N61165.AR.004588
CNC CHARLESTON
5090.3a

UNDERGROUND INJECTION CONTROL PERMIT APPLICATION WITH TRANSMITTAL AND ATTACHMENTS CNC CHARLESTON SC

11/30/2001

CH2MHILL

November 30, 2001

158814.ZE.EX.03

Mr. Todd Adams
Permit Coordinator
South Carolina Department of Health and Environmental Control
Bureau of Water
Water Monitoring Assessment & Protection Division
Groundwater Management Section
2600 Bull Street
Columbia, SC 29201

Subject: Permit Application - Underground Injection Control
RCRA Facility Investigation
Solid Waste Management Unit (SWMU) 70
Charleston Naval Complex (CNC), North Charleston, South Carolina

Dear Mr. Adams:

On the behalf of the U.S. Navy Southern Division Naval Facilities Engineering Command, CH2M-Jones has prepared a Underground Injection Control Permit application (Form 1) and attachments A through K for a Pilot Study at SWMU 70 at the Charleston Naval Complex in North Charleston, South Carolina. The Pilot Study will involve *in-situ* chemical reduction, using the Ferox^{SM} process, to treat groundwater contaminated with hexavalent chromium.

The chemical reduction process to be implemented at SWMU 70 involves subsurface injection of zero-valent iron (ZVI). Redox reaction with ARS' Ferox^{SM} ZVI powder involves Fe^0 oxidation with dissolved oxygen and subsequent chromate ion reduction with Fe (II) cations.

The technical approach to implementing the IM is provided in the *Phase II Corrective Measures Study Work Plan, SWMU 70, Zone E* (October 2001). This work plan is currently under review with the SCDHEC Corrective Action Engineering Section, Division of Waste Management, Bureau of Land and Waste Management and the Environmental Protection Agency.

If you have any questions, comments or require additional information please do not hesitate to contact us.

Sincerely,

CH2M HILL

Paul J. Favara, P.E.
Senior Project Manager
(352) 35-5877 ext. 2396

cc: Tony Hunt, P.E./SOUTHDIV
Dean Willamson, P.E./CH2M HILL, GNV
Tom Beisel, P.G./CH2M HILL, ATL

Form 1 UIC	D H E C PROMOTE PROTECT PROSPER **Underground Injection Control Permit Application** **Ground-Water Protection Division** (Collected under the Authority of Title 48 Chapter 1 of the 1976 South Carolina Code of Laws)	**I. EPA ID NUMBER** SC0 170 022 560		
			T/A	C
		U		

Read attached instructions before starting.

For Offical Use Only

Application Approved month day year	Date Received month day year	Permit/Well Number

Comments

II. Facility Name and Address	**III. Owner/Operator and Address**
Facility Name Charleston Naval Complex	Owner/Operator Name United States Navy Southern Division ATTN: Tony Hunt, PE BEC
Street Address Bldg. 761 892 Avenue F	Street Address Naval Facilities Engineering Comm. 2155 Eagle Drive
City State Zip Code North Charleston, SC 29408	City State Zip Code North Charleston, SC 29406

IV. Ownership Status (Mark "x")	**V. SIC Codes**
[X] A. Federal [ ] B. State [ ] C. Private [ ] D. Public [ ] E. Other (Explain)	3731

VI. Well Status (Mark "x")

[ ] A. Operating	Date Started month day year	[ ] B. Modification/Conversion	[ ] C. Proposed

VII. Type of Permit Requested - Class and Type of Well (see reverse)

A. Class(es) enter code(s)	B. Type(s) enter code(s)	C. If class is "other" or type is code "x", explain	D. Number of Wells per type
V.A.	G		up to 16

VIII. Location of Wells or Approximate Center of field or Project

C	A. Latitude				B. Longitude			
		Deg	Min	Sec		Deg	Min	Sec	
1		32	51	51		79	58	7	

IX. Attachments

Complete the following questions on a separate sheet(s) and number accordingly; see instructions for Classes II, III, and V, complete and submit on a separate sheet(s) attachments A-U as appropriate. Attach maps where required. List attachments by letter which are applicable and include with your application.

X. Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment.

A. Name and Title (Type or Print)	B. Phone No.
ROBERT A. HARRELL JR P.E Remedial Project Manager	(843) 820-5551
C. Signature	D. Date Signed
Robert A Harrell Jr.	3 Dec 01

Attachments A-K to Form 1 - Underground Injection Control

Attachment A: Activity for Review

Submit a brief description of the activities to be conducted that require a UIC permit.

CH2M-Jones is requesting an Underground Injection Control (UIC) Permit for the injection of Zero-Valent Iron (ZVI) into the shallow aquifer system at Zone E, SWMU 70, Charleston Naval Complex (CNC), as part of a RCRA Corrective Measures Study (CMS). The purpose of the injection is to reduce hexavalent chromium to trivalent chromium in shallow groundwater. CH2M-Jones has contracted ARS Technologies, Inc., of Highland Park, NJ to implement the pilot study for *in-situ* hexavalent reduction at SWMU 70.

ARS will implement their proprietary Ferox℠ process at the site. The process involves installation of boreholes. The boreholes are used as access points for the ARS equipment that will be used to pneumatically fracture the subsurface formation and deliver ZVI into the fractures. A total of 16 boreholes (see Figure 1) will be installed at the project site; the holes will be held open with temporary well casing.

The process system consists of a skid-mounted fracture module complete with an injection control manifold and a digital data logger used to monitor various operational parameters. Due to the large quantity of compressed gas needed for fracturing and Ferox℠ injections within SWMU 70, ARS will use pressurized nitrogen as the fracturing fluid. A series of bulk nitrogen "tube" trailers will be mobilized to the site for this operation.

The compressed nitrogen is routed through the fracture modules' control manifold and is connected by a high-pressure hose to a proprietary injector. Once the necessary equipment is in place, and all field personnel are instructed on safety aspects of the activities, the outer drive casing will be raised, exposing the injector nozzle to the formation. The packers will be inflated and the formation will be fractured. Fracturing will consist of applying pressurized nitrogen for approximately fifteen seconds within a 20 to 30-inch interval isolated by the use of a double pneumatic straddle packer assembly (the actual injection interval will be finalized in the field).

