The treatability study consists of the following field activities:

- Clearing and grubbing of trees and shrubs in the treatability study area, as necessary.
- Installation of the permeable adsorptive barrier filled with an activated alumina and sand mixture.
- Installation and survey of 10 microwells using DPT.
- Quarterly water level measurements and sampling and analysis of the 10 new microwells to evaluate arsenic concentrations. These sampling events will coincide with the ongoing monitoring at OU 3. As part of that ongoing monitoring, 15 wells from SA 9 are sampled and analyzed (OLD-09-01, OLD-09-02, OLD-09-03, OLD-09-04, OLD-09-05, OLD-09-06, OLD-09-07, OLD-09-10, OLD-09-11, OLD-09-12, OLD-09-14, OLD-09-15, OLD-09-16, OLD-09-17, and OLD-09-19).
- Unless otherwise specified herein, all work will be performed following guidance detailed in the Project Operations Plan (POP) (ABB-ES, 1997) and the Health and Safety Plan (HASP) (TtNUS, 2001b). In addition, purging and sampling procedures will meet or exceed the guidance provided in *Environmental Investigations, Standard Operating Procedures and Quality Assurance Manual* (USEPA, 1996).

4.2 MOBILIZATION/DEMOBILIZATION

Following approval of this Work Plan, Tetra Tech NUS, Inc. (TtNUS) will procure the required subcontractors and begin mobilization activities. Mobilization/demobilization includes:

- Mobilizing all required subcontractors, equipment, and materials to the site.
- Obtaining all necessary drilling and/or well permits.
- Conducting an approximately 1-hour-long, site-specific health and safety review meeting.
- Delineating work zones (exclusion zone, contamination reduction zone, and support zone) as required by the HASP.
- Arranging an area to perform decontamination procedures.
- Demobilizing all equipment and materials from the site.
- Performing general site clean-up and removal of trash.
- Submitting all boring logs in accordance with applicable regulations (by DPT subcontractor).

All field team members will review the Work Plan, the Site Emergency Procedures Plan, and the HASP. Mobilization includes attendance at a site-specific health and safety meeting during the initiation of onsite activities. This meeting will also include field team orientation to familiarize all personnel with the scope of the field activities.

The Field Operations Leader (FOL) will coordinate the mobilization activities. These activities include responsibilities such as conducting equipment inventories to ensure equipment is available, purchasing equipment as required, staging equipment for efficient loading and transport to the site, and, after field activities are completed, demobilizing the equipment.

The DPT subcontractor will furnish a truck-mounted DPT rig, support crew, all necessary tools required, personal protective equipment (PPE) for their crew, and any miscellaneous equipment and materials required to complete the described activities. All downhole DPT equipment, sampling tools, and the rear of the DPT rig will be steam cleaned prior to arrival onsite. All safety shut-off equipment will be in full working condition and will be tested by the FOL prior to initiating DPT activities.

4.3 PERMEABLE ADSORPTIVE BARRIER INSTALLATION

The proposed location of the permeable adsorptive barrier is shown on Figure 3-2. The barrier will be 100 feet long, 1.5 feet wide, and will be installed to a depth of approximately 25 feet bgs. The installation method will be proposed by the subcontractor selected to perform the work, but will likely use either a one-pass trenching machine or a trackhoe with trench stability provided by using a biopolymer slurry. A 50/50 mixture of sand and activated alumina, which ships in 1,850-pound "supersacks," will be used to backfill to within 2 feet of the surface. Compacted soil will be placed in the top 2 feet of the trench. The sand will be a uniformly graded sand with a D_{15} size range of 0.6 – 1.6 mm and a uniformity factor (D_{60}/D_{10}) no greater than 2.5.

4.4 MICROWELL INSTALLATION

Additional monitoring wells (microwells) will be installed around and in the permeable adsorptive barrier to monitor the movement of the groundwater and the arsenic concentrations. The proposed locations of the new microwells are shown on Figure 3-2. Microwells screened from 7-12 feet bgs will be installed as follows: two immediately upgradient of the barrier, two in the barrier, two immediately downgradient of the barrier, and one near each end of the barrier (cross-gradient from the barrier). Two additional microwells screened from 26-28 feet bgs will also be installed, one immediately upgradient of the barrier and one immediately downgradient. A typical microwell is shown in Figure 4-1.

