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FINAL CONTAMINATION ASSESSMENT REPORT ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY/METHODOLOGY AT SOLID WASTE MANAGEMENT UNIT 15 AND BUILDING 191 AREA NS MAYPORT FL

9/1/1998

ICON ENVIRONMENTAL SERVICES

FINAL CONTAMINATION ASSESSMENT REPORT

ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY / METHODOLOGY AT THE SWMU 15 AND BUILDING 191 AREA NAVSTA MAYPORT, FLORIDA

FILE **Contract No. N47408-96-C-7246** FILE

Prepared For:

NAVAL FACILITIES ENGINEERING SERVICE CENTER (NFESC) PORT HUENEME, CALIFORNIA

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September 29, 1998

Attn: Mr. Randy Bishop
Receiving Officer, Code N4E4
NAVSTA Mayport
Environmental Division
Naval Station Mayport
Mayport, FL 32228-0067
(904) 270-6730 xtn 13

Subject: **Final Contamination Assessment Report, Additional Assessment Using Innovative Technology/Methodology at the SWMU 15 and Building 191 Area, NAVSTA Mayport, Florida; Contract No. N47408-96-C-7246**

Dear Mr. Bishop,

ICON Environmental Services, Inc. (ICON) submits the referenced report. The distribution has been made according to the list at the end of this letter. Comments on the Draft Contamination Assessment Report were issued by Ms. Martha Berry, Remedial Project Manager at EPA. No other comments were issued by reviewing parties. Comments were addressed and incorporated into this Final report as follows:

1.0 General Comments

Ms. Berry provided an overview of direct-push well technology, and indicated that the project objectives were accomplished: [a] the delineation of the groundwater contamination using the DPW technology and conventional wells; and [b] a demonstration and evaluation of the DPW technology with conventional technology. We are in agreement that additional data are needed to conduct a statistical evaluation of sampling comparisons between the two technologies. As Ms. Berry indicated, there existed some significant bias between laboratory results of samples from the DPW and conventional wells. However, ICON submits that during this study, and in all other projects in which this technology is utilized, we invariably note higher laboratory results in samples from DPWs as compared to conventional wells. Since the DPW technology does not introduce concentrations of contaminates of concern, the only conclusion that can be made is that a more discrete sample is acquired from DPW wells as compared to conventional wells. This bias may possibly result from dilution by cleaner higher-permeability stringers encountered in conventional wells, aggravated by an additional two feet of filter sand over a five foot screen, larger diameter of disturbed aquifer, etc.

2.0 Specific Comments

2.1 All references to Figure 1-1 in Section 2.0 were corrected to reference Figure 2-1.

2.2 We agree that in order to conduct a statistically sound evaluation of the DPW technology, that additional rounds of sampling should be performed. Three sets of twinned DPW/conventional wells were installed at Building 191, and one set at the SWMU 15 site.

2.3 The observed concentrations of PCE, TCE and DCE in DPW wells at Building 191 were 25% to 100% greater than those from conventional wells at DPW2d/MW07d. When concentrations are near the detection limit, these differences are not as great. Ms. Martha Berry suggested that contaminant concentrations in the hot spot area where DPW technology was used should be evaluated further. ICON suggests that this could be accomplished through several events of concurrent sampling of the paired wells DPW2d/MW07d and other wells in the area for laboratory analysis of Halocarbons. ICON suggests that these data differences are likely to continue because DPW2d was installed with much less disturbance to the surrounding aquifer as compared to the adjacent conventional well MW07d. Additionally, two feet of sand filter pack extends above the conventional well screen providing additional dilution to the well, assuming that the higher concentrations are located at the base of the zone, immediately above the clay. As previously mentioned, the installation and sampling of DPW2d did not contribute to the observed levels of PCE, TCE or DCE in the groundwater samples.

The calculated hydraulic conductivity values obtained from slug testing the DPWs are generally smaller than those obtained from the conventional wells. All results are within the same order of magnitude, which is the general accuracy of slug tests. It should be noted that in general, the DPW test more often results in a linear straight-line plot (7 of the 11 tests conducted at Building 191), as compared to the conventional wells which in three tests exhibited double or triple-straight line plots. Therefore, interpretation of the DPW slug test data is less ambiguous because of the lack of a sand filter pack that otherwise could contribute to multiple straight-line effects.

2.4 The calculation of hydraulic conductivity based on slug test analysis was evaluated using the Bouwer and Rice method. As per the method, if the screen is fully saturated during the test, the falling head results should mirror the rising head result. In actuality, the falling head test is easier to conduct (by the addition of water to the well) in DPWs because of the small diameter of the DPW. Because of the ambiguity associated with multiple straight-line plots in some of the data, those wells exhibiting multiple straight-line plots were recalculated as presented in Sections 3 and 4, and Appendix G. If an outlier resulted from either early or late straight-line data plot, that outlier was flagged and not used in calculation of groundwater flow velocity. Outliers were determined based on results of retesting if the data were available, and/or the result was generally resulting from the early straight-line portion of the data, indicative of a development skin. Other than outliers, data were averaged into one value for calculation of mean groundwater flow velocity.

2.5 The method of comparing hydraulic conductivity values and lab results as presented in the draft reports was more accurately a percent difference (versus relative percent difference), because the "true" value was not known. We simply compared the difference in results for each measured parameter. In reference to analytical results of DPW2d / MW07d at Building 191, we had available a preliminary sample in May 1997, and a resample result with a blind duplicate in September 1997 for DPW2d. We had only one result in September 1997 for the adjacent conventional well MW07d. We recalculated the relative percent difference using the DPW as the "true" value. The DPW results were chosen as the true result because: a) we had available resampling and duplicate data, thereby increasing the confidence in the DPW result and b) at higher concentrations, the DPWs generally yield higher results, and because constituents are not concentrated or added to groundwater samples, the higher results have to be more representative of the discrete screened interval. Recalculated results for lab results are as follows:

Parameter (ug/L)	DPW2d	MW7d	RPD (%)	DPW8s	MW8s	RPD (%)	DPW8i	MW8i	RPD (%)[1]
Tetrachloroethene	200/280[2]	160	20/43	nd	nd	0	<1.0	1.4	-40
Trichloroethene	950/980[2]	610	36/38	1.2	<1	16	<1.0	1.0	0
Chloroform	nd	Nd	0	nd	nd	0	<1.0	2.0	-100
1,1-Dichloroethane	nd	Nd	0	nd	nd	0	14	<1	93
cis-1,2-Dichlorethene	150/150[2]	75	50	nd	nd	0	nd	nd	0

1 - detection limit used in calculating %RPD; 2 - two results indicate the sample and its blind duplicate.

Using similar analysis for hydraulic conductivity results for Building 191 wells yields:

Test Results (ft/day)	DPW2d Falling Head	MW7d Rising Head	RPD between wells (%)
Test 1 - 8/28/97 (avg of early&late)	31.83	70.33	-120.9 %
Test 2 - 8/28/97 (avg of early&late)	33.68	114.86	-241 %
% difference between tests	*5.5 %*	38.7 %	
	DPW8s Falling Head	MW8s Falling Head	
Test 1 - 9/2/97	26.65	23.07	*13.4 %*

As stated in the draft document, the DPWs yielded a single straight line plot in seven of eleven tests, and the conventional wells yielded double or triple straight line plots in all three tests. Interpretation of conventional well tests was thus more subjective.

2.6 The cost of borehole geophysical logging is not included in the cost comparison between DPW and conventional wells. This is because the geophysical surveys were used for both the conventional and DPW well screen design during this demonstration project.

The use of geophysical surveys is integral to DPW installation, and is comparable to continuous core sampling associated with conventional well installation. Continuous core sampling was not conducted for the conventional wells installed for this project. Such a comparison would therefore have to be based on past project experience. Typical historical results indicate that two 70-foot deep borings for characterization of lithology can be drilled and geophysically logged within 6 hours. Additionally, a "through pipe" log using direct push methods can be completed and grouted within 45 minutes, and would generate no cuttings. Lithological characterization using continuous coring for the same two borings would require approximately 15 hours, and would result in more soil cuttings.

It has been a pleasure completing this project for you and the US Navy. We welcome any future questions concerning this project. Should you have any specific questions or comments, feel free to call us at (225) 769-2073.

Sincerely,

ICON Environmental Services, Inc.

Gregory Miller, P.G.

1.0 INTRODUCTION

1.1 INTRODUCTION

Two sites at the Naval Station Mayport (NAVSTA), Florida reported soil and groundwater contamination, and were categorized as eligible for an Innovative Technology demonstration project under the Navy Environmental Leadership Program (NELP) program. Each site has had a complete delineation of shallow soil impact requiring no further soil assessment. Each site had confirmed groundwater impact, requiring further investigation to define horizontal and vertical extent of groundwater impact. ICON Environmental Services, Inc. (ICON) was retained by the US Department of the Navy to implement delineation of groundwater impacts at each site using innovative technology.

1.2 PROJECT OVERVIEW

The overall objectives of the project were twofold: 1) the horizontal and vertical delineation of groundwater impact using technically defensible groundwater sample results; and 2) the innovative technology demonstration including data to evaluate the operating range of the technique, the precision of the sampling technique, and the relative cost of the technique.

The following tasks were conducted at both of the project sites:

- Detailed vertical characterization of subsurface geology, using modified borehole geophysical logging equipment; the primary objectives were to determine the lateral extent of low-permeability sediments within the thick permeable zones previously identified at the sites;
- Installation of direct-push monitoring wells, throughout the area of concern. These wells were vertically stratified to ensure horizontal and vertical delineation of groundwater impact;
- Installation of conventionally-installed monitoring wells adjacent to selected direct-push wells, to allow comparison to the conventional installation;
- Groundwater sampling and aquifer testing of direct-push wells, existing wells, and new conventionally installed wells.

The project objectives (horizontal and vertical delineation of groundwater impact, and innovative technology demonstration) were addressed at each site as follows:

- Two perimeter boreholes were drilled at SWMU 15 and Building 191 to a depth of approximately 65 feet using rotary wash drilling technique (Figure 2-1and 2-2). Layne Environmental Drilling provided drilling services using a Gus Pech drilling rig with a 5" x 6" mud pump. These perimeter borings were geophysically logged using: natural gamma (calibrated to API standard), natural gamma (counts per second), spontaneous potential (SP), single point resistance, and 6" normal resistivity. Several existing monitoring wells at SWMU 15 were logged through casing using natural gamma, and several direct push borings were logged using natural gamma through steel casing at Building 191.
- During the initial phase of the project (April and May 1997), direct-push wells (DPWs) were installed, fifteen at Building 191 and seventeen at SWMU 15. Direct push wells were nested, with two or more screened intervals (depths) at one location. DPW driving was accomplished by either direct pushing with rig hydraulics in combination with the weight of the drill rig (Gus Pech) or by hammering with a downhole air hammer supplied by the air compressor installed on the drill rig. All DPWs were completed with flush-grade surface completions, and were developed by pumping with a peristaltic pump. Upon receipt of the lab results from the initial phase of the project, our contract was modified to include nine additional DPWs at Building 191 to further delineate the groundwater plume, and one additional DPW at SWMU 15. These additional DPWs and the conventional wells were installed in August and September 1997.
- Three conventional monitoring wells twinned adjacent to DPWs at each site were originally planned; however, upon evaluation of preliminary results, Navy personnel requested that two of the conventional monitoring wells at SWMU 15 be installed as stand-alone wells to provide additional lateral data on Arsenic concentrations. The conventional wells were installed using the hollow-stem auger drilling technique, and soil samples were acquired for lithology using split spoon samplers. Conventional wells were constructed with a five foot screened interval, adjacent to DPWs with the same screened interval (if twinned). Some of the conventional wells installed below the first groundwater zone included isolation casing to minimize potential carry down. The

conventional wells provided samples and aquifer test data that the direct-push well samples can be compared to in order to assess the precision of the innovative technology.