During each injection, the following system operational parameters will be observed and collected:

- Downhole injection initiation and maintenance pressures;
- Injection pressure influence at surrounding monitoring points, if available; and
- Ground surface heave adjacent to, and in the vicinity of, the injection point.

Other visual observations during injection will also be recorded.

Ferox[SM] injections will be performed immediately following Pneumatic Fracturing at each injection interval within the borehole. The iron powder/water slurry will be injected into the subsurface utilizing a nitrogen gas stream integrated with a high-pressure, high-flow injection manifold. The manifold system will provide accurate injection pressures, which will enable ARS to achieve the optimal iron powder dispersion.

Each borehole will be addressed starting at the deepest interval and working upward. This will ensure that borehole stability is maintained. When the targeted dosage of iron is emplaced into the formation, the packers will be deflated, and the nozzle assembly will be raised to the next injection location.

Approximately 40,000 pounds of ZVI will be injected into the subsurface saturated zone.

Assuming that each injection has a radial influence of approximately 20 ft, roughly 16 injection boreholes are needed to target the entire area TTA. The location and number of injection points may change depending on presence of utilities and building structures. Each borehole will be used for approximately five different injection intervals, ranging in depth from approximately 5 to 25 ft-bgs.

An extensive groundwater monitoring program is planned before and after injection to monitor changes in contaminant concentrations.

Attachment B: Well Construction Details

Submit schematic or other appropriate drawings of the surface and subsurface construction details of the recovery and injection wells.

Using the hydraulic push and hammering capabilities of the Geoprobe (or similar push-brand) drill rig, a 4.5-inch OD threaded HW casing will be advanced to depth (approximately 28 ft bls). This casing will serve as a conduit for the ARS equipment. The casing is emplaced to prevent borehole collapse. The casing will be lifted out of the ground after all the ZVI has been delivered through the borehole.

The open-borehole (i.e., the area where the casing has been lifted from and packers have been inflated), will serve as an injection point. As only temporary well casing will be installed, a well construction detail figure has not been prepared.

Attachment C: Operating Data

Submit the following proposed operating data for each injection well:

1) *Average and maximum daily rate and volume of fluid to be injected. In addition, indicate the average and maximum daily rate and volume of fluid to be withdrawn from each recovery well. Verification of the aquifer's hydraulic ability to produce and accept the quantities proposed should be presented.*

The injected fluid consists of iron powder slurry mixed with tap water. Approximately one gallon of water is slurried per kilogram of ZVI. The average and maximum amount of iron injected on a daily basis is 2,000 and 3,500 pounds, respectively. The average and maximum daily volumes of water to be injected with the iron are 900 and 1,600 gallons respectively.

The average and maximum number of injection events (each with a duration of approximately one-half our each.) is four to seven per day. The aquifer has capacity to accept the proposed injection volumes.

2) *Average and maximum injection pressure.*

Initiation pressures for pneumatic fracturing will be between 110 and 180 psi. The initiation phase of the pneumatic fracturing process has a duration of less than 15 seconds. The sustaining pressure of the injection will be between 50 and 100 psi. The sustaining pressure component of the ZVI delivery procedure will last from 15 to 30 minutes.

3) *Pumping schedule*

Four to seven injection events will occur daily.

4) *Proposed ranges in the concentration of all contaminant constituents within the injection fluid. Include comprehensive ground-water quality data from a "worst case" well sample.*

No wastes or contaminated water will be injected or generated during this work.

5) *Length of time the project is expected to require injection to complete remediation (to ensure the effective dates of the permit will allow sufficient time to complete the project).*

Injection will commence in January 2002 and will be completed in February 2002. The total number of days scheduled for injection during this time period is 16. If post-treatment results of the treatment show additional treatment is necessary, additional injections may be warranted. This work would be accomplished in the March through June 2002 time frame.

Attachment D: <u>Monitoring Program</u>

Discuss the planned monitoring program in detail:

1) *Include a discussion of monitoring devices, sampling frequency (sufficient to verify treatment system efficiency), sampling protocol, sampling location, parameters to be analyzed, and proposed method(s) of analysis.*

2) *This plan should indicate how, through monitoring, the proposed contaminant levels in the injectate will be verified.*

3) *This plan should also clearly illustrate exactly how hydraulic control of the contaminant plume (and injectate, where relevant) will be verified through monitoring (i.e., piezometers, quality analyses, etc.).*

As previously indicated, no wastes or contaminated water will be injected or generated during this work. ZVI, water, and nitrogen gas will be injected and result in only localized mounding of groundwater. As the injection will occur over a specified period, and then only 8-10 hours per day, the effects of mounding will be temporary. Normal groundwater elevations will become established shortly after injection of reagent has ceased. The baseline aquifer conditions (contaminant concentrations in groundwater and water levels) will be

determined prior to injection by sampling selected monitor wells at the site. The effectiveness of the chemical reduction process on improving groundwater quality will be monitored 30 to 60 days after injection.

Attachment E: Existing or Pending State/Federal Permits

List the program and permit number of any existing State or Federal permits for the facility (i.e., NPDES, RCRA, UST, etc.).

Currently, the CNC and its Annex are considered a large quantity generator under the Resource Conservation and Recovery Act. A revision to the Part B permit application to reflect closure of two treatment, storage, and disposal facilities was submitted in September 1997 and subsequently approved by SCDHEC in August 1998. The Environmental Protection Agency Identification Numbers for the CNC and Annex are SC0 170 022 560 and SC0 000 328 906, respectively.

Attachment F: Description of Business

Give a brief description of the nature of the business of the facility and any immediately adjacent facilities.

Limited tenant operations continue at the CNC following the April 1, 1996 closure of the facility under the Defense Base Closure and Realignment Act. The SWMU 70 area is currently leased by several light industrial manufacturers.

Attachment G: Area of Review

1) *The area of review should be a fixed radius of ¼ mile from the injection well, the outermost injection wells if a wellfield.*

2) *If a fixed radius is not selected, the methods and the calculations used to determine the size of the area of review should be submitted.*

The area of review is presented in Figure 2. The entire one-quarter mile radius is within the current boundary of the CNC.