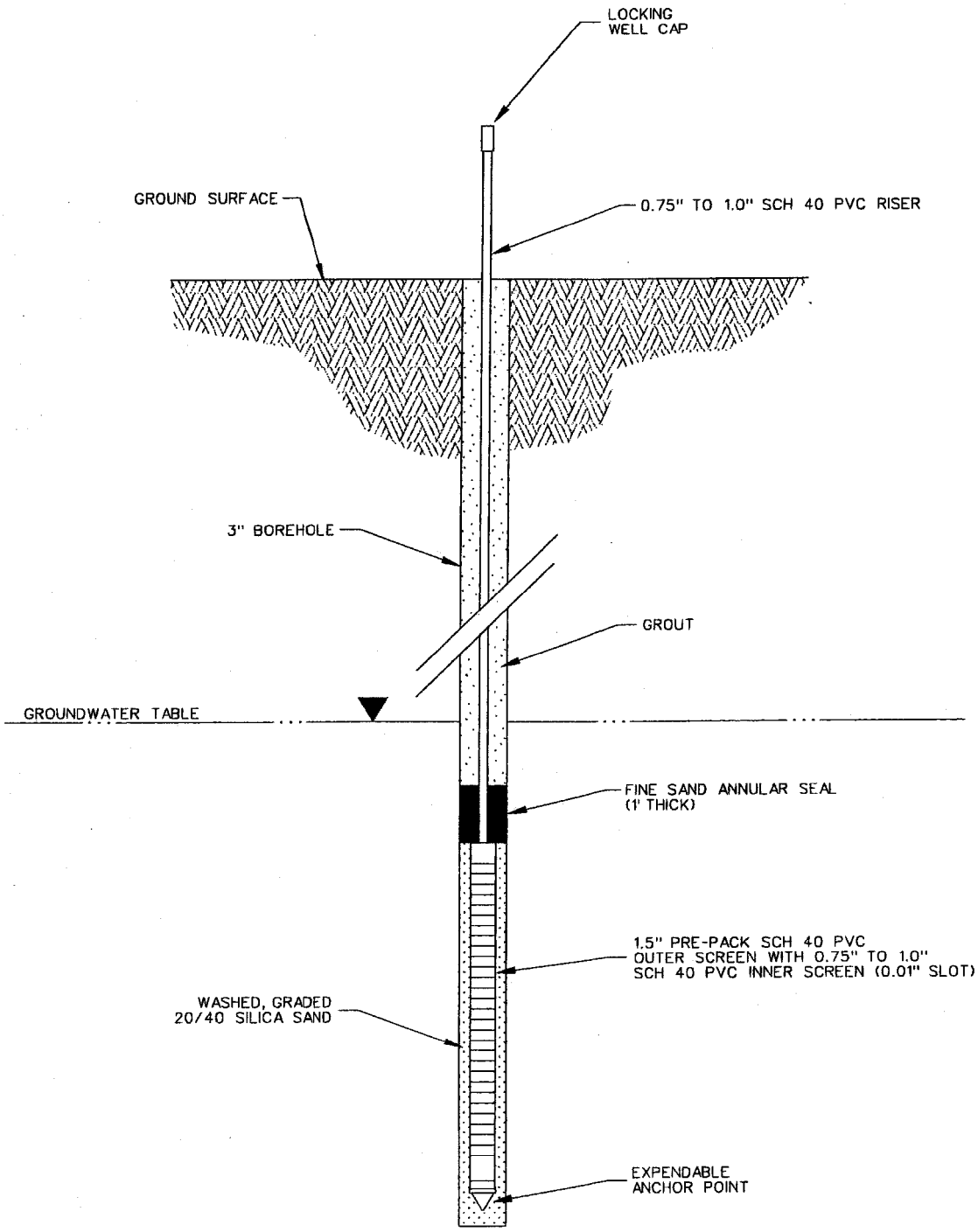

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FIGURE 3-3
TYPICAL MICROWELL CONSTRUCTION
OPERABLE UNIT 3 – STUDY AREA 9

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

en85x11v.dgn

CAD FILE NO. (DATE: k:\dgn\navy\orlando\sites\ou4\ou4-011.dgn(10-26-01 REMEDIAL DESIGN

Microwells will be constructed of schedule 40 polyvinyl chloride (PVC) risers and screens. The TtNUS on-site representative will provide specific microwell locations. All well screens will be factory slotted to 0.010-inch size. The filter pack will be clean silica sand of U.S. Standard Sieve Size No. 20 to 30. The sand pack will extend approximately 0.5 feet below the bottom of the screen and approximately 0.5 feet above the top of the well screen. A minimum 1-foot-thick layer of fine sand (uniformly graded clean silica sand of U.S. Standard Sieve Size No. 30 to 65) will be placed on top of the filter pack. The remaining annulus above the fine sand layer will be backfilled to the surface with a 10:1 cement/bentonite grout. A maximum of 6 to 7 gallons of water per 94-pound bag of Type I cement will be used.

The surface completions for the microwells will be flush mounted, sealing, well covers. The flush-mounted cover will be an 8- or 10-inch round security vault with bolt-down manhole cover provided with sealing gasket and a watertight well cap to reduce the amount of water infiltration. Approximately 4 to 6 inches of clearance will be left between the lid of the well cover and the top of the well riser. A 2-foot by 2-foot by 4-inch thick concrete apron will be constructed around each flush-mounted well. The flush-mounted casings will be completed a minimum of 1 inch above existing grade and the apron tapered to be flush with existing grade at the edges such that water will run off of the apron.

The microwells will be numbered in accordance with the existing wells at the site. Well designations will be of the following form:

OLD-09-*NN*

Where: *NN* is the well number beginning with 20. For example, the first microwell will be numbered OLD-09-20.

4.5 WELL DEVELOPMENT

New monitoring wells will be developed no sooner than 24 hours after well installation. Wells will be developed by bailing and low-stress surging, and/or by pumping, as determined by the field geologist. Because of the fine-grained formation and the potential for loosely compacted sediment (i.e., heaving sands), excessive stress during development must be avoided. The wells will be developed until the discharge water is visibly clear or stable as determined by the field geologist. The field geologist will obtain a minimum of three sequential, stable measurements of field parameters (pH, temperature, specific conductance, and turbidity) recorded near the end of development processes. At a minimum, development must remove twice the volume of water from the well that was used during well construction. Development will be performed in accordance with Section 4.4.6.7 of the POP (ABB-ES, 1997).

4.6 SURVEYING

After installation of the permeable adsorptive barrier and the microwells, their locations and elevations, as appropriate, will be surveyed. Surveyed items will include the dimensions and key points of the permeable adsorptive barrier, locations of the wells, and the measure point elevations of the wells.

4.7 SAMPLING

Field measurements and laboratory analyses will be conducted to evaluate groundwater flow through the permeable adsorptive barrier and the removal of arsenic from the groundwater. As part of this treatability study, groundwater samples will be obtained from the 10 new microwells during an initial baseline event and four subsequent quarterly events. These samples will be analyzed for arsenic and common anions that may interfere with barrier performance.

Unless otherwise specified herein, all work will be performed following guidance detailed in the POP (ABB-ES, 1997) and the HASP (TtNUS, 2001b). In addition, purging and sampling procedures will meet or exceed the guidance provided in *Environmental Investigations, Standard Operating Procedures and Quality Assurance Manual* (USEPA, 1996).

