

**GROUNDWATER SAMPLING PLAN  
ADDENDUM TO THE REMEDIAL  
INVESTIGATION WORKPLAN**

**Stratford Army Engine Plant  
Stratford, Connecticut**

**Contract Number DACW41-96D-8014  
Task Order 0011**

*Prepared for*  
U.S. Department of the Army  
Corps of Engineers, New York District  
26 Federal Plaza  
New York, New York 10278-0090

December 23, 1998

*Prepared by*  
URS Greiner-Woodward-Clyde Federal Services  
P.O. Box 290  
201 Willowbrook Boulevard  
Wayne, New Jersey 07470

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December 23, 1998

Ms. Simone Shields  
U.S. Army Corps of Engineers - New England District  
Attn: CENAE-EP-HTW  
696 Virginia Road  
Concord, MA 01742-2751

**Re: Indefinite Delivery Order Contract No. DACW45-96-D-0017  
Groundwater Sampling Plan Addendum  
Stratford Army Engine Plant  
Stratford, Connecticut**

Dear Ms. Shields:

This Groundwater Sampling Plan Addendum (GSPA) is being submitted by URS Greiner Woodward-Clyde Federal Services (URSGWCFS) in accordance with the scope of Task 9 of the Remedial Investigation Work Plan (RIWP) for the Stratford Army Engine Plant (SAEP) site in Stratford, Connecticut.

URSGWCFS has prepared this GSPA now, to maintain progress within the overall scope and schedule of the RIWP. This GSPA will also serve to begin the dialogue required to arrive at a groundwater investigation scope that is acceptable to all members of the Base Closure Team (BCT).

Several comments made during the review process suggest that more wells than the number proposed may be required to achieve the DQOs. URSGWCFS concurs with this possibility, but more data are required before additional wells can be justified. Consistent with the iterative DQO approach of the RIWP, the conceptual model of site groundwater flow will be re-visited after information from the proposed wells is added to the GIS and GMS. The Conceptual Model of the Site will be updated and additional investigations to address data gaps identified will be proposed and implemented during the RI, if they are required.

Despite the limitations discussed above, in URSGWCFS's judgment, there is sufficient information to develop proposed additional monitoring well locations that address the overall data objectives: characterize groundwater quality and assess flow (on-site) and assess off-site impacts and/or potential off-site sources. Information on groundwater flow and subsurface conditions obtained during previous investigations provides a conceptual framework upon which to identify data gaps. Furthermore, field observations from soil borings completed to

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date provide indication of potential source areas of groundwater contamination. URSGWCFS proposes a technical meeting be convened in early January, 1999 to discuss the GSPA so that individual concerns and the latest information from the on-going Remedial Investigation and Removal Actions can be incorporated into the GSPA.

The GSPA addresses the following items:

1. Proposed locations for 17 shallow monitoring wells, 13 intermediate monitoring wells, and 3 deep monitoring wells;
2. Groundwater sampling parameters to be measured during the upcoming groundwater sampling events;
3. Discussion on the installation of proposed tidal flat monitoring wells;
4. Details of the tidal study design.

Figure GSPA-1 shows the proposed additional monitoring well locations and tentative locations for the tidal/mud flat monitoring points. Monitoring well locations are based on a review of the data collected during the Phase I and Phase II investigations at the site. Where applicable, the results of preliminary soil chemistry data obtained during this RI were utilized to adjust the location(s) of proposed additional monitoring wells.

As a basis for evaluating the location of proposed new monitoring wells, Figures GSPA-2 and GSPA-3 depict the water table elevation during different seasons in the year. Groundwater elevation and tidal influence data collected during this RI will be used to revise these groundwater flow patterns.

Groundwater parameters to be analyzed during the two groundwater sampling events (Rounds I and II) will include:

- TCL Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs), Polychlorinated Biphenyls (PCBs), TAL Metals and Cyanide (CN); additional selected samples will be analyzed for Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), total and dissolved iron and manganese, sulfate, sulfide, nitrate, nitrite, ammonia, methane and alkalinity.
- Field parameters (groundwater elevation, pH, Eh, dissolved oxygen, specific conductivity and salinity).

Round I groundwater sampling will include approximately 38 on- and off- site existing monitoring wells and all (33) proposed additional monitoring wells. Lagoon monitoring wells are part of an on-going RCRA quarterly monitoring program and, thus, will not be

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sampled in either groundwater sampling round. Round II groundwater sampling is estimated to consist of a total of 33 monitoring wells. Monitoring wells to be sampled and the parameters for which they are sampled will be determined from an evaluation of results of Round I sampling and will focus on filling data gaps identified by the Round I sampling.