Attachment H: Maps of Wells and Area of Review

1) *Submit a topographic map of the area extending one mile beyond the project property boundaries. The map should show all ...*

2) *A scaled map should be included which shows the name and/or number and the location of all production, injection, monitoring, abandoned and dry wells within the area of review...*

3) *A potentiometric map of the project site should be submitted which accurately locates all monitoring wells and proposed recovery and injection wells...*

Figure 3 shows the one-mile area of review. The location of solid waste management units (SWMUs) and areas of concern (AOCs) at the CNC are noted on the figure. Numerous groundwater monitoring wells, installed as part of the investigations conducted at CNC, are located within the area of review.

Potentiometric maps for shallow and deep groundwater are presented in Figures 4 and 5.

Attachment I: Cross Sections/Diagrams

1) *Geologic cross sections indicating the lithology and stratigraphy of the site and the horizontal and vertical extent of the contaminant plume, should be submitted. At least two cross sections, one parallel and one perpendicular to the horizontal groundwater flow direction...*

2) *A schematic diagram, in the form of a cross section, showing the proposed remediation system with the components of flow, (above and below ground) and all associated appurtenances (i.e., stripping tower, piping, wells, etc...).*

Four bore-holes, completed to the top of Ashely formation, were logged. The location of these boreholes and proximity to the injection site, is presented in Figure 1. The boring logs are presented in Attachment I-A.

No permanent structures will be installed as part of this IM. The treatment is an "*in situ*" process which reduces contaminants in the subsurface and does not require installation of any engineered systems or controls, aside from boreholes and temporary well casings, to deliver ZVI into the subsurface. The injection equipment that will be used for delivering chemical reagents into the subsurface is mobile.

Attachment J: Name and Depth of Underground Sources of Drinking Water

Identify and describe all aquifers which may be affected by the injection.

The ZVI will be injected only into the uppermost aquifer system at the CNC, comprised of an unconfined (water table) aquifer system within Quaternary-age interbedded silt, sand and clay deposits, with the underlying Ashley Formation acting as a lower hydrologic bounding unit. This shallow water table is not used as a potable supply in the vicinity.

Depth to groundwater in the Zone E surrounding area is typically 3 -5 feet below land surface. Monitor wells are installed in the shallow and deep zones of the water table aquifer at SWMU 70.

The underlying Ashley Formation is comprised of Tertiary-age silts and clays, and will not be affected by the injection of ZVI. The Ashley Formation also acts as an upper confining unit for the Santee Limestone, which is under artesian conditions, and is used as a source of potable water. The Santee Limestone will not be affected by the injection of ZVI.

Because of the heterogeneity of the surface fill and subsurface Quaternary deposits, the hydraulic properties of the shallow (water table) aquifer system vary widely, depending on location and depth. The variable hydraulic gradients and hydraulic conductivity measured in wells result in locally variable estimates of groundwater flow rates and directions.

The localized and regional shallow groundwater flow direction is east towards the Cooper River.

Attachment K: ***<u>Hydraulic Control</u>***

1) *Sufficient supporting data (i.e. time/drawdown data, Theis curves and methods, calculations, etc,), used to determine aquifer characteristics to verify complete hydraulic control over the contaminant plume (and injectate, if proposed injectate quality does not conform to classified groundwater standards) during the injection should be submitted. At a minimum, values should be given for transmissivity, hydraulic conductivity, effective porosity, and specific yield.*

2) *Demonstrate the presence and magnitude of, or absence of, any vertical hydraulic gradient at the site. If a vertical hydraulic gradient exists, show how its direction and magnitude are incorporated in the calculations demonstrating hydraulic control.*

3) *Groundwater flow computer models (especially 2-D map view with potentiometric flow lines) may be utilized and submitted. All calculations should be in English units. All model-derived data and maps should be properly labeled and keyed so as to be clearly understood.*

The injection of ZVI into the subsurface is not anticipated to significantly alter the hydraulic properties of the site.