In addition, the ongoing quarterly monitoring for OU 3 will coincide with the treatability study sampling events, which will provide data from 15 additional wells at SA 9. These wells are OLD-09-01, OLD-09-02, OLD-09-03, OLD-09-04, OLD-09-05, OLD-09-06, OLD-09-07, OLD-09-10, OLD-09-11, OLD-09-12, OLD-09-14, OLD-09-15, OLD-09-16, OLD-09-17, and OLD-09-19. They are analyzed for arsenic as well as additional parameters as defined in the OU 3 monitoring plan.

4.7.1 Water Level Measurements

Groundwater level measurements will be obtained during sampling events from the same wells as those being sampled. These include the 15 wells under the OU 3 monitoring plan as well as the 10 new microwells. The synoptic measurements will be taken within a 2-hour period of consistent weather conditions to minimize atmospheric/precipitation effects on groundwater levels. Measurements will be taken with an electronic water level indicator or interface probe using the marked location on the top of the well casing as the reference point. Groundwater level measurements will be recorded to the nearest 0.01 foot on the appropriate field log. This information will be used to confirm groundwater flow direction. Only the monitoring wells to be sampled will be measured during the quarterly sampling events.

4.7.2 Purging Procedures for Monitoring Wells

Peristaltic pumps using dedicated Teflon® or Teflon®-lined discharge tubing will be used for both purging and sampling of the wells. In-line flow-through cells will be used for real-time groundwater parameter monitoring. The monitoring wells will be purged using micro-flow purging techniques prior to sampling. The steps listed below are to be followed for the purging procedure.

1. The water level will be measured and recorded prior to placing the tubing into the well.
2. The discharge tubing will be lowered into the well as slowly as possible to minimize disturbance to the water in the well.
3. The end of the tubing will be positioned at the midpoint of the saturated screen length. The end of the tubing will be kept at least 2 feet above the bottom of the well to minimize mobilization of any particulates present (where practical).
4. The water level will be measured and recorded before starting the pump.
5. Purging will begin with the pump at the lowest setting. The operator will slowly increase the pump speed until discharge occurs.
6. The water level will be checked again. The pumping rate will be adjusted until there is little or no water level drawdown. Drawdown should be less than 0.3 foot unless site conditions warrant a change. If the least drawdown that can be achieved exceeds 0.3 foot but remains stable, the purging procedure will continue.
7. The water level and pumping rate will be monitored and recorded every 3 to 5 minutes during purging. Pumping rate adjustments will be recorded (both time and flow rate). Adjustments are best made during the first 15 minutes of pumping to minimize purging time. During pump start-up, drawdown may exceed the 0.3 foot target and then recover as pump flow adjustments are made. Unless site conditions warrant a change, purging will proceed at a maximum of 100 mL/min.
8. Field parameters will be monitored and recorded every 3 to 5 minutes to document stabilization. Note that during the early phase of purging, emphasis will be placed on minimizing and stabilizing pumping stress and recording those adjustments.
9. Purging will be considered complete when temperature, specific conductance, pH, oxidation reduction potential (ORP), and dissolved oxygen (DO) have stabilized and turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs) (USEPA, 1996). Stabilization is considered to be achieved when three consecutive readings, taken at 3- to 5-minute intervals, are within the limits

listed in Table 4-1. If turbidity is greater than 10 NTUs and has not decreased significantly after 60 minutes, purging will be discontinued and sample collection may be performed at the discretion of the Task Order Manager.

TABLE 4-1
FIELD PARAMETERS STABILIZATION CRITERIA

STUDY AREA 9
NTC, ORLANDO

Parameter	Unit	Limit
Temperature	Degrees Fahrenheit or Celsius (°F or °C)	± 5%
Specific Conductance	Micro-siemens/centimeter (μs/cm)	± 5%
pH	Standard Unit (SU)	± 0.1
Oxidation Reduction Potential (ORP)	Millivolts (mV)	± 5%
Dissolved Oxygen (DO)	Milligrams per liter (mg/L)	± 5%
Turbidity	Nephelometric Turbidity Unit (NTU)	± 5% for values > 7 ± 10% for values < 7

4.7.3 Monitoring Well Sampling Procedures

When purging is complete, the flow-through cell will be disconnected and sample bottles will be filled directly from the Teflon® or Teflon®-lined tubing. Samples for arsenic analyses will be collected by allowing the pump discharge to flow into the sample bottle.

4.7.4 Sample Shipping

Inorganic samples will be shipped via overnight courier on a daily basis to the subcontract fixed-base analytical laboratory. The shipping address and contact information will be provided in the Field Instruction to be prepared for each field event.

4.7.5 Sample Numbering

The groundwater samples will be numbered as follows:

NTC09*TWWRR*

where: NTC = Naval Training Center
09 = two-digit SA designation (09)
T = sample type (“G” for groundwater, “D” for duplicate)
WW = well location (e.g., 15)
RR = sampling round number (e.g., 17)

For example, the sample collected from well OLD-09-02 will be designated as NTC09G0217. Dashes will not be used in the sample numbers. Samples for field duplicates will be identified with a “blind” number (e.g., the first duplicate would be NTC09D0117, the second would be NTC09D0217). The corresponding environmental sample will be noted in the field logbook.

Rinsate and field blanks are not required because all sampling will be done with dedicated Teflon® tubing. Trip blanks are to be numbered consecutively (e.g., NTC09TB0117 for the first trip blank).

4.7.6 Quality Control (QC) Samples

QC samples will be collected at the frequencies listed below.

- One field duplicate per 10 environmental samples.
- One matrix spike (MS)/matrix spike duplicate (MSD) per 20 environmental samples.
- No rinsate blanks (unless downhole pumps or non-dedicated tubing are used for sampling).
- No field blanks (unless decontamination of sampling equipment is required).