- ICON conducted sampling and head measurements of direct push wells, and all existing monitoring wells. Groundwater samples were sent to Quality Analytical Laboratories (QAL, CH_2M Hill Labs), a Navy-approved subcontracted offsite analytical laboratory. Falling head insitu tests were conducted in twinned DPWs and adjacent conventional wells, and data was evaluated for comparative analysis.

1.3 PREVIOUS INVESTIGATIONS

The two sites at Naval Station Mayport include: Building 191 Area, an active warehouse facility with tetrachloroethene (PCE) groundwater impacts; and Solid Waste Management Unit (SWMU) 15, listed in the HSWA permit as requiring a RCRA Facility Investigation (RFI) for pesticide impact (benzene hexachloride and arsenic). The history and characteristics of each site follows.

1.3.1 BUILDING 191 AREA

A contamination assessment was conducted in 1994, for the release of diesel fuel from underground piping associated with an aboveground storage tank located on the south side of Building 191. Tetrachloroethene (PCE) was detected in one of the wells on the north site of the building. A groundwater assessment targeting PCE was conducted in May 1995. The assessment included the installation of six (6) shallow monitoring wells (MPT-TC-MW01s through MPT-TC-MW06s) screened at a range of 2.5 to 14 feet bls, and one deeper well (MPT-TC-MW01I) screened at 35 to 40 feet bls. Organic analytes detected in groundwater were reported in the *SWMU Assessment Report for TCE Release near Building 191, US Naval Station Mayport, Florida, 1996* as follows:

Parameter (ug/L)	MPT-TC-MW2s (27-Jun-95)	MPT-TC-MW4s (27-Jun-95)	MPT-TC-MW05s (26-Jun-95)[2]
Tetrachloroethene	Nd[1]	26	100 / 73
Trichloroethene	Nd	9	10 / 8
Chloroform	11	Nd	Nd
1,2-Dichloroethene	Nd	1 J	1 J
Bromodichloromethane	5	Nd	Nd
Dibromochloromethane	1 J	Nd	Nd

1 – Nd – not detected; 2 - two results indicate the sample and its blind duplicate; J – estimated value.

Wells MW04s and MW05s are located on the north side of Building 191, and MW02s is located on the south side of the building. None of these compounds were detected in subsurface soil samples (2-3 feet bls) analyzed during that sampling event.

Groundwater occurred at water table conditions at an average depth of 4.5 feet below land surface. Potentiometric data indicated groundwater flow to the west at an average hydraulic gradient of 0.009.

1.4.2 SWMU 15

Pesticides and application equipment were stored in a covered shed east of Building 48A during 1963 and 1964. As a result of probable washing and rinsing activities, area soils and groundwater exhibit impact from pesticides. An initial investigation of SWMU 15 was conducted in 1993, and additional sampling was conducted in 1994.

Surface soil samples were acquired and the following compounds were detected: 4-4'-DDE, 4,4'-DDT, Chlordane, Heptachlor, and Heptachlor epoxide; additionally, Arsenic and Beryllium were detected at concentrations that exceeded benchmark concentrations. Shallow soil sample data indicated that shallow pesticide impact occurs in numerous "hot spots" at the surface, with minimal downward migration.

Groundwater was sampled utilizing six shallow monitoring wells (MPT-15-MW01s through MPT-15-MW05s) screened at a maximum depth of 18 feet bls, and on well (MPT-15-MW5I) screened at 25-30 feet bls. Pesticides were detected in two of the wells, including alpha-, beta-, and gamma-benzene hexachloride (BHC). Arsenic and Sodium were also detected at levels above benchmark and background screening concentrations. A summary of these detected compounds is as follows:

Parameter (ug/L)	MPT-15-MW01s (27-Jun-95)	MPT-15-MW02s (27-Jun-95)	MPT-15-MW03s (27-Jun-95)	MPT-15-MW04s (27-Jun-95)	MPT-15-MW05s (27-Jun-95)	MPT-15-MW05i (27-Jun-95)
Arsenic	9J / 10.4	0.7J	1.6J	62J	nd[1]	2.9J
Benzene Hexachloride (total)	0.927	nd	nd	3.83	nd	nd

1 – nd – not detected; 2 - two results indicate the sample and its blind duplicate; J – estimated value.

Groundwater occurred at shallow depths, generally within 4 feet below land surface. Potentiometric data indicated groundwater flow to the northwest at an average hydraulic gradient of 0.004.

1.4 REPORT ORGANIZATION

The success of the innovative technology demonstration is discussed in a separate report entitled Direct-Push Well (DPW) Innovative Technology Evaluation Report, Additional Assessment Using Innovative Technology at the SWMU 15 and Building 191 Area, NAVSTA, Mayport, Florida, ICON, January 1997.

Methodology used at both sites is discussed in Section 2.0 of this report. Results of assessment at Building 191 are presented in Section 3.0, and results of assessment at SWMU 15 are presented in Section 4.0. A summary is presented in Section 5.0.

3.0 RESULTS OF ASSESSMENT AT BUILDING 191

3.1 SUBSURFACE GEOLOGY

Subsurface geology was characterized using data from: previously installed wells (hollow stem auger borings); two open hole borings (MPT-TC-B1 and MPT-TC-B2) in which one was core sampled and both were geophysically logged; three pushed borings in which natural gamma was logged through the drive assembly (MPT-TC-DP3 through MPT-TC-DP5); and from the borings of conventional wells installed during this study (hollow stem auger). Boring locations can be found on Figure 3-1.

The open-hole borings were continuously sampled to 20 feet (bls), and sampled at five-foot centers to 65 feet (bls). Core samples were obtained using split-spoon core barrels, advanced using the rig hammer following the guidance of American Society for Testing Materials (ASTM-D1586-84). The blow counts were recorded and used to identify relative changes in the density of material at each sample interval. Core samples were visually described based on the Unified Soil Classification System. Upon completion of core sampling the boring was geophysically logged.

Log interpretations at Boring MPT-TC-B1 (correlated to cores from that boring) were then correlated to the geophysical log at open-hole Boring MPT-TC-B2 across the area of interest, and to three through-casing gamma ray logs in the area of interest (MPT-TC-DP1 through MPT-TC-DP3). Cross sections with subsurface geology were generated based on the geophysical log data and are presented in Figures 3-2 and 3-3. Subsurface geology across the site from west to east was generally consistent from surface to approximately 65 feet (bls) and is as follows:

Depth **<u>Feet (bls)</u>**	**<u>Description</u>**
0.0' - 33.0'	Poorly Sorted Sand (SP), dark gray, shell layers and fragments, worm reef (3") at 24 feet (bls), herein denoted *Zone "A"*. This zone extends to 41.0 feet (bls) in the western section of the project area.
33.0' - 36.0'	Silty Clay (CL), gray, sand and shell lenses.
36.0' - 39.0'	Silty Sand (SM), gray with sand lenses, herein denoted *Zone "B"*. This zone exists only in the eastern section of the project area.
39.0' - 43.0'	Sandy Clay (SC), gray-green, with sand lenses .

Depth Feet (bls)	Description (continued)
43.0' - 47.0'	Silty Sand (SM), dark gray, clayey with shell fragments, shell reef (3") near base of zone, herein denoted *Zone "C"*.
47.0' - 49.0'	Silty Clay (CL), dark gray with shells and shell fragments,
49.0' - 64.0'	Poorly Sorted Sand (SP), dark gray, shell layers and fragments.

Sediments beneath Building 191 were probably deposited in a marine environment within the tidal delta offshore bar area.

3.2 GROUNDWATER FLOW

Additional wells and DPWs were installed at Building 191 during the September 1997 sampling event. The potentiometric elevation on September 3, 1997 in each well is summarized on Table 3-1, and was used to generate the potentiometric contour map presented as Figure 3-4. Because of a significant vertical hydraulic gradient, potentiometric maps were drawn on a layered basis for the following screened intervals:

Top of Zone A
Groundwater flow generally to the west shifting to the southwest along the southern site boundary, with apparent hydraulic loading (mounding) in the northeast, possibly related to leaky water lines; average horizontal hydraulic gradient of 0.029 in the northeast, and 0.0006 elsewhere across the site.

Mid-Zone A
Groundwater flow generally to the west in the northern half, and to the south in the southern half of the site at an average horizontal hydraulic gradient of 0.001.

Base of Zone A
Similar flow pattern to that in Mid-Zone A, with a similar average horizontal hydraulic gradient of 0.001.

Zone C
Groundwater flow to the west with gradually increasing gradient to the east at an average horizontal hydraulic gradient of 0.004.

The vertical potentiometric hydraulic gradient is illustrated in cross section diagrams as Figures 3-5 (east-west) and 3-6 (north-south). The area of mounding at the top of Zone A in the northeast portion of the site (Figure 3-4), combined with an upward vertical hydraulic gradient near DPW1 and DPW3 clusters, results in a lower potentiometric elevation at the Base of Zone A and in Zone B as compared to zones above and below. The vertical gradient flattens and is negligible at the northwest corner of the site. A downward vertical hydraulic gradient of 0.032 was observed to the west and south near clusters DPW8 and DPW7. The vertical gradient exceeded the horizontal gradient in this area.

Results of twinned DPW-conventional wells screened at identical vertical intervals for purposes of the technology evaluation yielded a maximum difference in hydraulic head of 0.03 ft. This data suggests that hydraulic head from the DPWs is representative of actual conditions.

3.3 GROUNDWATER CHEMISTRY

3.3.1 Data Validation

Samples from two sampling events (May and September 1997) were sent to CH_2MHill Analytical Services, Montgomery, Alabama (formerly QAL, Inc.). Groundwater samples were analyzed for Purgeable Halocarbons as per SW-846 Method 8010A-modified. A summary of the laboratory data validation is included in Appendix H1.