NOTE: Original figure created in color

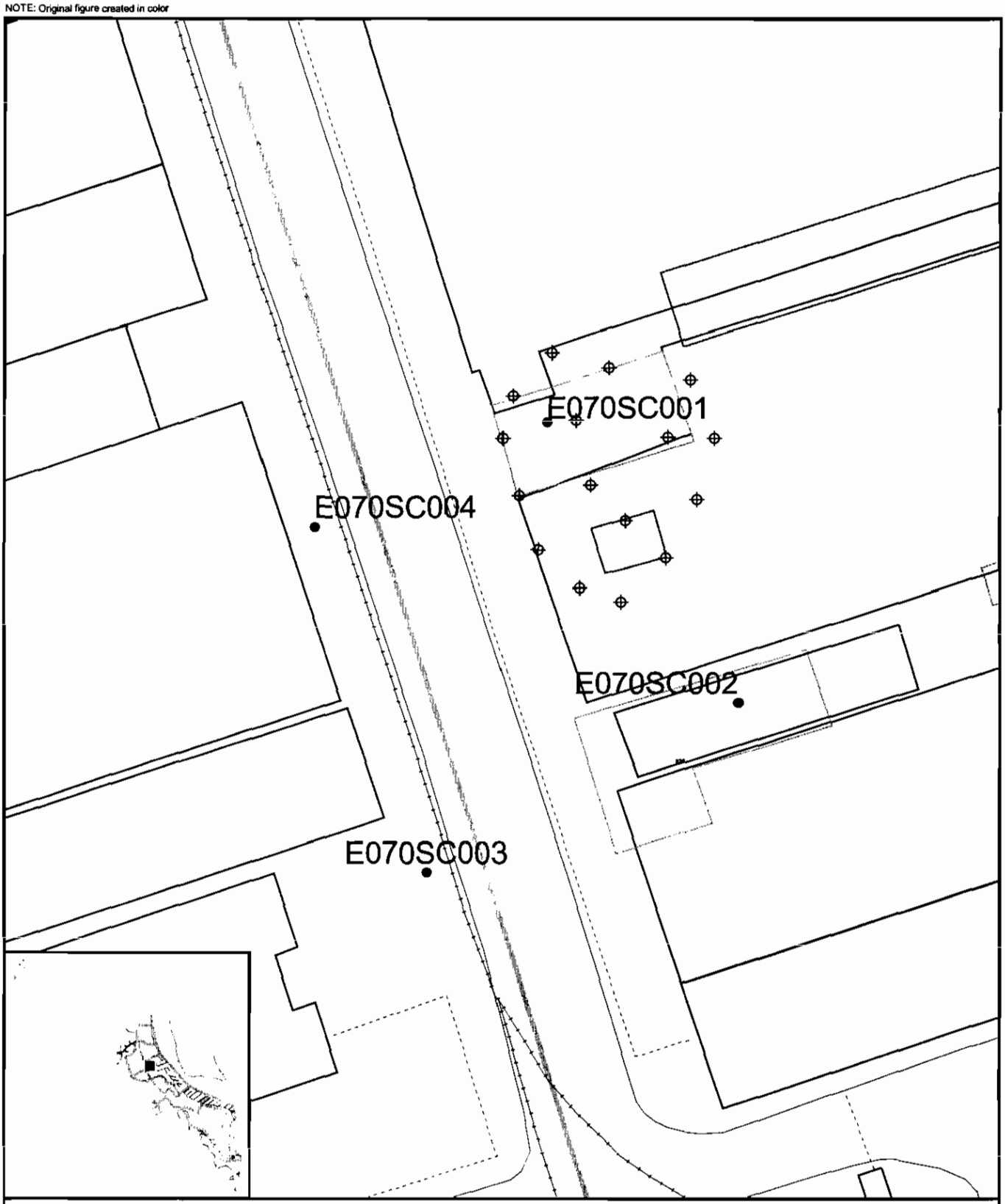

Figure 1
Injection Locations and Boring Locations
SWMU 70, Zone E
Charleston Naval Complex

CH2MHILL

File Path: c:\paulsarcview\aprs\swmu70up.apr, Date: 30 Nov 2001 13:38, User: PFAVARA, UIC: Figure 1 Injection Locations and Boring Locations

NOTE: Orginal figure created in color

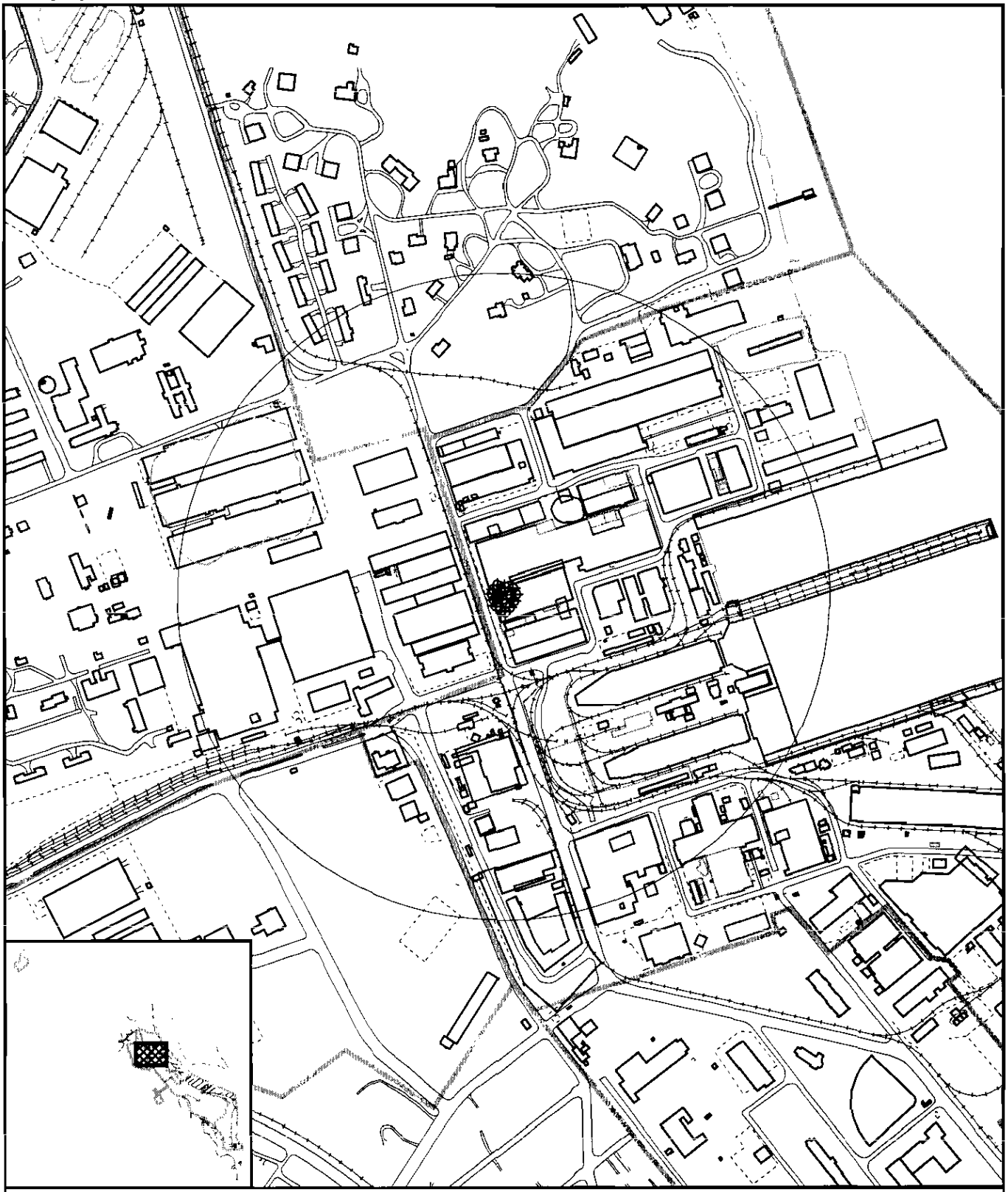

Figure 2
1/4 Mile Radius Around Injection Site
SWMU 70, Zone E
Charleston Naval Complex