"MS/MSD" will be added to the sample label and the chain of custody. New sample numbers will not be created for these samples. MS/MSD samples will be selected in the field by the FOL and will require 3X sample volume for each set (1X for environmental sample, 1X for MS sample, and 1X for MSD sample).

If a rinsate blank is required (should downhole submersible pumps be used), analyte-free water from a decontaminated bucket or other decontaminated container will be pumped through the entire reel of discharge tubing directly into the sample bottles.

4.7.7 Laboratory Sample Analysis Summary

The laboratory specified by TtNUS will perform the routine chemical analyses for the environmental samples collected for the SA 9 site during the permeable adsorptive barrier pilot-scale study. Unless otherwise specified, standard turnaround times will be used.

The laboratory analytical methods, bottle requirements, preservation requirements, and holding times are shown in Table 4-2.

TABLE 4-2
ANALYTICAL LABORATORY ANALYSES

STUDY AREA 9
NTC, ORLANDO

Parameter	Analytical Method	Bottle/Preservation Requirements[a]	Holding Time
Target Analyte List Arsenic	SW-846 6010B	1-L plastic/nitric acid	6 months
Anions (chloride, sulfate, nitrate, and phosphate)	USEPA 300.0	250-mL HDPE Cool to 4°C	48 hours to analysis

[a]Bottle requirements will be provided (and revised if appropriate) in the Field Instruction for each field event.

The analytical laboratory, specific analyses, methods, bottle requirements, and preservatives for the groundwater sampling will be provided in the Field Instruction to be prepared for each field event.

4.7.8 Data Validation

Qualification of the data will be performed using the *USEPA Contract Laboratory Program: National Functional Guidelines for Inorganic Data Review* (USEPA, 1994). The data validation evaluates data completeness, holding time compliance, calibration compliance, laboratory blank contamination, and detection limits. Limited data validation will be performed primarily to eliminate false positives and false negatives.

4.8 EQUIPMENT CALIBRATION

Several monitoring instruments may be used during field activities; these include:

- Photoionization detector or flame ionization detector
- Horiba U-22 water quality meter/probe
- Electronic water-level meter
- Turbidity meter

Calibration will be documented on an equipment calibration log. During calibration, an appropriate maintenance check will be performed on each piece of equipment. If damaged or defective parts are identified during the maintenance check and it is determined that the damage could have an impact on the instrument's performance, the instrument will be removed from service until the defective parts are repaired or replaced.

4.9 RECORD KEEPING

In addition to chain-of-custody records, certain standard forms will be completed for sample description and documentation. These forms will include sample log sheets, boring logs, well completion diagrams, daily record of subsurface investigation reports, and logbooks. Field documentation and example field log forms are provided in Appendix B.

A bound/weatherproof site logbook will be maintained by the FOL. All information related to sampling or field activities will be recorded in the site logbook. This information will include, but is not limited to, sampling time, weather conditions, unusual events, field measurements, descriptions of photographs, etc.

5.0 DECONTAMINATION

5.1 DOWNHOLE EQUIPMENT

All downhole excavation and drilling equipment, including the rear of the drill/DPT rig, will be steam cleaned on these occasions:

- Prior to arrival on-site.
- Prior to beginning work.
- Any time the equipment leaves the site.
- Any time the equipment returns to the site.
- At the conclusion of the excavation and drilling/DPT program.

Due to the nature of this pilot study and previous delineation of impacted groundwater, the DPT equipment will not be decontaminated between microwell installations. All large equipment decontamination activities will take place at a location designated by base personnel. However, all loose soil material and debris will be removed at the individual site prior to decontamination. Decontamination operations will consist of washing large equipment (drill rig, augers, push probes, downhole tools, etc.) using a high-pressure portable steam wash.

5.2 SAMPLING EQUIPMENT

All sampling tools and miscellaneous sampling equipment coming in contact with contaminated media will be decontaminated using the steps identified below.

1. Wash with potable water and Alconox.
2. Rinse thoroughly with potable water.
3. Rinse with deionized water or analyte-free water.
4. Rinse with isopropanol.
5. Rinse with analyte-free water and air dry.

Clean sampling equipment will be wrapped in aluminum foil to prevent contamination during storage or transport.

5.3 DISPOSABLES

The field team PPE will be disposed as required. These items, such as disposable latex gloves and paper towels, will be temporarily stored in plastic bags with daily transfer to 55-gallon drums (with lids) at the end of each workday. Personnel will also perform decontamination procedures as required by the HASP before any departure from the site.

6.0 INVESTIGATION-DERIVED WASTE (IDW) MANAGEMENT

Drill cuttings, development water, and decontamination fluids will be drummed separately in containers provided by the drilling subcontractor. Field personnel will use a paint stick or other permanent marker to label the drums with the following information:

- Identification No. (TtNUS-SA9-xxx)
- Company name (Tetra Tech NUS)
- Base contact (Barbara Nwokike) and phone number (407-895-6714)
- Site (NTC SA9)
- Material contained in the drum (e.g., decon fluids)
- Date the IDW was produced

All drums will be removed from SA 9 prior to leaving the site. The IDW will be picked up by a licensed waste hauler or sampled for analysis (if necessary) and moved to the storage area at Area C. Navy personnel will sign all manifests and bills of lading prior to transporting the drums from NTC.

Miscellaneous sampling material (e.g., gloves, tubing, and plastic) will be disposed of in dumpsters located in Area C near Building 1056 on Seabee Street.

Excavated soil from the construction of the permeable adsorptive barrier will be spread on-site upgradient of the completed permeable adsorptive barrier.