The May 1997 samples were shipped as a single batch, and included 17 groundwater samples, two (2) equipment rinsate samples, two (2) field duplicates, and one (1) trip blank. The laboratory package indicated that 4 method blanks were run. All results were determined to be usable, resulting in a completeness of 100%. Chain of custody records were in agreement with laboratory information. Analyses were conducted within method holding times, surrogate recoveries were within method limits, and matrix spike/LCS samples were within required limits. No blank contamination was detected. Documentation necessary to verify initial and continuing calibrations was not available, but the lab package stated that all calibration acceptance criteria were met.

The September 1997 samples were shipped as a single batch, and included 13 groundwater samples, one (1) equipment rinsate sample, one (1) field duplicate, and one (1) trip blank. The laboratory package indicated that 4 method blanks were run. All results were determined to be usable, resulting in a completeness of 100%. Chain of custody records were in agreement with laboratory information. Analyses were conducted within method holding times, surrogate recoveries were within method limits, and matrix spike/LCS samples were within required limits. No blank contamination was detected. Documentation necessary to verify initial and continuing calibrations was not available, but the lab package stated that all calibration acceptance criteria were met.

3.3.2 Summary of Results

A summary of field and laboratory results is included in Table 3-2. Copies of the Laboratory Report are included in Appendix F1. Because of the low concentration and sporadic detection of target analytes, approximate areas of contaminant occurrence in each zone are indicated as hatched zones on Figure 3-7, instead of the more common presentation using isopleth contours. To exhibit the vertical distribution of groundwater impact, laboratory results are presented on cross-section diagrams in Figures 3-8 and 3-9.

Note that the well designations *s,i,d* refer only to the relative screened depth at a particular well cluster, and do not indicate an absolute depth of the screened interval. Because of this, discrete groundwater bearing zones have been designated as *Zone A* through *Zone C* in this report.

In general, the highest concentration (160 to 980 ug/L) of purgeable Halocarbons consisted of Tetrachloroethene (PCE) and Trichloroethene (TCE), detected in one small area north of Building 191 in the twinned wells DPW2d / MW07d, both screened at the base of Zone A. All parameters were non-detect (<1 ug/L) in the mid and upper portion of Zone A at the same location (DPW2s & DPW2d). The compound cis-1,2-Dichloroethene was also detected in the twinned wells DPW2d/MW07d, at concentrations of 75 to 150 ug/L. This compound is frequently cited as a degradation compound of PCE under reducing groundwater conditions, and was also detected at low concentrations (less than 6 ug/L) in DPWs to the west screened at the base of Zone A, and in Zones B and C (Figures 3-1 and 3-3). Other compounds detected at low concentrations (23 ug/L or less), generally to the west and southwest of DPW2d included 1,1-Dichloroethane and 1,1-Dichloroethene.

Another detected compound that appears to be unrelated to those previously cited was Chloroform, sporadically detected at low concentrations (less than 3.1 ug/L) in top- and mid-Zone A at DPW4, and at the base of Zone A at the DPW8 cluster.

Detected analytes were compared to benchmark concentrations, and are presented in Table 3-3. The source of benchmark values is denoted on the table. Three wells (or twinned DPW/well cluster) exhibited groundwater analyte concentrations exceeding benchmark values, as follows:

Well	Compounds Exceeding Benchmark Values
DPW2d / MW7d	Tetrachloroethene
	Trichloroethene
	cis-1,2-Dichloroethene
MW04s	Tetrachloroethene
DPW7d	1,1-Dichloroethene

Results of three sets of twinned DPW-Conventional wells screened at identical vertical intervals were evaluated for the technology demonstration using data from the September 1997 sampling event. In general, results of the DPW samples were approximately 20 - 30 % higher as compared to samples from conventional wells. Results of resampling the same DPW (May - September events) yielded differences of approximately 50%; and results of blind duplicate analysis during the same sampling event of the same DPW yielded an average difference of 22%. The compound cis-1,1-Dichloroethene was not detected in MPT-TC-DPW2d during the May 1997 event, but was detected at 150 ug/L during the September 1997 event. Laboratory variability was clearly higher than the variability between DPWs and conventional wells.

3.4 MEAN GROUNDWATER FLOW VELOCITY

Twinned DPWs/conventional wells in which insitu radial hydraulic conductivity testing was conducted at Building 191 included:

MPT-TC-DPW2d / MPT-TC-MW7d (falling head test vs. rising head test)
MPT-TC-DPW8s / MPT-TC-MW8s (both falling head tests)

The theory of the Bouwer and Rice Method states that falling head data should mirror rising head data in the same well; however, experience of this author suggests that differences may result from these two methods. Each of these twinned well clusters are screened well below the static water level, and were modeled as partially penetrating wells. Other wells tested included DPW2i, DPW2d, DPW7i, DPW7d, DPW9s, and DPW9i. The drawdown curves (Appendix G1) indicate that the DPW data results in a more linear curve as compared to the conventional wells. Out of 11 DPW tests (multiple tests on some DPW wells), 7 exhibited a single straight line slope, and 4 exhibited double-straight line effects. Of three conventional well tests (multiple tests of MW7D), two exhibited double-straight line effects, and one (MW8S) exhibited triple-straight-line effects.

Publications suggest that late time data be used in slug test evaluation of data exhibiting double-straight line effects, to eliminate potential effects of an overdeveloped well bore skin *(Wellbore Skin Effect in Slug-Test Data Analysis for Low-Permeability Geologic Materials, Yang & Gates, Ground Water, Vol. 35,Number 6, Nov/Dec, 1997)*. Results of data evaluation using both early and late straight line data from Building 191 wells are presented as follows:

Slug Test Results DPW and Conventional Wells	Location	Zone	Hydraulic Conductivity (ft/day)
DPW2s – Test 1 (early/late)	North of 191	Top of Zone A	5.02# / 2.33
DPW2s – Test 2 (linear plot)	North of 191	Top of Zone A	1.89
DPW2i - Test 1 (linear plot)	North of 191	Mid Zone A	27.76
DPW2i – Test 2 (linear plot)	North of 191	Mid Zone A	27.21
DPW2d - Test 1 (early/late)	North of 191	Base Zone A	46.31 / 17.34
DPW2d – Test 2 (early/late)	North of 191	Base Zone A	46.15 / 21.2
MW07D – Test 1 (early/late)*	North of 191	Base Zone A	153.86# / 70.33
MW07D – Test 2 (early/late)*	North of 191	Base Zone A	177.88# / 114.86
DPW7i – (linear plot)	South of 191	Base Zone A	73.39
DPW7d – (linear plot)	South of 191	Zone C	13.98
DPW8s – (early/late)	West of 191	Mid Zone A	39.84 / 13.45
MW08S – (early/middle/late)	West of 191	Mid Zone A	97.73# / 39.34 / 6.79
DPW9s – (linear plot)	North of 191	Base Zone A	10.89
DPW9I – (linear plot)	North of 191	Zone B	1.43

* - Results are for rising head test; all other tests were falling head.
\# - Result is viewed as outlier due to either suspected skin effect, or retesting results.

Results viewed as probable outliers due either to suspected skin effects or to retesting results are not included in hydraulic conductivity evaluation. All other results per screened interval are averaged for purposes of flow velocity evaluation. Reports of previously conducted insitu radial hydraulic conductivity testing at Building 191 were made available to ICON. The range in hydraulic conductivity in shallow wells screened at zones analogous to the "Top of Zone A" were: (north of Building 191) 1.4 to 11.4 ft/day; and (south of 191) 11.5 – 20.5 ft/day. The wells tested at Building 191 in similarly screened zones include DPW2s (screened 3-8 feet bls) and MW8s/DPW8s (screened at 10 – 15 feet bls), with results of 2.11 ft/day and 24.86 ft/day (average) correlate well to previously reported data.

The average linear velocity in the direction of horizontal groundwater flow can be calculated using an assumed effective porosity of 0.35, the measured horizontal hydraulic gradient, and the average hydraulic conductivity (ft/day) as follows:

$v = (K)(i) / (n)$, where : K (hydraulic conductivity) [ft/day]
i (hydraulic gradient) [ft/ft – dimensionless]
n (porosity) = [dimensionless]

Calculated average linear groundwater flow velocities using the gradient observed on the September 1997 event are as follows:

Wells	Zone	Hydraulic Conductivity (ft/day)	Hydraulic Gradient	Average Linear Groundwater Flow Velocity (ft/year)
DPW2s	Top of Zone A	2.11	0.0011	2.42
DPW2i	Mid Zone A	27.49	0.0018	51.6
DPW2d / MW8s	Base Zone A	52.7	0.0016	87.93
DPW7i	Base Zone A	73.39	0.002	153.1
DPW7d	Zone C	13.98	0.0016	23.3
DPW8s / MW8s	Mid Zone A	24.86	0.0006	15.56
DPW9s	Base Zone A	10.89	0.0011	12.5
DPW9i	Zone B	1.43	0.0015	0.78

These calculations indicate that contaminant transport is expected to be at the fastest rate at the Base of Zone A. The distribution of detected compounds as indicated on Figure 3-7, supports the calculations.

probable

The most ~~probably~~ source of impact to groundwater at Building 191 is landfill debris, believed to be located beneath Building 191. Landfill debris was encountered in borings west of Building 191 (MPT-TC-DPW8 cluster). PCE and TCE were detected in groundwater at the Base of Zone A, and apparent secondary plumes of degradation compounds (1,1-DCA, cis-1,2-DCE) appear to be migrating through advection and dispersion in that zone, and in lower zones (Zone B and Zone C).