CH2MHILL

File Path: c:\paulsarcview\aprs\swmu70up.apr, Date: 30 Nov 2001 13:24, User: PFAVARA, UIC: Figure 2 1/4 Mile Radius Around Injection Site

NOTE: Original figure created in color

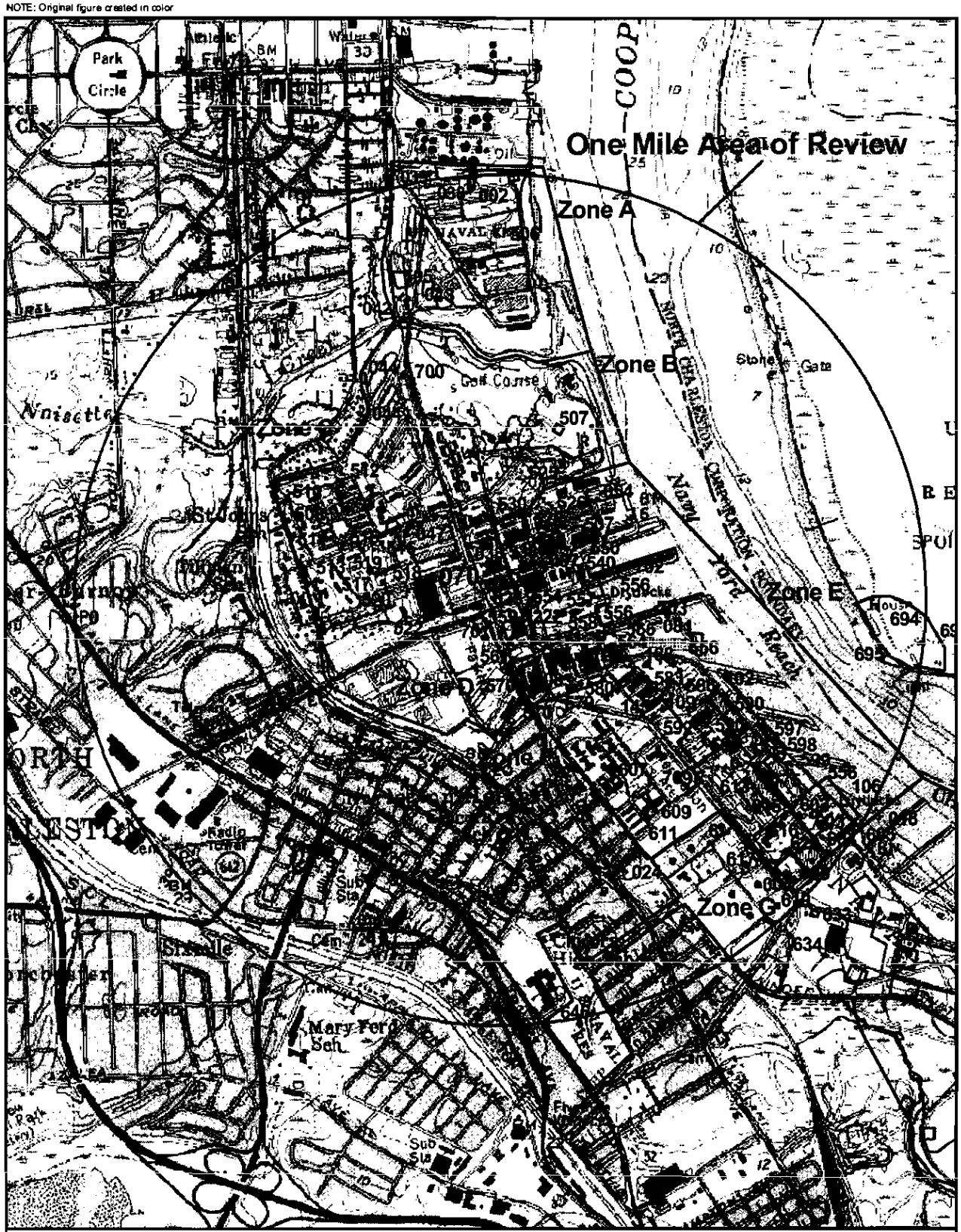

Figure 3
One Mile Area of Review
SWMU 70, Zone F
Charleston Naval Complex

CH2MHILL

File Path: c:\18gis\projects\zone_f\swmu_70\apr\swmu_70.apr, Date: 29 Nov 2001 10:47, User: ASWINFOR, EGIS: Charleston Naval Complex - Figure 3 One Mile Area of Review