7.0 REPORTING

During performance of the Treatability Study, TtNUS will prepare the following reports:

Permeable Adsorptive Barrier Installation and Baseline/First Quarter Treatability Study Report

Upon completion of the initial quarter of performance monitoring, TtNUS will prepare the first quarter Treatability Study Report, which will include the following:

- Documentation of the permeable adsorptive barrier installation activities, including photographs and sketches.
- The permeable adsorptive barrier installation procedures, drilling logs, and any other data developed as part of the pilot-scale field activities.
- The groundwater sampling procedures and sample analytical results from the baseline and first quarter sampling events.
- The groundwater flow conditions.
- Any other data collected during the most recent sampling event.

Second and Third Quarter Treatability Study Results Transmittal Letters

Upon completion of the second and third quarters of performance monitoring, TtNUS will prepare letter reports presenting the test results, including in particular preliminary conclusions as to the effectiveness of the permeable adsorptive barrier.

Treatability Study Report

Upon completion of the fourth quarter of performance monitoring, TtNUS will prepare a Treatability Study Report discussing the groundwater sampling procedures and presenting a summary and comparison of the previous three quarters of sample results. The Treatability Study Report will present information on the groundwater flow conditions and any other data collected during the past year of sampling. In addition, the report will present conclusions and recommendations for future remedial action at the site, if any. The Treatability Study Report will be submitted in final form only to SOUTHDIV, NTC, USEPA, and the FDEP.

8.0 CONTACTS

The following personnel are approved contacts for their respective project areas.

Project Area	Responsible Personnel	Phone Number
Base Contact	Barbara Nwokike	407-895-6714 843-820-5566
Task Order Management	Steven McCoy	865-220-4730
Technical Issues	Jim Davis (Permeable Adsorptive Barrier) Michael Campbell (Well installation/sampling)	865-220-4768 865-220-4714
Health & Safety	Matthew Soltis	412-921-8912
Procurement	Sandy D'Alessandris	412-921-8435
Task Order Chemist	Joe Samchuck	412-921-8510
Laboratory Services	[a]	[a]
Drilling Contractor	[a]	[a]

[a] To be provided in the Field Instruction for each field event.

REFERENCES

ABB-ES (ABB Environmental Services, Inc.), 1997. *Project Operations Plan for Site Investigations and Remedial Investigations, Volume I of II, Naval Training Center,* Orlando, Florida. Unit Identification Code N65928, Contract No. N62467-89-D0317/107, August.

Cedergren, H.R., 1977. *Seepage, Drainage, and Flow Nets*. Second Edition. John Wiley & Sons.

HLA (Harding Lawson Associates), 1999. *Remedial Investigation and Feasibility Study, Operable Unit 3,* Naval Training Center, Orlando, Florida, Unit Identification Code N65928, Contract No. N62467-89-D-0317/136, June.

TtNUS, (Tetra Tech NUS, Inc.), 2001a. *Bench-Scale Treatability Studies – Operable Unit 3.* Document No. 470101013, February 2.

TtNUS, 2001b. *Health and Safety Plan for Performing Investigative Work and Data Sampling,* Naval Training Center, Orlando, Florida, Contract No. N62467-94-D-0888, April.

TtNUS, 2001c. *Groundwater Sampling at Operable Unit 3.* Document No. 470401002, May 11.

USEPA (U.S. Environmental Protection Agency), 1994. *USEPA Contract Laboratory Program: National Functional Guidelines for Inorganic Data Review*, EPA/540/R-94/013, Office of Solid Waste and Emergency Response, Washington, D.C., February.

USEPA, 1996. *Environmental Investigations, Standard Operating Procedures and Quality Assurance Manual,* California, May.

APPENDIX A

ACTIVATED ALUMINA MATERIAL SAFETY DATA SHEET

ACTIVATED ALUMINA MATERIAL SAFETY DATA SHEET

ALCOA

Alcoa Industrial Chemicals

ACTIVATED ALUMINAS

General Purpose Scavenger Granular Grade DD-2

Granular scavenger for removal of process impurities — High macroporosity and high surface area

Application

Granular scavenger for the removal of process impurities from aqueous or hydrocarbon streams. Particularly useful for the removal of low level polar and/or ionic species. High macroporosity improves diffusion rates while high surface area provides enhanced capacity.

Availability

Shipping Point	Port Allen, LA
Packaging	300 lb. steel drums
	300 lb. fiber drums
	1800 lb. super sacks

Typical Properties

Chemical	
Al_2O_3 %	91.50
Na_2O %	0.35
SiO_2 %	0.015
LOI % (1000 °C)	8.00
Physical	
Total Pore Volume (cc/gm)	0.50
Macroporosity >750A (cc/gm)	0.13
Surface Area (m^2/gm)	350
Bulk Density (lbs/ft^3)	40
Sizes (U.S. Screen mesh)	8x14 14x28 28x100
(Other sizes on request)	

Information presented herein is believed to be accurate and reliable but is not intended to meet any specification and does not imply any guarantee or warranty by Alcoa.

MSDS Number - 149

ALCOA

PRODUCT DATA

United States of America & Latin America
Alcoa Industrial Chemicals
Adsorbents & Catalysts Division
16010 Barkers Point Lane, Suite 250, Houston, TX 77079, USA
Phone: 800-221-7392 or 281-870-9696 • Fax: 281-870-9844
South America São Paulo, Brazil • **Europe** Frankfurt, Germany • **Asia** Tokyo, Japan

Material Safety Data Sheet

acc. to 91/155/EEC

Printing date 04/19/2001

Reviewed on 03/28/2001

* 1 Chemical Product and Company Identification

· **Product Name:** Activated Aluminas
Activated and Amorphous Aluminas

149

· **Other Designations:**
Active bed supports, CG-20, CPA series, CPN, CSS series, DD-2, D-410, DD-420, DD-422, DD-431, DD-440, DD-447, DD-450, DD-460, DD-470, DD-6, DD-PG, DF Series, F-200, HF-200, HPX, LD-5, LD-350, PSD-350, RC-AA, RC-400, RF-200, S-100, S-400, S-431, SRU, TG-431 and Selexsorb(R) Si.