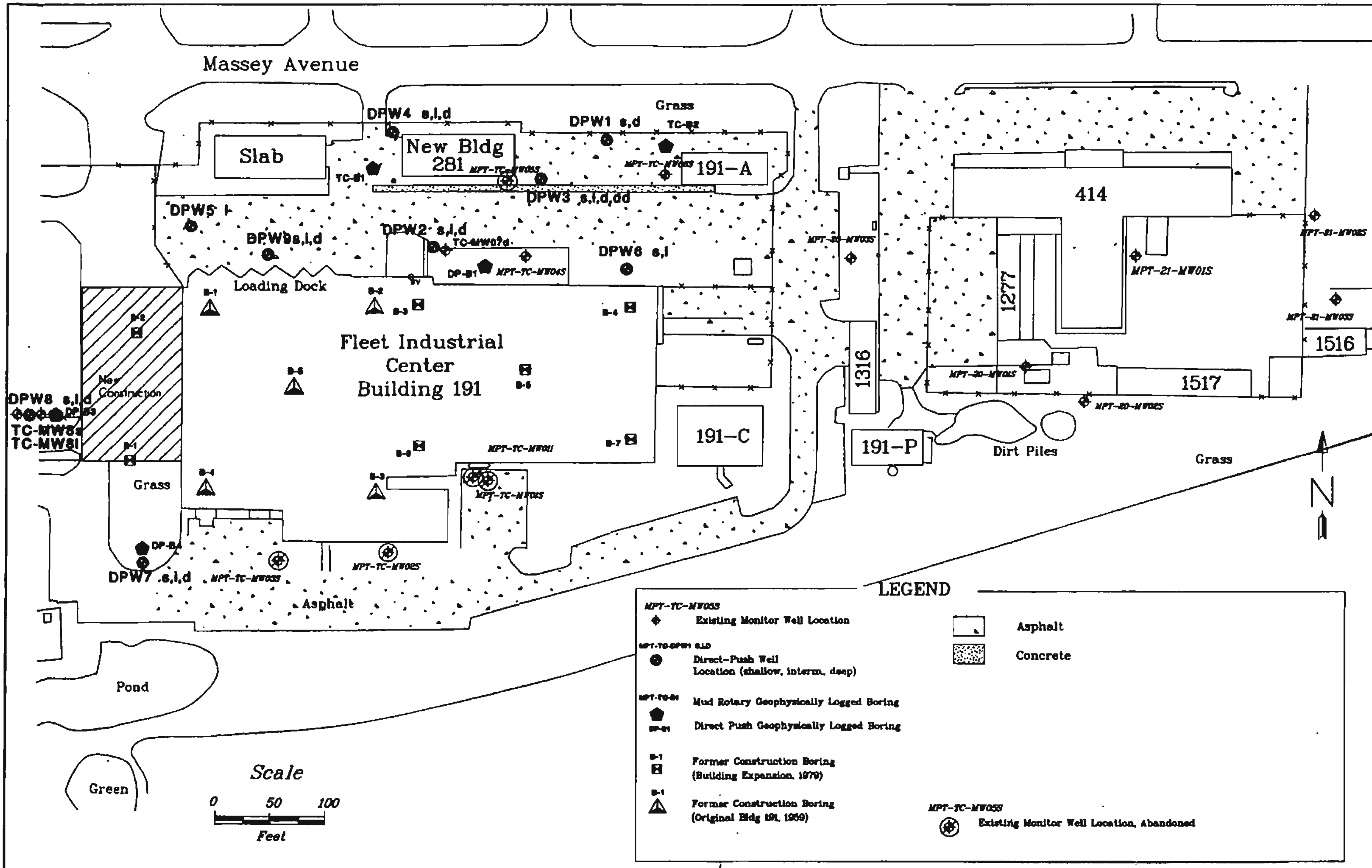

Figure 3-1

BUILDING 191 AREA SITE PLOT PLAN
NAVSTA MAYPORT, FLORIDA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY/METHODOLOGY
NAVAL FACILITIES ENGINEERING SERVICE CENTER (NFESC)

ICON
5637 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name: Sitemap.gcd	Date: 12/16/96
Project Number: 9052-001-0100	Source: NFESC
Revision Number	Field Measurement
File Directory	ICON Env. Svcs.; 1993; 1996
Drawn By	

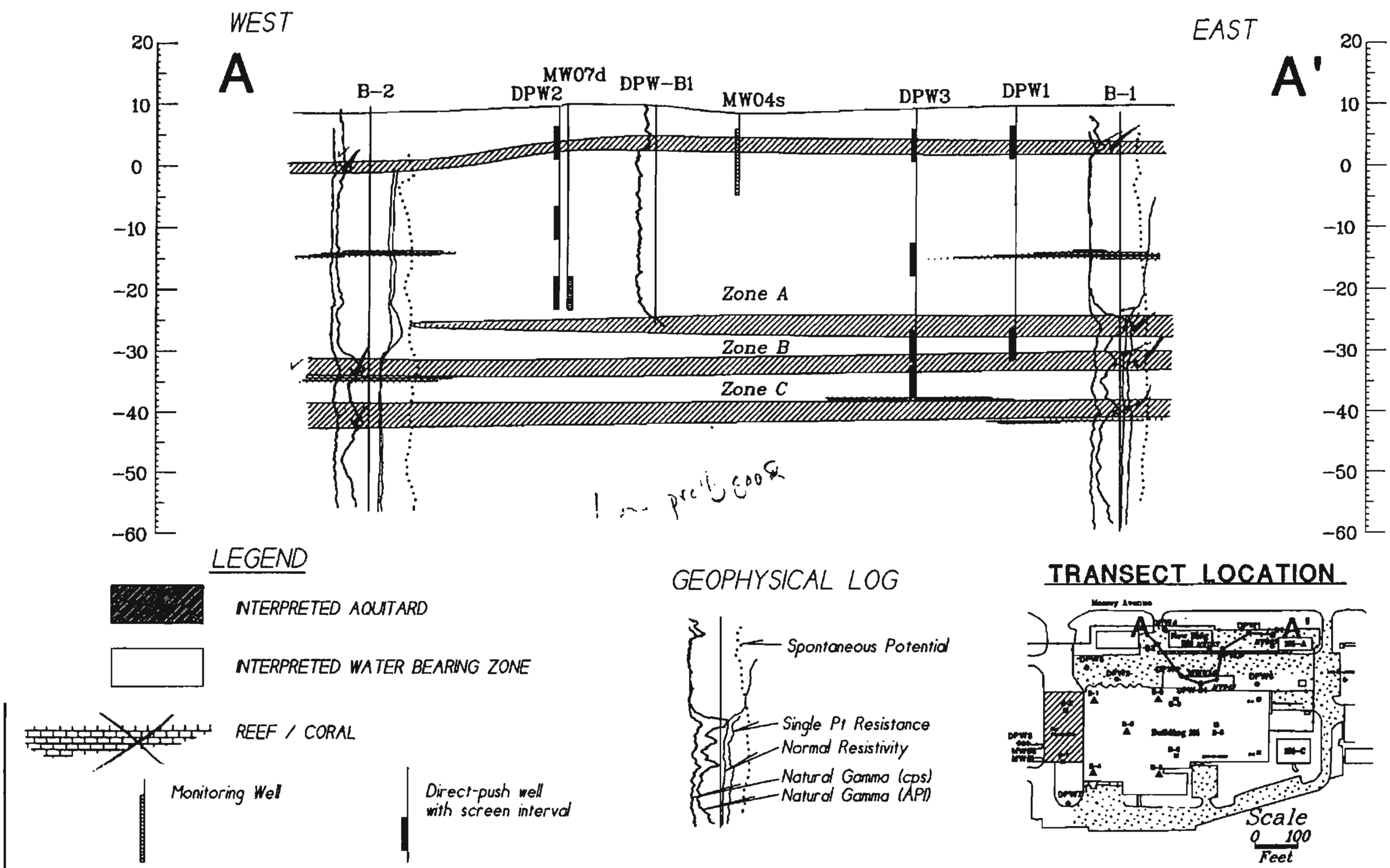

Figure 3-2

EAST-WEST CROSS SECTION DIAGRAM DEPICTING SUBSURFACE GEOLOGY
BUILDING 191 AREA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

ICON
5437 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name:	Date: 05/23/97
Project Number: 9052-001-0300	Source: Field Measurement ICON Env. Svcs.; 1993; 1996
Revision Number	
File Directory	
Drawn By	

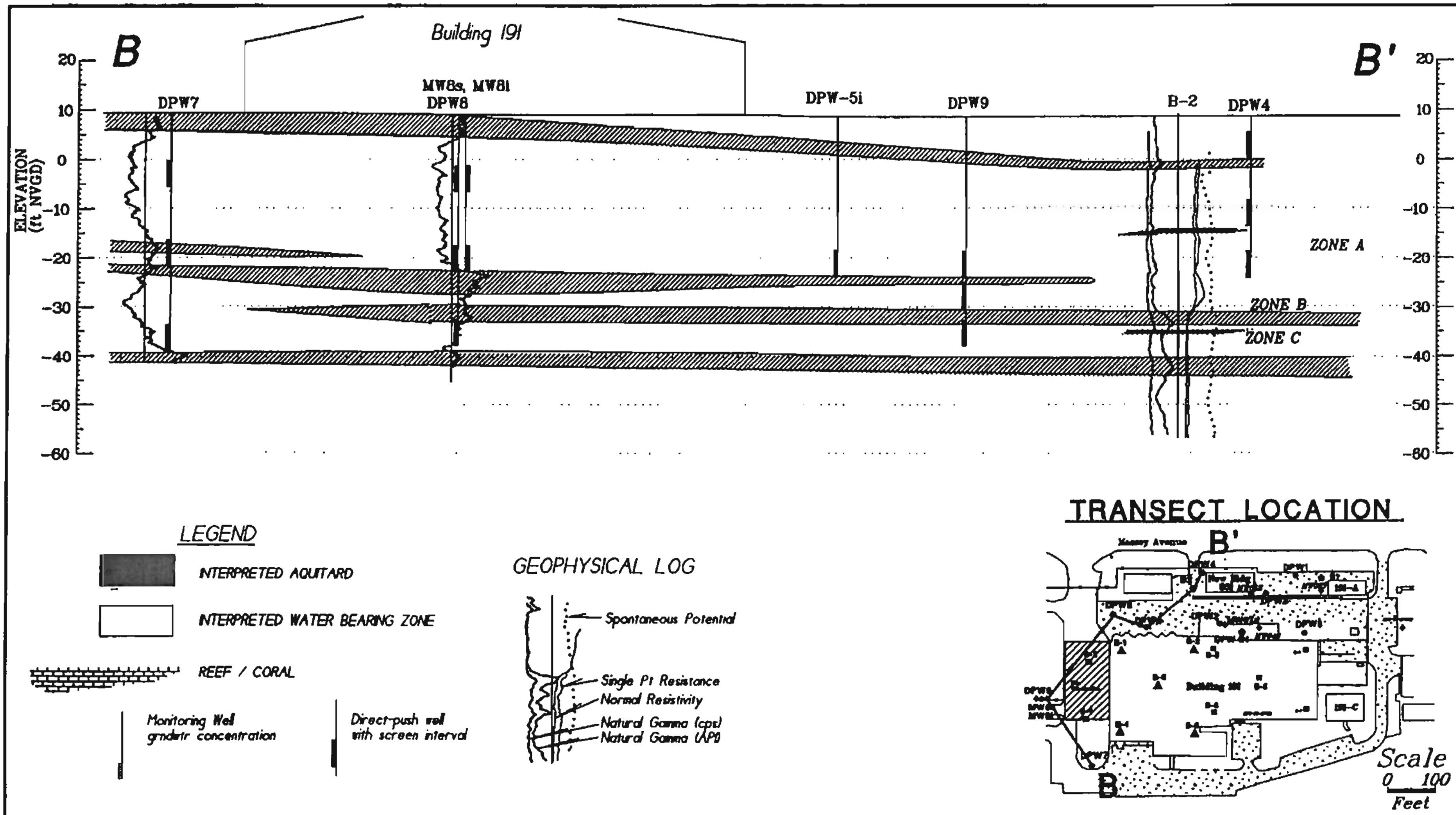

Figure 3-3

NORTH - SOUTH CROSS SECTION DIAGRAM DEPICTING SUBSURFACE GEOLOGY
BUILDING 191 AREA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