NOTE: Original figure created in color

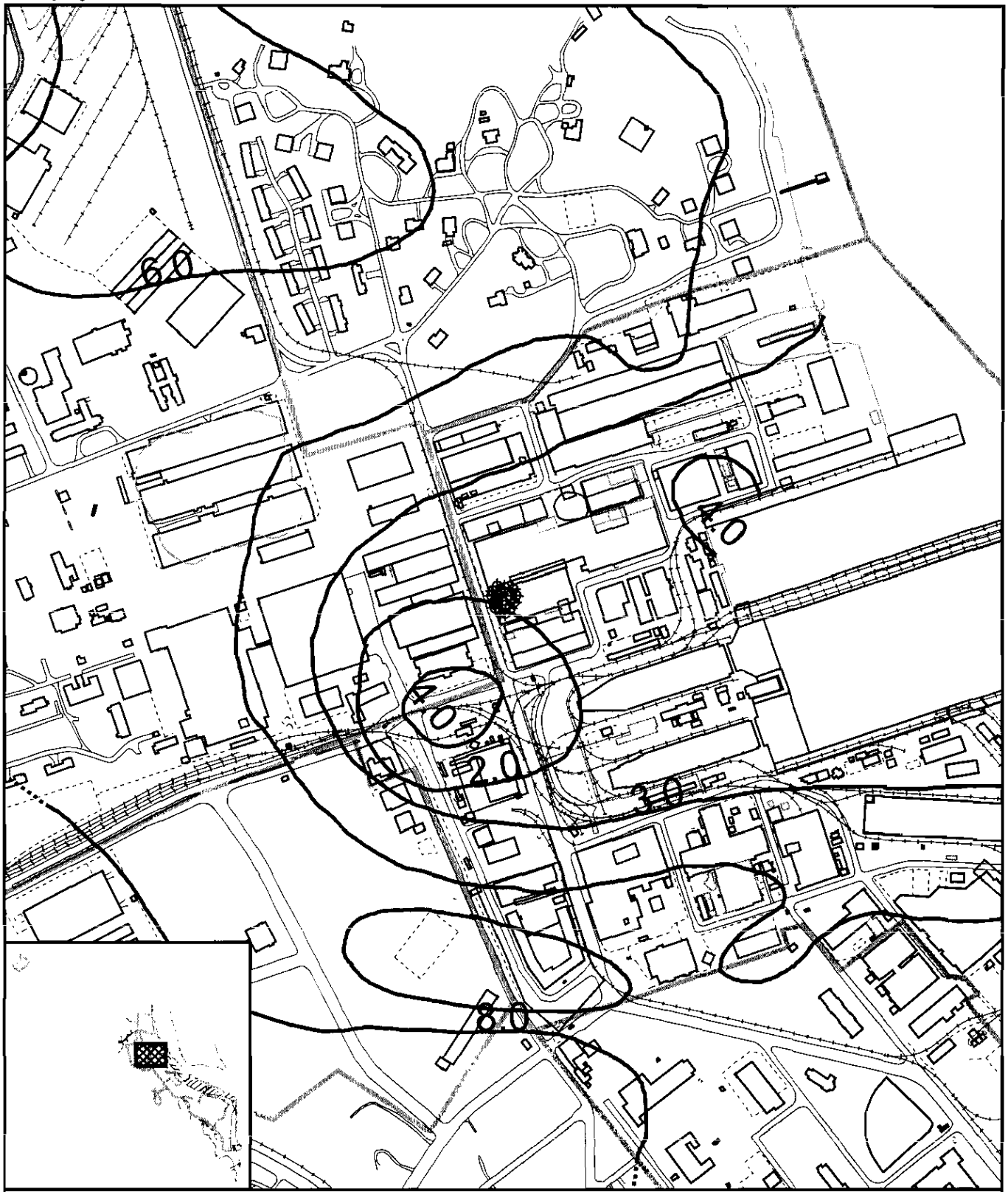

Figure 4
Shallow Groundwater Elevations
SWMU 70, Zone E
Charleston Naval Complex

CH2MHILL

File Path: c:\paul\arcview\aprs\swmu70up.apr, Date: 30 Nov 2001 13:31, User: PFAVARA, UIC: Figure 4 Shallow Groundwater Elevations

NOTE: Original figure created in color

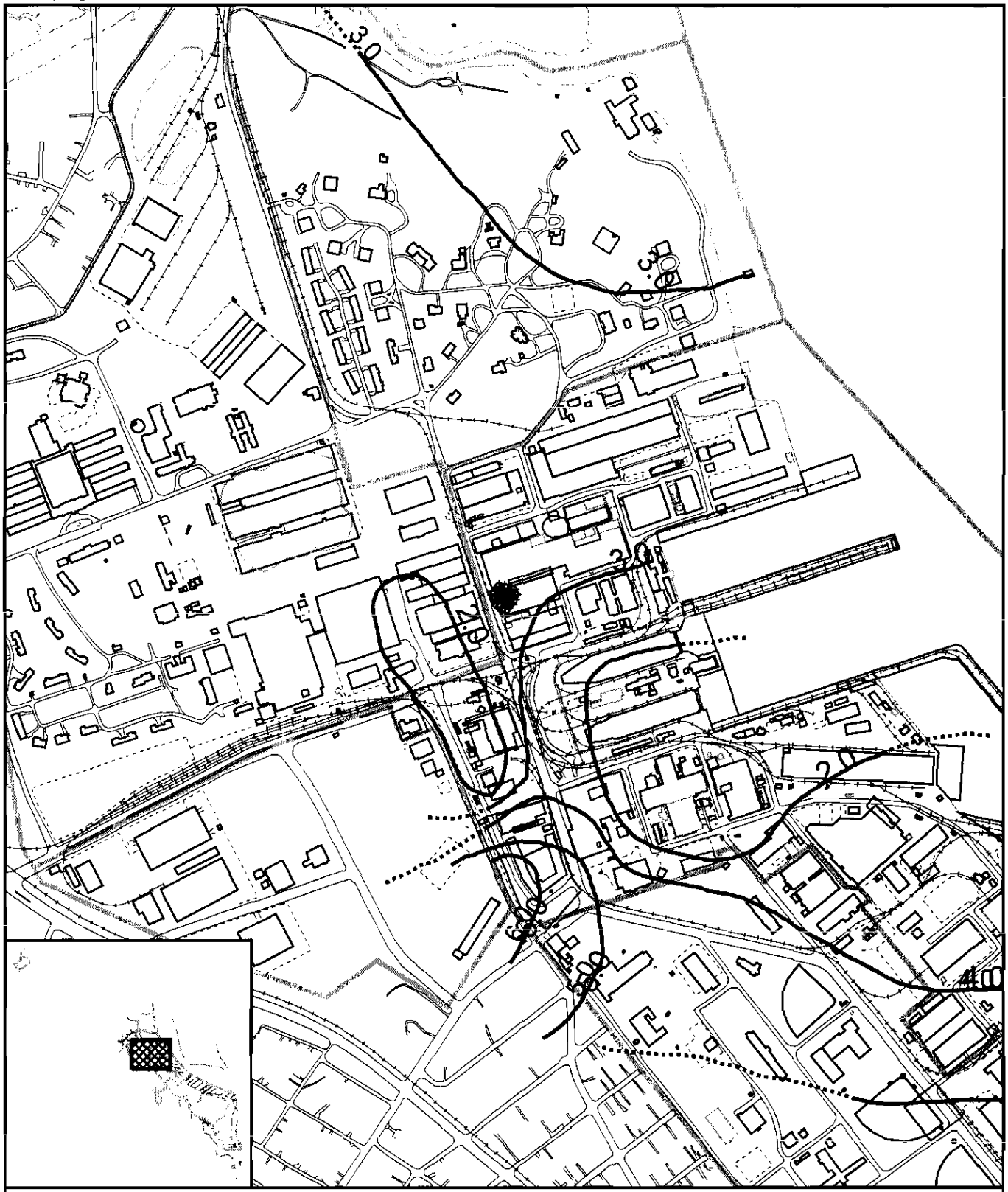

Figure 5
Deep Groundwater Elevations
SWMU 70, Zone E
Charleston Naval Complex

CH2MHILL

File Path: c:\paulsarcview\aprs\swmu70up.apr, Date: 30 Nov 2001 13:33, User: PFAVARA, UIC: Figure 5 Deep Groundwater Elevations