· **Manufacturer/Supplier:**
Alcoa Inc.
201 Isabella Street
Pittsburgh, PA 15212-5858 USA
Health & Safety: +1-412-553-4649

Alcoa World Alumina LLC
109 Highway 131
Vidalia, LA 71373
Tel: +1-318-336-9601 or +1-800-533-4511

Discovery Aluminas, Inc.
3502 South Riverview Drive
Port Allen, LA 70767
Tel. +1-504-389-9945

Malakoff Industries, Inc.
PO Box 487
Highway 31, West
Malakoff, Texas 75148
Tel. 1-903-489-1910

· **Information department:** Product Information - Recycling of activated aluminas +1-318-336-9601

· **Emergency Information:** USA: Chemtrec: +1-703-527-3887 +1-800-424-9300 ALCOA: +1-412-553-4001

* 2 Composition/Data on components:

· CAS No:	Component	
1333-84-2	Aluminum oxide (non fibrous)	<97%

· **Additional information:**
Loss on ignition 4.0-7.0 %

*1333-84-2 (See Section 15)

* 3 Hazards identification

· **EMERGENCY OVERVIEW:**
· **EYES:** Can cause mild irritation.
· **SKIN:** Can cause mild irritation.
· **INHALATION:** Can cause mild upper respiratory tract irritation.
· **INGESTION:** Can cause mild irritation.

· **Chemical ingredient and possible processing hazards:**

Alumina: Low health risk by inhalation. ACGIH: Listed as a nuisance dust.

(Contd. on page 2)

Material Safety Data Sheet

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Printing date 04/19/2001 Reviewed on 03/28/2001

Product Name: Activated Aluminas
Activated and Amorphous Aluminas **149**

(Contd. from page 1)

· **Hazard description:**
· **Medical conditions aggravated by exposure to the product:**
Asthma, chronic lung disease, and skin rashes.
· **Information pertaining to particular dangers for man and environment** See item 11.
· **Classification system**
The classification was made according to the latest editions of the EU-lists, and expanded upon from company and literature data.

* 4 First aid measures

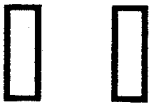
· **After inhalation**
Remove to fresh air.
Check for clear airway, breathing, and presence of pulse.
Provide cardiopulmonary resuscitation for persons without pulse or respirations.
Consult a physician.
· **After skin contact**
Wash with soap and water for at least 15 minutes.
Consult a physician.
· **After eye contact**
Immediately flush eyes with plenty of water for at least 15 minutes.
Consult a physician.
· **After swallowing**
Do not induce vomiting.
Never give anything by mouth to a convulsing or unconscious person.
If swallowed, dilute by drinking large amounts of water.
Consult a physician.

5 Fire fighting measures

· **Suitable extinguishing agents** Use fire fighting measures that suit the environment.
· **Protective equipment:**
Wear self-contained breathing apparatus.
Wear fully protective suit.

* 6 Accidental release measures

· **Person-related safety precautions:**



Wear protective clothing.

· **Measures for environmental protection:** No special measures required.
· **Measures for cleaning/collecting:** Clean up using dry procedures; avoid dusting.
· **Additional information:** No dangerous substances are released.

* 7 Handling and storage

· **Handling**
· **Information for safe handling:**
Ensure good ventilation/exhaust at the workplace.
Avoid generating dust.

(Contd. on page 3)

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Printing date 04/19/2001 Reviewed on 03/28/2001

Product Name: Activated Aluminas
Activated and Amorphous Aluminas 149

(Contd. from page 2)

Provide adequate ventilation if dust is formed.

· **Information about protection against explosions and fires:** No special measures required.

· **Storage**

· **Requirements to be met by storerooms and receptacles:** Keep material dry.

· **Information about storage in one common storage facility:** Not required.

· **Further information about storage conditions:** None.

* 8 Exposure controls and personal protection

· **Additional information about design of technical systems:** No further data; see item 7.

· **Components with limit values that require monitoring at the workplace:**	
1333-84-2 Aluminum oxide (non fibrous)	
ACGIH TLV	10 mg/m³
OSHA PEL	15 total, 5 respirable mg/m³

· **Personal protective equipment**

· **General protective and hygienic measures**

Do not inhale dust.

Avoid contact with the eyes.

· **Breathing equipment:**

Use suitable respiratory protection in case of insufficient ventilation.

Short term filter device:

Filter NIOSH N95.

· **Protection of hands:** Impervious gloves.

· **Eye protection:** Safety glasses.

* 9 Physical and chemical properties:

· **Form:**	Crystalline powder Gelatinous Balls Granules Pellets
· **Color:**	Off-white
· **Odor:**	Characteristic
· **Change in condition**	
Melting point/Melting range:	2050°C (3722°F)
Boiling point/Boiling range:	Undetermined
· **Flash point:**	Not applicable
· **Auto igniting:**	Product is not self igniting.
· **Danger of explosion:**	Product does not present an explosion hazard.
· **Density:**	Not determined
· **Bulk density at 20°C (68°F):**	0.62-0.83 kg/m³ 38.0-51.8 lb/ft3

(Contd. on page 4)

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Printing date 04/19/2001 Reviewed on 03/28/2001

Product Name: Activated Aluminas
Activated and Amorphous Aluminas **149**

(Contd. from page 3)

· **Solubility in / Miscibility with Water:**	Insoluble
· **pH-value at 20°C (68°F):**	9.4-10.1 (10% in water)

10 Stability and reactivity

· **Thermal decomposition / conditions to be avoided:** No decomposition if used according to specifications.
· **Reactions:** Heating occurs when water is added.
· **Dangerous products of decomposition:** No dangerous decomposition products known.
· **Additional information:** Non-corrosive.

*11 Toxicological information

· **Acute toxicity:**
· **Primary irritant effect:**
· **On the skin:** Can cause mild irritation.
· **On the eye:** Can cause mild irritation.
· **Inhalation:** Can cause mild upper respiratory tract irritation.
· **Ingestion:** Can cause mild irritation.