ICON
8437 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name:	Date: 05/23/97
Project Number: 9052-001-0300	Source: Field Measurement ICON Env. Svcs.; 1993; 1996
Revision Number	
File Directory	
Drawn By	

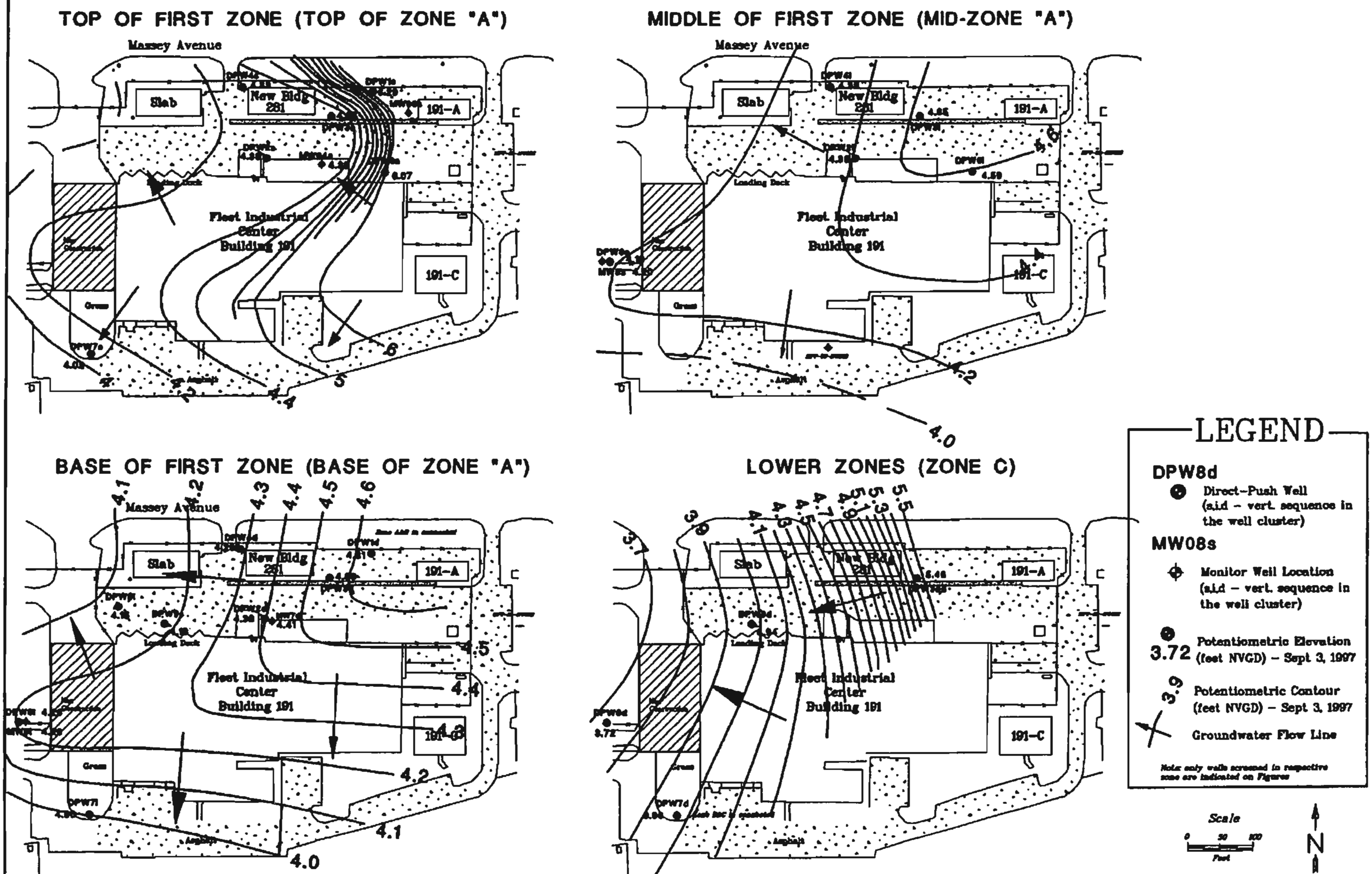

Figure 3-4

POTENTIOMETRIC CONTOURS, BUILDING 191 AREA, SEPTEMBER 3, 1997

NAVSTA MAYPORT, FLORIDA

ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY/METHODOLOGY

NAVAL FACILITIES ENGINEERING SERVICE CENTER (NFESC)

ICON

File Name: 191-pots.gcd	Date: January 1997
Project Number: 9052-001-6100	Source: NFESC Field Measurement ICON Env. Svcs.; 1996, 1997
Revision Number 0	
File Directory data\navy	
Drawn By Greg Miller	

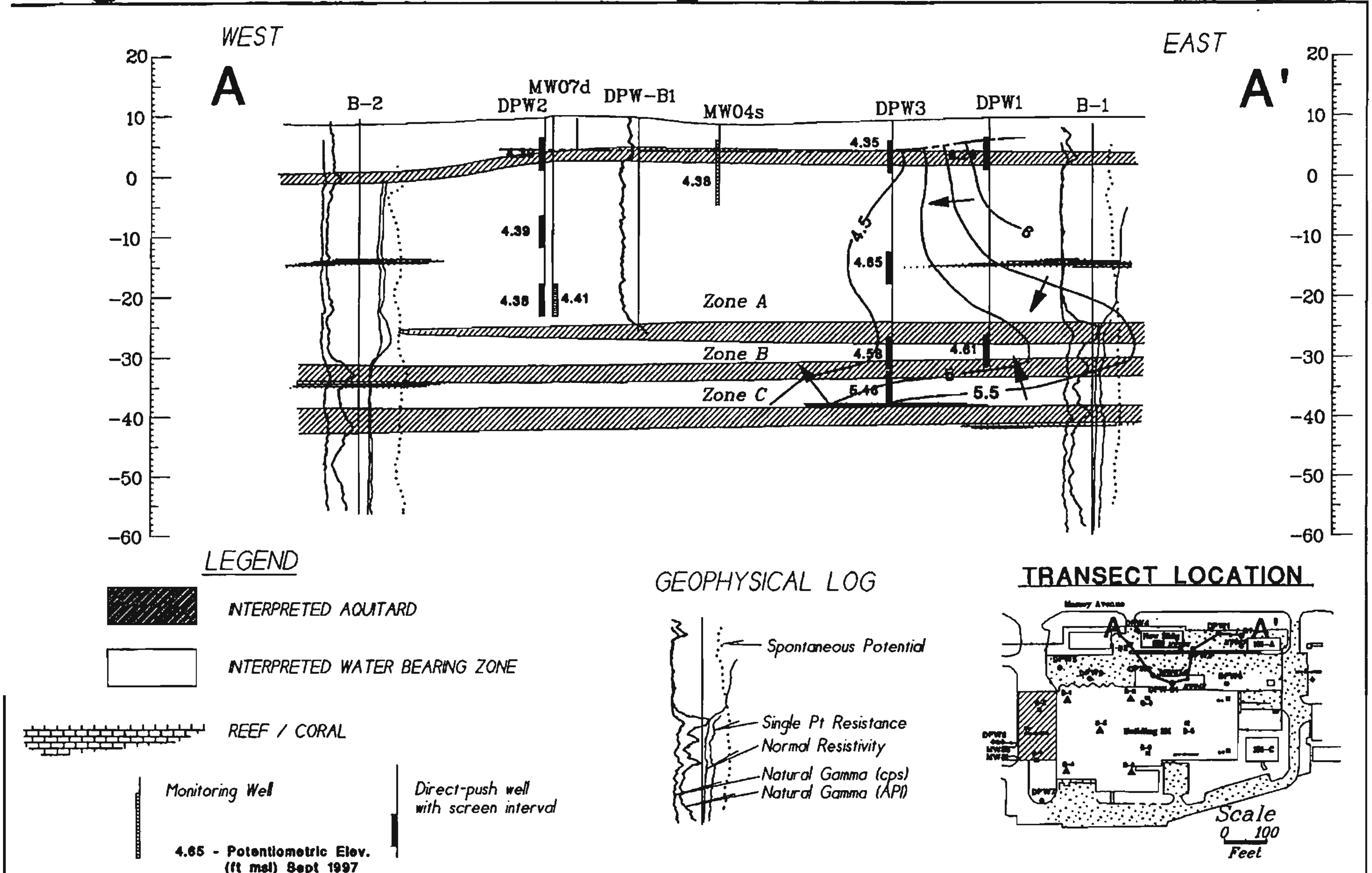

Figure 3-5

EAST-WEST CROSS SECTION DIAGRAM WITH POTENTIOMETRIC CONTOURS - SEPT 1997

BUILDING 191 AREA

ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY

NAVSTA MAYPORT, FLORIDA

ICON

5437 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name:	Date: 05/23/97
Project Number: 8052-001-0300	Source: Field Measurement ICON Env. Svcs.; 1993; 1996
Revision Number	
File Directory	
Drawn By	