ATTACHMENT I-A

BORING LOGS

SOIL AND BORING COMPLETION LOG

BORING NUMBER : E070GP002

SHEET 3 of 2

PROJECT NUMBER : 158814

PROJECT : Charleston Naval Complex
DRILLING METHOD : GeoProbe
DRILLING CONTRACTOR : Columbia
START : April 4, 2001
FINISH : April 4, 2001
LOGGER : T. Belsel

NORTHING (ft) :
EASTING (ft) :
LOCATION : SWMU 25/70
GROUND SURFACE ELEVATION (ft msl) :
WATER LEVEL AND DATE (ft bgs) : Approx. 7 feet

DEPTH BELOW SURFACE (FT)	WATER LEVEL	SAMPLE NUMBER	SAMPLE RECOVERY	SAMPLE STANDARD PENETRATION 6"-6"-6" (N)	SAMPLE RECOVERY	SAMPLE SYMBOL	USCS SYMBOL	SAMPLE DESCRIPTION	COMMENTS
1								Asphalt	
2		1	75	na	75			Dense grey silty fine SAND, dry Compact mottled reddish brown to tan silty fine SAND, dry	
3								No recovery	
4								Compact tan fine SAND, damp	
5									
6									
7								Compact tan silty SAND, wet at approximately 7 feet	
8		2	100	na	100			Compact light brown to tan silty fine SAND, wet	
9									
10									
11									
12								Tan compact silty fine SAND, wet	
13									
14		3	100	na	100				
15								Reddish brown compact silty fine SAND, wet	
16								Compact reddish brown silty fine SAND, interbedded with 1" medium plastic CLAY, wet	
17									
18									
19									
20		4	100	na	100			Loose reddish brown silty fine SAND, wet	
21									
22								Dark tan fine to medium well sorted SAND, wet	
23								Dense dark olive grey silty low plasticity CLAY, trace fine to medium sand, wet (top of Ashley Formation)	
24									
25									

SOIL AND BORING COMPLETION LOG

BORING NUMBER : E070GP002

PROJECT NUMBER : 158814

PROJECT : Charleston Naval Complex
DRILLING METHOD : GeoProbe
DRILLING CONTRACTOR : Columbia
START : April 4, 2001
FINISH : April 4, 2001
LOGGER : T. Beisel

NORTHING (ft) :
EASTING (ft) :
LOCATION : SWMU 25/70
GROUND SURFACE ELEVATION (ft msl) :
WATER LEVEL AND DATE (ft bgs) : Approx. 7 feet

DEPTH BELOW SURFACE (FT)	WATER LEVEL	SAMPLE NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION 6"-6"-6"- (N)	SAMPLE RECOVERY	SYMBOL	USCS SYMBOL	SAMPLE DESCRIPTION	COMMENTS
26		5	100	na	100			Dense dark olive grey silty low plasticity CLAY, trace fine to medium sand, wet (Ashley Formation)	
27								Stiff dark olive grey CLAY interbedded with loose 2" to 3" stringers of olive grey silty fine to medium sand and shell	
28									
29									
30									
31									
32		6	100	na	100				
33									
34									
35									
36									
37									
38		7	100	na	100				
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

SOIL AND BORING COMPLETION LOG

BORING NUMBER : E070GP003

SHEET 4 of 2

PROJECT NUMBER : 158814

PROJECT : Charleston Naval Complex
DRILLING METHOD : GeoProbe
DRILLING CONTRACTOR : Columbia
START : April 4, 2001
FINISH : April 4, 2001
LOGGER : T. Beisel

NORTHING (ft) :
EASTING (ft) :
LOCATION : SWMU 25/70
GROUND SURFACE ELEVATION (ft msl) :
WATER LEVEL AND DATE (ft bgs) : Approx. 7 feet

DEPTH BELOW SURFACE (FT)	WATER LEVEL	SAMPLE NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION 6"-6"-6" (N)	SAMPLE RECOVERY	SAMPLE SYMBOL	USCS SYMBOL	SAMPLE DESCRIPTION	COMMENTS
1								Dense organic rich grey sandy SILT, dry (top soil)	
2								Dense mottled reddish brown to tan silty fine SAND, dry	
3								no recovery	
4									
5								Dense mottled brownish orange sandy silt, damp	
6									
7								Dense tan silty fine SAND, wet at approx. 7 feet	
8		2	100	na	100				
9								Very loose tan fine to medium well sorted SAND, wet	
10									
11								Dense well sorted fine to medium silty SAND, wet	
12									
13								Compact tan silty fine SAND, wet	
14		3	100	na	100				
15									
16								Compact well sorted silty fine to medium SAND, wet	
17								Compact mottled reddish brown to tan silty fine SAND, wet	
18									
19								Compact tan silty fine to medium well sorted SAND, wet	
20		4	100	na	100				
21								Compact tan silty fine to medium well sorted SAND, wet	
22								Grades into dense dark olive grey silty fine to medium SAND AND SHELL, interbedded with stiff dark olive grey clay (Top of Ashley Formation)	
23									
24									
25									

SOIL AND BORING COMPLETION LOG

BORING NUMBER : E070GP003

SHEET 2 of 2

PROJECT NUMBER : 158814

PROJECT : Charleston Naval Complex
DRILLING METHOD : GeoProbe
DRILLING CONTRACTOR : Columbia
START : April 4, 2001
FINISH : April 4, 2001
LOGGER : T. Beisel