12 Ecological information:

· **General notes:** Generally not hazardous for water.

*13 Disposal considerations

· **Product:**
· **Recommendation**
Collect in containers, bags, or covered dumpster boxes. If reuse or recycling is not possible, material may be disposed of at an industrial landfill.

· **Uncleaned packagings:**
· **Recommendation:** Disposal must be made according to official regulations.

*14 Transport information

· **DOT regulations:**
· **Remarks:** U.S.A. DOT: Not regulated - Enter the proper freight classification. "MSDS Number," and "Product Name" on the shipping paperwork.

Canadian TDG Hazard Class & PIN: Not regulated.

· **Land transport ADR/RID (cross-border)**
· **Remarks:** Not regulated

· **Maritime transport IMDG:**
· **Marine pollutant:** No
· **Remarks:** Not regulated

(Contd. on page 5)

Material Safety Data Sheet

acc. to 91/155/EEC

Printing date 04/19/2001 Reviewed on 03/28/2001

Product Name: Activated Aluminas
Activated and Amorphous Aluminas 149

(Contd. from page 4)

· **Air transport ICAO-TI and IATA-DGR:**
· **Remarks:** Not regulated

*15 Regulations

· **U.S. Federal Regulations:**
· **TSCA STATUS:**
All components of this product are listed on the TSCA inventory.
*For TSCA inventory reporting purposes, CAS No. 1344-28-1 was assigned for all forms of aluminum oxide instead of the CAS No. 1333-84-2 as indicated in Section 2.
· **CERCLA REPORTABLE QUANTITY:** None.
· **SARA TITLE III:**
Section 302 Extremely Hazardous Substances:
None.
· **Section 311/312 Hazardous Categories:** Immediate (acute).
· **Section 313 Toxic Categories:** None.
· **OTHER INFORMATION:**
In reference to Title VI of the Clean Air Act of 1990, this material does not contain nor was it manufactured using ozone-depleting chemicals.

· **Markings according to EU guidelines:**
Observe the general safety regulations when handling chemicals.
The product is not subject to identification regulations under EU Directives and the Ordinance on Hazardous Materials (GefStoffV).

· **National regulations**

· **Water hazard class:** Generally not hazardous for water.
· **International Regulations:**
· **CANADIAN DOMESTIC SUBSTANCES LIST:** All components of this product are listed on the Canadian DSL.
· **AUSTRALIAN INVENTORY OF CHEMICAL SUBSTANCES:**
All components of this product are listed on the AICS.
· **Japan - Existing and New Chemical Substances (ENCS)**
All components of this product are listed on ENCS.

*16 Other information:

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

· **Department issuing MSDS:**
Hazardous Materials Control Committee
Alcoa Inc., 201 Isabella Street, Pittsburgh, PA 15212-5858 USA
28.03.01 Supersedes 10.01.00
· **Alcoa MS No:** 103396
· **Appendix:**
- Guide to Occupational Exposure Values 2000, Compiled by the American Conference of Governmental Industrial Hygienists (ACGIH). .
- Documentation of the Threshold Limit Values and Biological Exposure Indices, Sixth Edition, 1991, Compiled by the American Conference of Governmental Industrial Hygienists, Inc. (ACGIH).
- NIOSH Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, June 1994.
- Dangerous Properties of Industrial Materials, Sax, N. Irving, Van Nostrand Reinhold Co., Inc., 1984.
- Patty's Industrial Hygiene and Toxicology: Volume II: Toxicology, 4th ed., 1994, Patty, F. A.; edited by

(Contd. on page 6)

Material Safety Data Sheet

acc. to 91/155/EEC

Printing date 04/19/2001 Reviewed on 03/28/2001

Product Name: Activated Aluminas
Activated and Amorphous Aluminas 149

(Contd. from page 5)

Clayton, G. D. and Clayton, F. E.: New York: John Wiley & Sons, Inc.
- TOMES CPS(TM), MICROMEDEX, Inc., 2000

LEGEND:

ACGIH	American Conference of Governmental Industrial Hygienists
AICS	Australian Inventory of Chemical Substances
CAS	Chemical Abstract Services
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CPR	Cardio-pulmonary Resusitation
DOT	Department of Transportation
DSL	Domestic Substances List (Canada)
EINECS	European Inventory of Existing Commercial Chemical Substances
ENCS	Japan - Existing and New Chemical Substances
EWC	European Waste Catalogue
EPA	Environmental Protective Agency
IARC	International Agency for Research on Cancer
LC	Lethal Concentration
LD	Lethal Dose
MAK	Maximum Workplace Concentration (Germany) "maximale Arbeitsplatz-Konzentration"
NDSL	Non-Domestic Substances List (Canada)
NIOSH	National Institute for Occupational Safety and Health
NTP	National Toxicology Program
OEL	Occupational Exposure Limit
OSHA	Occupational Safety and Health Administration
PIN	Product Identification Number
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
STEL	Short Term Exposure Limit
TCLP	Toxic Chemicals Leachate Program
TDG	Transportation of Dangerous Goods
TLV	Threshold Limit Value
TSCA	Toxic Substances Control Act
TWA	Time Weighted Average

m meter, cm centimeter, mm millimeter, in inch,
g gram, kg kilogram, lb pound, µg microgram,
ppm parts per million, ft feet

APPENDIX B

FIELD FORMS

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: _____
PROJECT NUMBER: _____
DRILLING COMPANY: _____
DRILLING RIG: _____

BORING No.: _____
DATE: _____
GEOLOGIST: _____
DRILLER: _____

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: _____

Drilling Area Background (ppm): [ ]