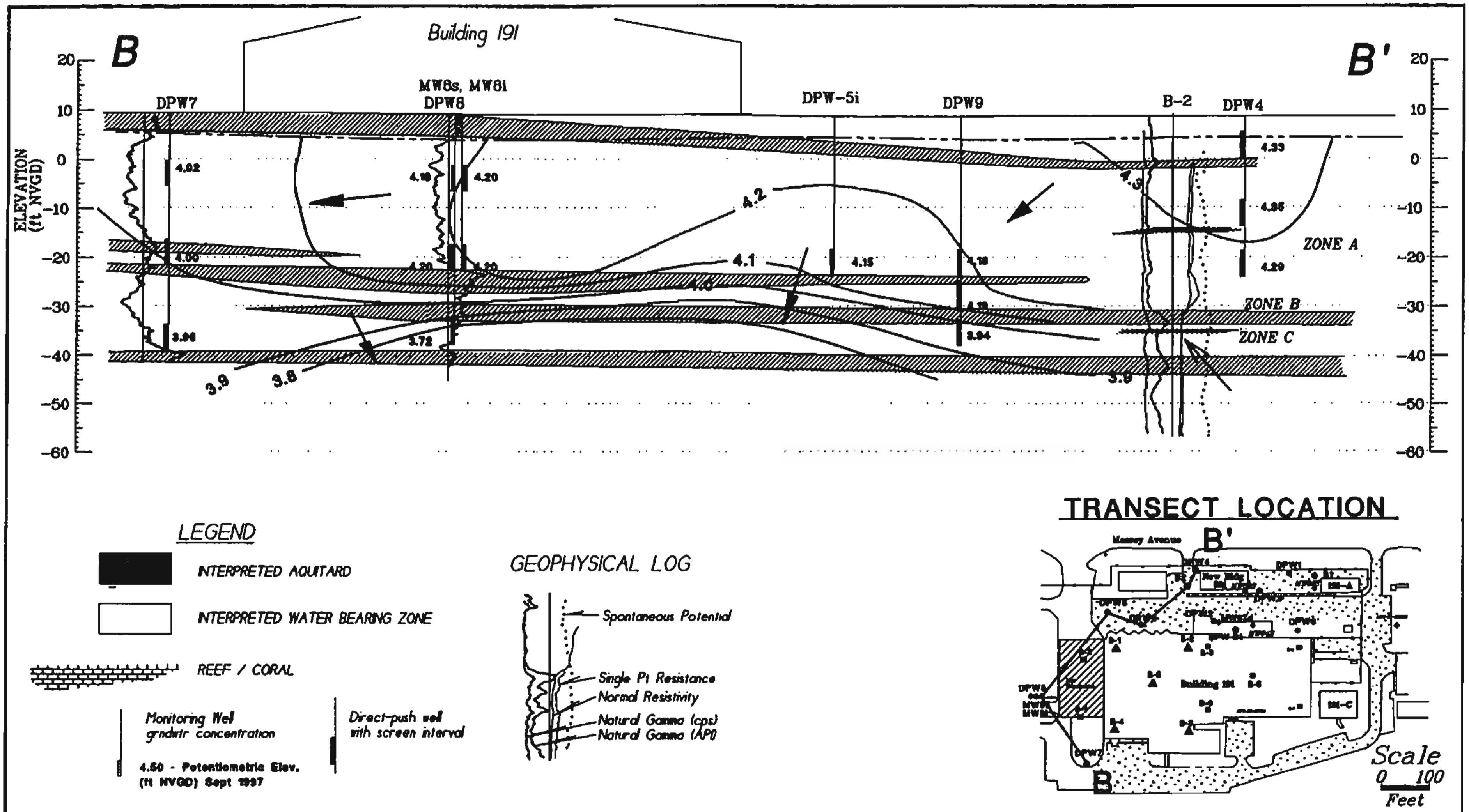

Figure 3-6

NORTH - SOUTH CROSS SECTION DIAGRAM WITH POTENTIOMETRIC CONTOURS - SEPT 1997
BUILDING 191 AREA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

ICON
5637 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name:
Project Number: 9052-001-0300
Revision Number
File Directory
Drawn By

Date: 05/23/97

Source:
Field Measurement
ICON Env. Svcs.; 1993; 1996

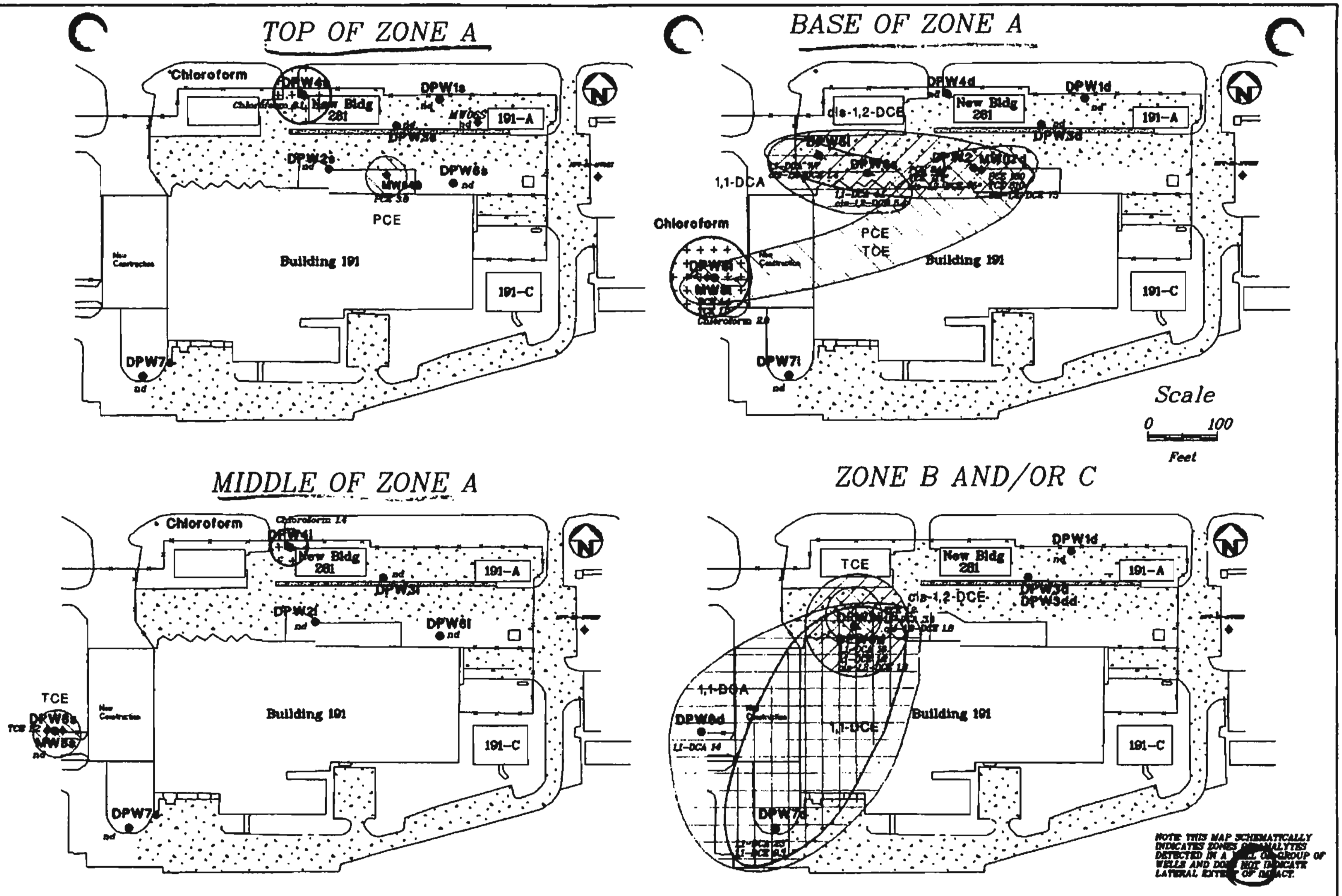

Figure 3-7

BUILDING 191 WELL LOCATIONS WITH ZONES OF DETECTED ANALYTES
NAVSTA MAYPORT, FLORIDA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY/METHODOLOGY
NAVAL FACILITIES ENGINEERING SERVICE CENTER (NFESC)

ICON

6140 Perkins Road Suite 100 Baton Rouge, LA 70808
(504) 769-2078 fax (504) 761-4489

File Name: 191-pots.gcd	Date: January 1997
Project Number: 9052-001-0100	Source: NFESC
Revision Number 0	Field Measurement
File Directory data\navy	ICON Env. Svcs.; 1996, 1997
Drawn By Greg Miller	

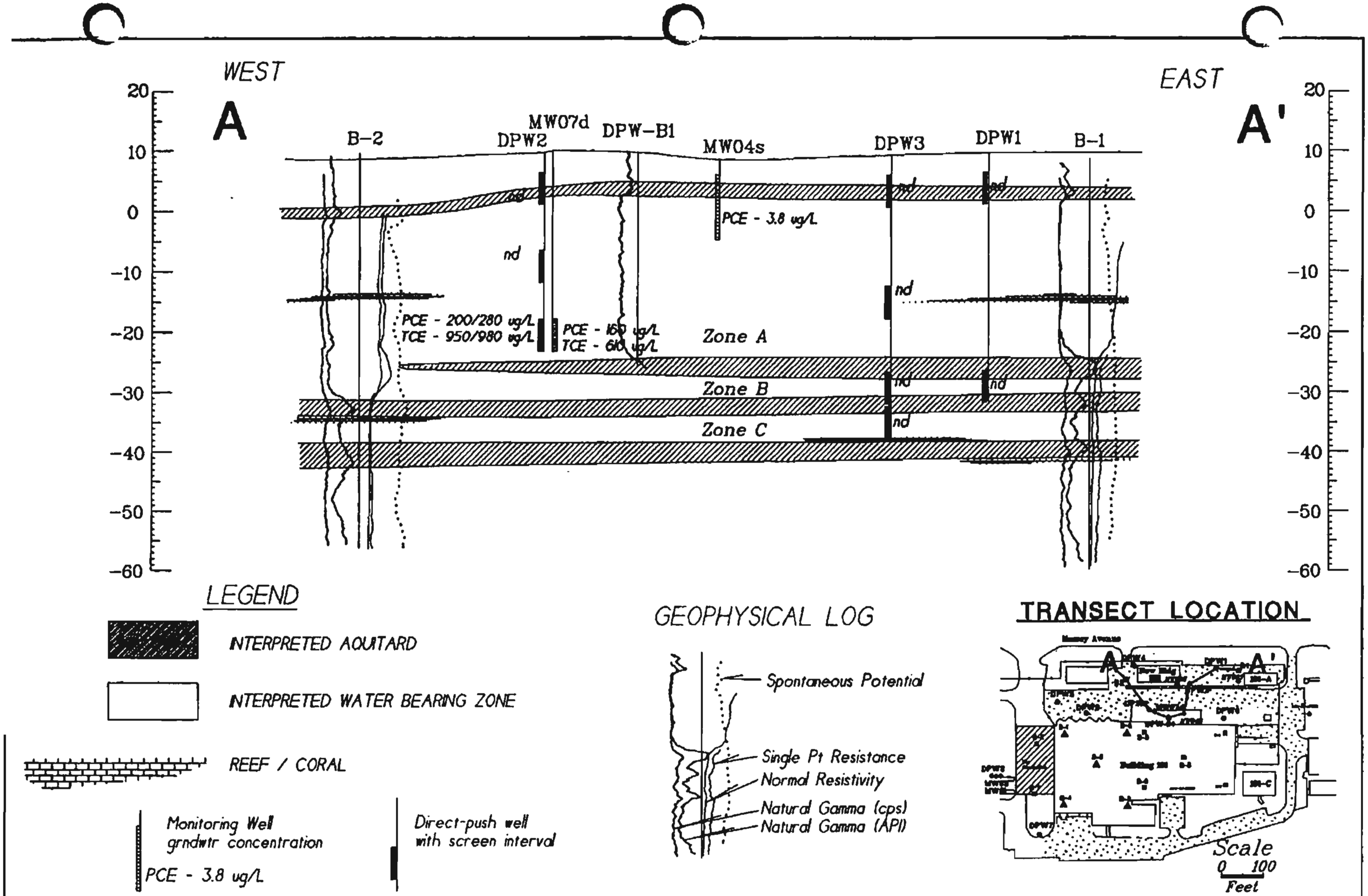

Figure 3-8

EAST-WEST CROSS SECTION DIAGRAM, WITH GROUNDWATER CHLORINATED HALOGEN RESULTS
BUILDING 191 AREA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