NORTHING (ft) :
EASTING (ft) :
LOCATION : SWMU 25/70
GROUND SURFACE ELEVATION (ft msl) :
WATER LEVEL AND DATE (ft bgs) : Approx. 7 feet

DEPTH BELOW SURFACE (FT)	WATER LEVEL	SAMPLE NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION 6"-6"-6" (N)	SAMPLE RECOVERY	SYMBOL	USCS SYMBOL	SAMPLE DESCRIPTION	COMMENTS
26		5	100	na	100			Dense dark olive grey silty low plasticity CLAY, trace fine to medium sand, interbedded with 2" to 3" dark olive grey well sorted fine to medium sand	
27									
28									
29									
30									
31									
32		6	100	na	100				
33									
34									
35									
36									
37									
38		7	100	na	100				
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

SOIL AND BORING COMPLETION LOG

BORING NUMBER : E070GP007

SHEET 1 of 1

PROJECT NUMBER : 158814

PROJECT : SWMU 25/70
DRILLING METHOD : GeoProbe Acetate Sleeve
DRILLING CONTRACTOR : Columbia
START : April 4, 2001
FINISH : April 4, 2001
LOGGER : T. Belsel

NORTHING (ft) :
EASTING (ft) :
LOCATION : SMWU 25/70
GROUND SURFACE ELEVATION (ft msl) :
WATER LEVEL AND DATE (ft bgs) : approx 7 feet

DEPTH BELOW SURFACE (FT)	WATER LEVEL	SAMPLE NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION 6"-6"-6"- (N)	SAMPLE RECOVERY	SYMBOL	USCS SYMBOL	SAMPLE DESCRIPTION	COMMENTS
1								Asphalt	
2		1	50	na	50			Dense grey silty fine SAND, dry Compact brownish tan silty fine SAND, dry	
3									
4								No recovery	
5								Loose tan silty fine SAND, grades to silty medium SAND, wet at approximatly 7 feet	
6									
7									
8		2	75	na	75			Loose tan silty fine SAND, wet	
9									
10								Compact mottled tan to reddish brown silty fine SAND, wet	
11									
12								Compact tan silty fine SAND, wet	
13									
14		3	100	na	100			Tan moderatly plastic CLAY, wet	
15								Tan slightly plastic sandy CLAY, wet	
16								Dense mottled tan to reddish brown silty fine SAND, wet	
17									
18								Mottled tan to reddish brown sandy CLAY, interbedded with 2" stiff clay lenses, wet	
19									
20		4	100	na	100			Compact tan silty fine SAND, wet	
21									
22								Mottled compact tan to dark red silty fine to medium SAND with 1" to 2" interbedded stiff CLAY stringers, wet	
23									
24								Ashley Formation Dense dark olive silty CLAY, wet	
25									

SOIL AND BORING COMPLETION LOG

BORING NUMBER : E070GP009

SHEET 2 of 2

PROJECT NUMBER : 158814

PROJECT : Charleston Naval Complex
DRILLING METHOD : GeoProbe
DRILLING CONTRACTOR : Columbia
START : April 3, 2001
FINISH : April 3, 2001
LOGGER : T. Belsel

NORTHING (ft) :
EASTING (ft) :
LOCATION : SWMU 25/70
GROUND SURFACE ELEVATION (ft msl) :
WATER LEVEL AND DATE (ft bgs) :

DEPTH BELOW SURFACE (FT)	WATER LEVEL	SAMPLE NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION 6"-6"-6"- (N)	SAMPLE RECOVERY	SAMPLE SYMBOL	USCS SYMBOL	SAMPLE DESCRIPTION	COMMENTS
1								Concrete	
2		1	50	na	50			Compact brownish tan silty fine SAND, dry	
3								No recovery	
4									
5								Compact reddish brown sandy SILT, damp	
6								Compact reddish brown sandy SILT interbedded with brownish tan silty fine SAND, wet	
7									
8		2	75	na	75			No recovery	
9								Compact silty fine SAND interbedded with reddish brown silty fine SAND, wet	
10								Compact tan silty fine SAND, wet	
11									
12								Compact tan silty fine SAND, wet	
13									
14		3	100	na	100				
15									
16								Compact tan fine SAND, wet	
17									
18									
19									
20		4	100	na	100			Compact reddish brown silty fine SAND interbedded with 1" to 2" medium plastic grey CLAY stringers at 19.5 to 20 feet	
21								Very loose light tan fine SAND, wet, "flowing sand"	
22								Compact dark tan fine SAND, wet	
23									
24									
25								Very loose tan fine SAND, likely caved in from above, wet	

SOIL AND BORING COMPLETION LOG

BORING NUMBER : E070GP009
SHEET 2 of 2

PROJECT NUMBER : 158814

PROJECT : Charleston Naval Complex
DRILLING METHOD : GeoProbe
DRILLING CONTRACTOR : Columbia
START : April 3, 2001
FINISH : April 3, 2001
LOGGER : T. Beisel

NORTHING (ft) :
EASTING (ft) :
LOCATION : SWMU 25/70
GROUND SURFACE ELEVATION (ft msl) :
WATER LEVEL AND DATE (ft bgs) :

DEPTH BELOW SURFACE (FT)	WATER LEVEL	SAMPLE NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION 6"-6"-6" (N)	SAMPLE RECOVERY	SYMBOL	USCS SYMBOL	SAMPLE DESCRIPTION	COMMENTS
26		5	100	na	100			Dense mottled reddish brown to tan silty fine SAND with 2" to 3" medium plastic grey CLAY stringers, wet	
28								Dense mottled reddish brown to tan fine SAND with 1" to 2" grey CLAY stringers, wet	
32		6	50	na	50			Dense mottled reddish brown to tan silty fine SAND, wet	
35								Ashley Formation Dense dark olive silty medium SAND with 2" to 3" clay stringers, wet	
38		7	100	na	100				
44		8	100	na	100				
50		9	100	na	100				