Converted to Well: Yes _____ No _____ Well I.D. #: _____

CALIBRATION FORM

Project Name _____

Site Name: _____

Project No.: _____

Instrument Make _____

Instrument Model _____

Serial # (probe/meter) _____ / _____

Date	Time	Name	PH	Conductivity	Dissolved O_2	ORP	Temp	Other	Comments

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: _____ **Project No.:** _____

Location: _____ **Personnel:** _____

Weather Conditions: _____ **Measuring Device:** _____

Tidally Influenced: Yes ____ No ____ **Remarks:** _____

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Total Well Depth (feet)*	Water Level Indicator Reading (feet)*	Thickness of Free Product (feet)*	Groundwater Elevation (feet)*	Comments

* All measurements to the nearest 0.01 foot

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Domestic Well Data
[] Monitoring Well Data
[] Other Well Type: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____
Type of Sample:
[] Low Concentration
[] High Concentration

SAMPLING DATA:

Date: Time: Method:	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	Other

PURGE DATA:

Date:	Volume	pH	S.C.	Temp.	Turbidity	DO	Salinity	Other
Method:								
Monitor Reading (ppm):								
Well Casing Diameter & Material								
Type:								
Total Well Depth (TD):								
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

MONITORING WELL DEVELOPMENT RECORD

Page ___ of _____

Well: _____
Site: _____
Date Installed: _____
Date Developed: _____
Dev. Method: _____
Pump Type: _____

Depth to Bottom (ft.): _____
Static Water Level Before (ft.): _____
Static Water Level After (ft.): _____
Screen Length (ft.): _____
Specific Capacity: _____
Casing ID (in.): _____

Responsible Personnel: _____
Drilling Co.: _____
Project Name: _____
Project Number: _____

Time	Estimated Sediment Thickness (Ft.)	Cumulative Water Volume (Gal.)	Water Level Readings (Ft. below TOC)	Temperature (Degrees C)	pH	Specific Conductance (Units _____)	Turbidity (NTU)	Remarks (odor, color, etc.)

Tetra Tech NUS, Inc.

WELL COMPLETION FORM

JOB NAME:

JOB NUMBER: | PROJECT MANAGER:

LOGGED BY: | EDITED BY:

WELL NAME: | DATE:

DRILLING COMPANY:

EQUIPMENT: | DRILLER:

☐ ____ INCH HOLLOW STEM AUGER

☐ ____ INCH ROTARY WASH | HOURS DRILLED:

GALLONS OF WATER USED DURING DRILLING:

METHOD OF DECONTAMINATION PRIOR TO DRILLING:

DEVELOPMENT

METHOD OF DEVELOPMENT:

DEVELOPMENT BEGAN DATE: TIME:

YEILD: GPM TIME: FROM TO | DATE:

YEILD: GPM TIME: FROM TO | DATE:

YEILD: GPM TIME: FROM TO | DATE:

TOTAL WATER REMOVED DURING DEVELOPMENT: GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER ____

MATERIALS USED

____ SACKS OF ____ SAND

____ SACKS OF ____ CEMENT

____ GALLONS OF GROUT USED

____ SACKS POWDERED BENTONITE

____ POUNDS OF BENTONITE PELLETS

____ FEET OF ____ INCH PVC BLANK CASING

____ FEET OF ____ INCH PVC SLOTTED SCREEN

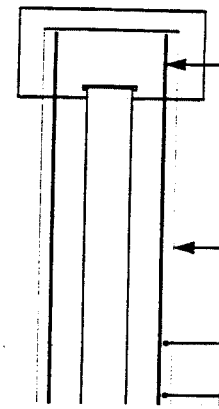
____ YARD3 CEMENT-SAND (REDI-MIX) ORDERED

____ YARDS3 CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☐ NO ☐ YES

NAME ____

WELL COVER USED: ☐ LOCKING STEEL COVER ☐ CHRISTY BOX ☐ OTHER ____



☐ SEE "OTHER" BELOW

☐ LOCKING STEEL COVER

____ INCH DIAMETER STEEL CONDUCTOR CASING

____ to ____ feet

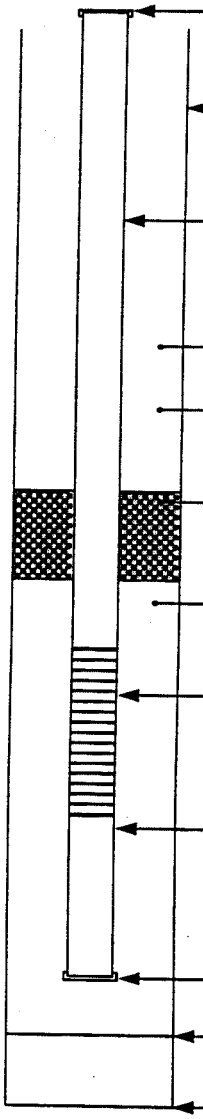
____ INCH DIAMETER BOREHOLE

____ to ____ feet

☐ BENTONITE-CEMENT SEAL OR

☐ 8-SACK CEMENT-SAND SEAL

____ to ____ feet



TOP OF CASING AT ____ FEET ABOVE AT BELOW GROUND LEVEL

____ INCH DIAMETER BOREHOLE

____ to ____ feet

____ INCH DIAMETER SCHEDULE 40 PVC BLANK CASING

____ to ____ feet

☐ BENTONITE-CEMENT SEAL OR

☐ 8-SACK CEMENT-SAND SEAL

____ to ____ feet

BENTONITE PELLET SEAL

____ to ____ feet

SAND PACK

____ to ____ feet

____ INCH DIAMETER SLOTTED ____ INCH SCREEN

____ to ____ feet

____ INCH DIAMETER SCHEDULE 40 PVC BLANK SILT TRAP

____ to ____ feet

BOTTOM WELL CAP

____ feet

HOLE CLEANED OUT TO

____ feet

BOTTOM OF BOREHOLE

____ feet

NOT TO SCALE

ADDITIONAL INFORMATION: ____