ICON
8437 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name:	Date: 05/23/97
Project Number: 9052-001-0300	Source: Field Measurement ICON Env. Svcs.; 1993; 1996
Revision Number	
File Directory	
Drawn By	

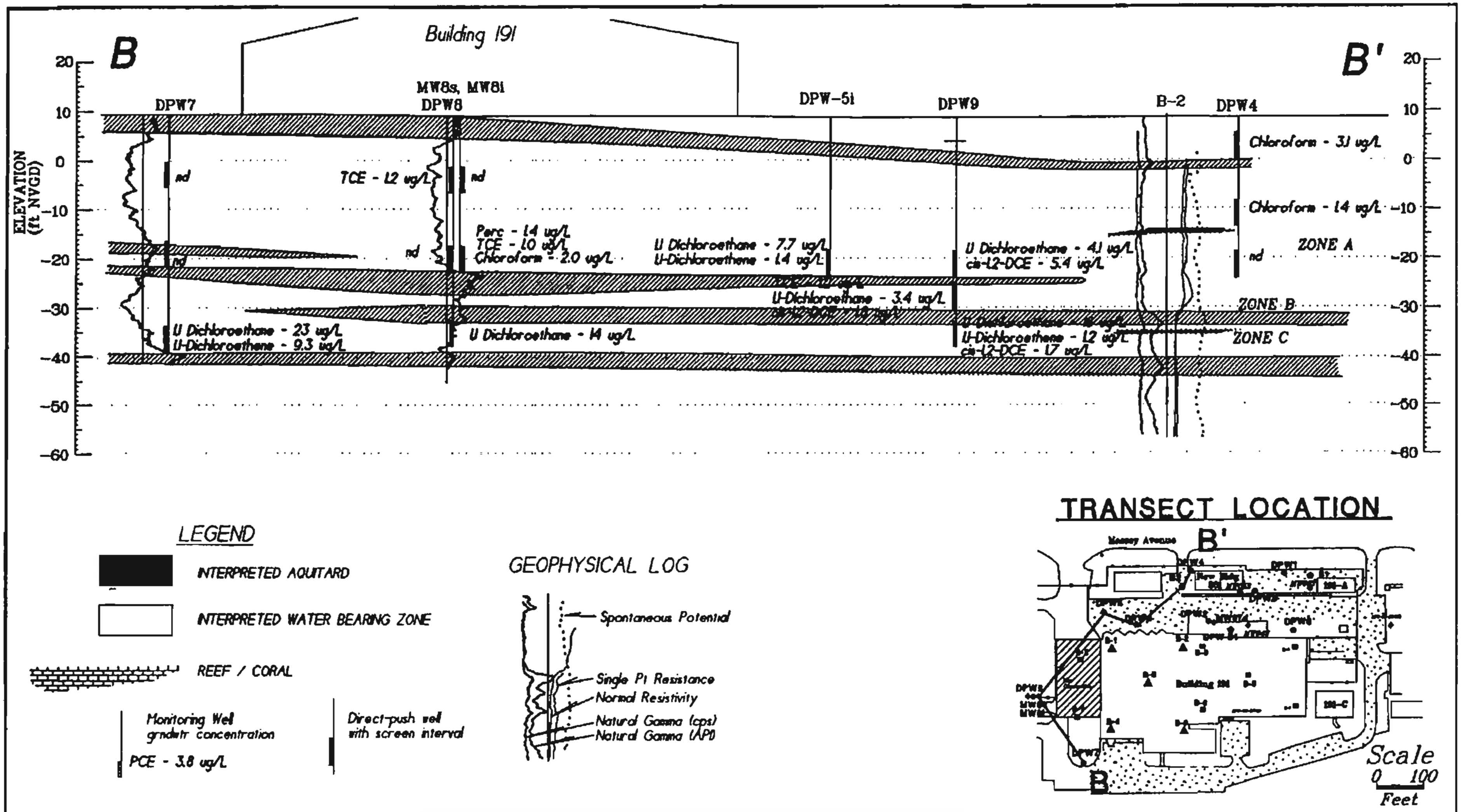

Figure 3-9

NORTH - SOUTH CROSS SECTION DIAGRAM WITH GROUNDWATER CHLORINATED HALOGEN RESULTS

BUILDING 191 AREA

ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY

NAVSTA MAYPORT, FLORIDA

ICON

5437 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name:	Date: 05/23/97
Project Number: 9052-001-0300	Source: Field Measurement
Revision Number	ICON Env. Svcs.; 1993; 1996
File Directory	
Drawn By	

TABLE 3-1
BUILDING 191 HYDRAULIC HEAD DATA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

Well	TOC Elev. (ft NGVD)	Water Bearing Zone	Screened Interval (ft bls)	Screened Interval (ft NGVD)	MAY 9, 1997 Depth to Wtr (ft)	MAY 9, 1997 Wtr Elev. (ft NGVD)	3-Sep-97 Depth to Wtr (ft)	3-Sep-97 Wtr Elev. (ft NGVD)
MPT-TC-DPW1s	9.64	Top-A	3.0 - 8.0	6.64 - 1.64	3.18	6.46	3.35	6.29
MPT-TC-DPW1d	9.65	Base A / B	36.5 - 41.5	-26.85 - -31.85	4.96	4.69	5.04	4.61
MPT-TC-DPW2s	9.75	Top-A	3.0 - 8.0	6.75 - 1.75	5.15	4.60	5.36	4.39
MPT-TC-DPW2i	9.92	Mid-A	17.0 - 22.0	-7.08 - -12.08	5.35	4.57	5.53	4.39
MPT-TC-DPW2d	9.95	Base A	27.0 - 32.0	-17.05 - -22.05	5.43	4.52	5.57	4.38
MPT-TC-MW7d	10.06	Base A	27.0 - 32.0	-16.94 - -21.94	ni		5.65	4.41
MPT-TC-DPW3s	9.09	Top-A	3.0 - 8.0	6.09 - 1.09	3.59	5.50	4.74	4.35
MPT-TC-DPW3i	9.03	Mid-A	22.0 - 27.0	-12.97 - -17.97	4.39	4.64	4.38	4.65
MPT-TC-DPW3d	9.10	Base-A / B	35.5 - 40.5	-26.40 - -31.40	4.57	4.53	4.52	4.58
MPT-TC-DPW3dd	9.10	C	41.5 - 46.5	-32.40 - -37.40	4.97	4.13	3.64	5.46
MPT-TC-DPW4s	8.78	Top-A	3.0 - 8.0	5.78 - 0.78	4.27	4.51	4.45	4.33
MPT-TC-DPW4i	8.75	Mid-A	17.0 - 22.0	-8.25 - -13.25	4.25	4.50	4.40	4.35
MPT-TC-DPW4d	8.65	Base A	27.5 - 32.5	-18.85 - -23.85	4.18	4.47	4.36	4.29
MPT-TC-DPW5i	8.65	Base A	27.0 - 32.0	-18.35 - -23.35	4.37	4.28	4.50	4.15
MPT-TC-DPW6s	9.72	Top A	3.2 - 8.2	6.52 - 1.52	3.55	6.17	3.65	6.07
MPT-TC-DPW6i	9.84	Mid-A	22.0 - 27.0	-12.18 - -17.18	5.13	4.71	5.25	4.59
MPT-TC-DPW7s	9.68	Mid-A	10.0 - 15.0	-0.32 - -5.32	ni		5.66	4.02
MPT-TC-DPW7i	9.82	Base A	26.0 - 31.0	-16.18 - -21.18	ni		5.82	4.00
MPT-TC-DPW7d	9.74	Zone C	43.5 - 48.5	-33.76 - -38.76	ni		5.78	3.96
MPT-TC-DPW8s	8.72	Mid A	10.0 - 15.0	-1.28 - -6.28	ni		4.54	4.18
MPT-TC-MW8s	8.60	Mid-A	10.0 - 15.0	-1.40 - -6.40	ni		4.40	4.20
MPT-TC-DPW8i	8.70	Base A	26.0 - 31.0	-17.30 - -22.30	ni		4.50	4.20
MPT-TC-MW8i	8.65	Base A	26.0 - 31.0	-17.35 - -22.35	ni		4.45	4.20
MPT-TC-DPW8d	8.70	Zone C	41.0 - 46.0	-32.30 - -37.30	ni		4.98	3.72
MPT-TC-DPW9s	8.26	Base A	26.5 - 31.5	-18.24 - -23.24	ni		4.08	4.18
MPT-TC-DPW9i	8.27	Zone B	33.0 - 38.0	-24.73 - -29.73	ni		4.08	4.19
MPT-TC-DPW9d	8.32	Zone C	41.0 - 46.0	-32.68 - -37.68	ni		4.38	3.94
MPT-20-MW3s	12.01	Top-A	6.0 - 16.0	6.01 - -3.99	3.63	8.38	nm	
MPT-TC-MW4s	8.68	Top-A	5.0 - 15.0	3.68 - -6.32	4.12	4.56	4.30	4.38
MPT-TC-MW6s	9.84	Top-A	4.5 - 9.5	5.34 - 0.34	3.98	5.86	nm	
MPT-TC-MW8i	8.65	Base A	26.0 - 31.0	-17.35 - -22.35	ni		4.45	4.20

ni - not installed
nm - not measured

TABLE 3-2
NAVSTA MAYPORT, FLORIDA
BUILDING 191 AREA
SAMPLING SUMMARY - DETECTED COMPOUNDS

	MW04s	MW06s	DPW1s	DPW1d	DPW2s	DPW2i	DPW2d	DPW2d	MW07d	DPW3s	DPW3i	DPW3d	DPW3dd
Sample Date	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	9/3/97	9/3/97	5/9/97	5/9/97	5/9/97	5/9/97
Screen Depth (ft bls)													
top	3	2.5	3	36.5	3	17	27	27	27	3	22	35.5	41.5
bottom	13	12.5	8	41.5	8	22	32	32	32	8	27	40.5	46.5
Zone	Top-A	Top-A	Top-A	Zone B	Top-A	Mid-A	Base-A	Base-A	Base-A	Top-A	Mid-A	Zone B	Zone C
Depth to Wtr (5/8/97)	4.12	3.98	3.09	4.88	5.14	5.37	5.38	5.57	5.65	3.37	4.35	4.65	5.38
Develop Volume (gal)	n/a	n/a	7.5	9.3	5	13	13	n/a	110	3.8	4	8.3	7
Purge Volume (gal)	4.2	3.3	0.5	1.8	1.5	1.3	1.4	3	2.7	1.8	1.75	2.8	31
Field Turbidity (ntu)	11.7	2.5	2.1	5	4.2	10.1	3	5	2	1.9	2.9	9.5	2.5
Field PH (std units)	7	7.3	7.8	7.7	7.2	7.8	7.5	7.2	7.1	7.2	7.4	7.5	7.1
Field Cond (uS/cm)	300	500	600	1,800	400	300	700	655	618	600	600	7100	15,400
Field Appearance	Initial Biosolids	red bacteria	clear	clear, slight H_2S odor	clear	clear	clear w/ sl gry color	clear	clear	clear	clear w/ sl gry color	clear	clear
Tetrachloroethene (ug/L)	3.8	< 1	< 1	< 1	< 1	< 1	240	200 / 280	160	< 1	< 1	< 1	< 1
Trichloroethene (ug/L)	< 1	< 1	< 1	< 1	< 1	< 1	470	950 / 980	610	< 1	< 1	< 1	< 1
Chloroform (ug/L)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
1,1-Dichloroethane	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
1,1-Dichloroethene	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
cis-1,2-Dichloroethene	< 1	< 1	< 1	< 1	< 1	< 1	< 1	150 / 150	75	< 1	< 1	< 1	< 1

2.9/2.9 - denotes sample and blind duplicate result
< 0.6 - less than limit of quantification

TABLE 3-2
NAVSTA MAYPORT, FLORIDA
BUILDING 191 AREA
SAMPLING SUMMARY - DETECTED COMPOUNDS

	DPW4s	DPW4i	DPW4d	DPW5i	DPW6s	DPW6i	DPW7s	DPW7i	DPW7d
Sample Date	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97
Screen Depth (ft bls)									
top	3	17	27.5	27	3.2	22	10	26	43.5
bottom	8	22	32.5	32	8.2	27	15	31	48.5
Zone	Top-A	Mid-A	Base-A	Base-A	Top-A	Mid-A	Mid-A	Base-A	Zone C
Depth to Wtr (ft fm TOC)	4.21	4.19	4.2	4.37	3.53	5.08	5.66	5.82	5.78
Develop Volume (gal)	7.8	8	8.5	13	2.4	5.7	3.5	7	5
Purge Volume (gal)	2.2	1.2	1.7	2.7	1.5	2	3.1	3.3	3.1
Field Turbidity (ntu)	17	4.1	4.2	22	2.2	2.6	9	18	5
Field PH (std units)	7.8	8	7.6	7.4	7.5	7.6	7.5	8.7	7
Field Cond (uS/cm)	200	600	600	700	700	600	420	350	1151
Field Appearance	clear sl gry color	clear	clear	sl turbid, milky white	clear	clear	clear sl yellow	clear sl yellow	clear H_2S odor
Tetrachloroethene (ug/L)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Trichloroethene (ug/L)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Chloroform (ug/L)	3.1	1.4	< 1	< 1	< 1	< 1	< 1	< 1	< 1
1,1-Dichloroethane (ug/L)	< 1	< 1	< 1	7.7	< 1	< 1	< 1	< 1	23
1,1-Dichloroethene (ug/L)	< 1	< 1	< 1	1.4	< 1	< 1	< 1	< 1	9.3
cis-1,2-Dichloroethene	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1

2.9/2.9 - denotes sample and blind duplicate result
< 0.6 - less than limit of quantification

TABLE 3-2
NAVSTA MAYPORT, FLORIDA
BUILDING 191 AREA
SAMPLING SUMMARY - DETECTED COMPOUNDS

	DPW8s	MW08s	DPW8i	MW08i	DPW8d	DPW9s	DPW9I	DPW9d
Sample Date	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97
Screen Depth (ft bls)								
top	10	10	26	26	41	26.5	33	41
bottom	15	15	31	31	46	31.5	38	46
Zone	Mid-A	Mid-A	Base-A	Base-A	Zone C	Base-A	Zone B	Zone C
Depth to Wtr (ft fm TOC)	4.54	4.4	4.5	4.45	4.98	4.08	4.08	4.38
Develop Volume (gal)	6	45	8.5	80	8.9	9	4.5	6.5
Purge Volume (gal)	2.8	2.9	3.3	3.5	3.3	5	4	3.2
Field Turbidity (ntu)	2	2.9	5	5	10	41	25	7
Field PH (std units)	7.2	7	7.1	7.4	7.2	7.5	7.3	7.6
Field Cond (uS/cm)	501	536	595	629	5,550	659	4,990	3,610
Field Appearance	clear	clear, sl yellow	clear	clear	clear	white milky turbidity	yellow	clear
Tetrachloroethene (ug/L)	< 1	< 1	< 1	1.4	< 1	< 1	< 1	< 1
Trichloroethene (ug/L)	1.2	< 1	< 1	1.0	< 1	< 1	1.2	< 1
Chloroform (ug/L)	< 1	< 1	< 1	2.0	< 1	< 1	< 1	
1,1-Dichloroethane (ug/L)	< 1	< 1	< 1	< 1	14	4.1	3.4	18
1,1-Dichloroethene (ug/L)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1.2
cis-1,2-Dichloroethene	< 1	< 1	< 1	< 1	< 1	5.4	1.8	1.7

2.9/2.9 - denotes sample and blind duplicate result
< 0.6 - less than limit of quantification

TABLE 3-3
GROUNDWATER SUMMARY STATISTICS AND BENCHMARK VALUE COMPARISONS
BUILDING 191, NAVSTA MAYPORT, FLORIDA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY

Parameter	Frequency of Detection[1]	Concentration Range in Detected Samples	Water Quality Criteria (ug/L)	Source[2]	Number of Wells Exceeding Benchmark Concentrations	Identification of Well with Exceedances
Tetrachloroethene (ug/L)	3 / 26	1.4 - 280	3	FDER	2	DPW2d/MW7d *[160 to 280 ug/L]* MW04s *[3.8 ug/L]*
Trichloroethene (ug/L)	4 / 26	1.0 - 980	3	FDER	1	DPW2d/MW7d *[470 - 980 ug/L]*
Chloroform (ug/L)	3 / 26	1.4 - 2.0	none	FDER[3]	n/a	
1,1-Dichloroethane	6 / 26	3.4 - 23	none	FDER[3]	n/a	
1,1-Dichloroethene	3 / 26	1.2 - 9.3	7	FDER/MC	1	DPW7d *[9.3 ug/L]*
cis-1,2-Dichloroethene	4 / 26	1.7 - 150	70	FDER/MC	1	DPW2d/MW7d *[75 - 150 ug/L]*

1 - Frequency of detection is the number of wells in which the analyte was detected divided by the total number of wells sampled; the arithmetic average of duplicate samples was used as one value; results of twinned DPW/MW well results were evaluated as a single well because the twinned wells are both representative of water quality at one location.

2 - MCL (EPA maximum contaminant level) and/or FDER (Florida Department of Environmental Protection, Groundwater Guidance Concentrations, 1997).

3 - No current criteria; listed as a Group II contaminant requiring monitoring

n/a - not applicable

5.0 SUMMARY

5.1 BUILDING 191

Existing monitoring wells were screened within 15 feet below land surface (bls), and historically yielded groundwater samples exhibiting Tetrachloroethene (PCE) and Trichloroethene (TCE) on the north side of Building 191. Bromodichloromethane and chloroform were detected in one well on the south side of the building. One previous well (MW5s) was destroyed during recent construction activities. Two wells remained for sampling during this project.

ICON installed 24 direct-push wells (DPWs) using innovative technology in May and September 1997. ICON also installed three conventional wells, all twinned to adjacent DPWs to evaluate the technology. Geology was characterized using the log of boring of conventional wells, and by geophysically logging two open-hole borings and three direct-push borings (through pipe). Groundwater was sampled from all DPWs and conventional wells. All wells were surveyed, and depth to water measurements were obtained to determine groundwater flow direction.

The geophysical and core logs indicated three distinctive water-bearing zones within 50 feet bls, denoted in this report as *Zone A* (0 – 33 ft bls), *Zone B* (36 – 39 feet bls), and *Zone C* (43 – 47 feet bls). The zones are separated by silty or sandy clay. Groundwater in Zones A and B generally flows to the west north of Building 191, and to the southwest south of Building 191. Groundwater in Zone C flows to the west. An upward vertical hydraulic gradient was observed in the northeast corner of the site, and a net downward vertical gradient elsewhere. The following compounds were detected in groundwater from the site:

Top of Zone A	Chloroform **PCE**	No published benchmark level. Slightly above benchmark levels.
Middle of Zone A	Chloroform, TCE	Both below benchmark levels.
Base of Zone A	**TCE, PCE, cis-1,2-Dichloroethene** 1,1-Dichloroethane	All above benchmark levels. No published benchmark level.
Zone B	TCE, cis-1,2-Dichloroethene 1,1-Dichloroethane	Both below benchmark levels. No published benchmark level.
Zone C	**1,1-Dichloroethene** 1,1-Dichloroethane cis-1,2-Dichloroethene	Above benchmark level. No published benchmark level. Below benchmark level.

Hydraulic conductivity tests were conducted in selected DPWs and conventional wells. The calculated mean groundwater flow velocity averaged 2.42 feet/year (ft/yr) at the top of Zone A, 84.5 ft/yr at the Base of Zone A, and 23 ft/yr in Zone C. The source of groundwater impact is believed to be a former landfill reportedly beneath the Building 191 foundation.

5.2 SWMU 15

Five existing monitoring wells are screened within 18 feet below land surface (bls); one well is screened from 25 – 30 feet bls. Historically, groundwater samples from some of these wells exhibited Arsenic and beta-BHC at levels above background benchmark screening values. All six wells remained onsite for verification sampling during this study.

ICON installed 18 direct-push wells (DPWs) using innovative technology in May and September 1997. ICON also installed three conventional wells; one was twinned to an adjacent DPW to evaluate the technology. Geology was characterized using the log of boring of conventional wells; and by geophysically logging two open-hole borings, one direct push (through pipe) boring, and several of the existing wells. Groundwater was sampled from all DPWs and conventional wells. All wells were surveyed, and depth to water measurements were obtained to determine groundwater flow direction.

The geophysical and core logs indicated three water-bearing zones within 36 feet bls, within silty clay/silty sand sequences. Some organics and peat layers were observed in this interval. Below 36 feet bls, lithology changed becoming predominantly sand with some clay layers to the north, and silty sand/clay sequences to the south. Groundwater in the upper two zones (within 15 feet bls) flowed to the northwest, and to the southwest in the southern half of the site. Groundwater flow patterns in the deeper zones (22 – 32 feet bls) was characterized by a north-south trending elongate mound with flow to the east and west. A substantial downward vertical hydraulic gradient was observed throughout the site.

Pesticides were detected in two conventional wells. The pesticide beta-BHC was detected in MW4s and MW6s, at concentrations below benchmark screening levels. Additionally, heptachlor epoxide and 4,4'-DDE were detected in MW6s at concentrations below benchmark screening levels. Arsenic was detected in 18 wells at the site; arsenic concentrations from MW4s and MW6s exceeded benchmark screening levels.