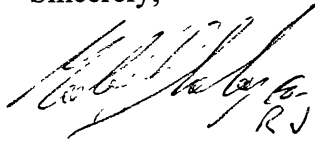
The proposed monitoring well locations are based on information on subsurface conditions, groundwater flow patterns, and potential sources of groundwater contamination identified to date. The proposed monitoring well locations, however, must nevertheless be considered preliminary for the following reasons:

- According to the RIWP, the groundwater investigation portion of the RIWP will be based on a conceptual model developed in concert with the GIS/GMS. The GIS/GMS, though in progress, has not been completed yet;
- Monitoring well locations may be adjusted on the basis of areas of concern identified by the results of the soil boring program. The soil boring program, though in progress, has not been completed.
- Harding Lawson Associates (HLA) is currently conducting investigations and a removal action in the area of the chromium plating area in the eastern part of Building 2. As part of the investigations, groundwater pumping and injection are proposed. These remedial measures will alter the groundwater flux to some degree and, hence, may influence placement of additional monitoring wells. Once URSGWCFS has reviewed specifications with this remedial measure (i.e. the field pilot testing of in-situ reduction and immobilization of chromium), the GSPA will be revised, as appropriate.

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If you have any questions or comments, please contact Rezie Jan at 973-785-8013 extension 331 or Robert Wolff at 973-812-6805.

Sincerely,

Handwritten signature of Rezie Jan in black ink, with the initials 'RJ' written below it.

Rezie Jan  
Hydrogeologist

Handwritten signature of Robert Wolff in black ink.

Robert Wolff  
Project Manager

cc: K. Feathers, CDEP (2 copies)  
J. Burelson, TACOM (1 copy)  
M. Cassidy, USEPA (3 copies)  
J. Frye, NYACOE (2 copies)  
N. Walter, HLA (1 copy)

## ATTACHMENT A

### SECTION 1 – SUMMARY OF PROPOSED ADDITIONAL MONITORING WELLS

Based on currently available information, 33 monitoring wells are proposed at 14 locations on the plant Site. The wells include 17 shallow (water table) wells with 10-foot screened sections intersecting the water table which generally is found at 4 to 11 feet below ground surface depending on the location on the Site, 13 intermediate (mid-depth) wells with a 10-foot screen at depths of about 30- to 50-foot depths, and 3 deep (bedrock surface) wells screened with 10 feet of screen at the bedrock surface, about 150 feet below ground surface.

#### Groundwater Investigation Area 1 (Plant Area)

**Rationale/DQO:** Evaluate groundwater chemistry and flow relationship of intertidal flats to Frash Pond. The major DQO here is better definition of the apparent division of flow from this area towards the mudflats to the east and to Frash Pond to the west.

**Preliminary RI Findings:** None to date.

**Existing Monitoring Well(s):** None.

**Proposed Additional Monitoring Well:** One shallow (water table) well - WC1-1S. (Figure GSPA-1)

#### Groundwater Investigation Area 2 (Plant Area)

**Rationale/DQO:** The critical DQO in this area is to determine the relationship of on-site groundwater to the intertidal flats. This area has a considerable potential for as yet unidentified potential sources of groundwater contamination, as indicated by the potential areas targeted for investigation with soil borings. Moreover, the area is downgradient of the main manufacturing portions of the site (mainly building 2 and environs. Because this area is relatively accessible, coverage by previous investigation wells has been rather good (see existing monitoring wells, below) and known areas of groundwater contamination (i.e. monitoring wells ECD-4 and maybe WC-12S as well) are being addressed by the HLA investigation of the former chrome plating room in Building 2 (B-2). Therefore, the proposed well locations generally are at locations with existing shallow wells, and intermediate wells are proposed to delineate vertical extent of groundwater contamination in areas of contaminated shallow groundwater, and a deep well to provide deeper stratigraphy in the eastern part of the Site and evaluate groundwater quality at bedrock surface.

**Preliminary RI Findings:** Soil borings, recently collected, east of and inside of Building 16 (B-16) had elevated PID readings (as high as 400 ppm), strong hydrocarbon odor, and some green-gray colored soil (possible Chromium). WC2-3S is in the same area as above-mentioned borings. In addition, free product was observed in the soil boring located adjacent to MW-2 and in borings near proposed monitoring wells WC2-10 and WC2-11.

**Existing Monitoring Wells (21 total):** MW-1, MW-2, MW-3, MW-4, PZ-13D, PZ-16D, PZ-1D, PZ-4D, PZ-5D, PZ-7D, PZ-8D, WC-1S, WC-2D, WC-3S, WC-4S, WC-5S, WC-6S, WC-7S, WC-8S, WC-12S, and WC-13S (Figure GSPA-1).

**Proposed Additional Monitoring Wells (9 total):** WC2-1S through WC2-5S, WC2-1I through WC2-3I, and WC2-1D (Figure GSPA-1).

### **Groundwater Investigation Area 2 (Tidal/Mud Flats)**

**Rationale/DQO:** The primary DQO for groundwater investigation in the Area 2 portion along the tidal/mud flats is to provide information needed to evaluate the groundwater quality at the zone of groundwater discharge from the Site to the intertidal flats. This is an important area to monitor, because it downgradient of most potential source areas, and transitions and enters the area of the tidal/mud flats where there is concern of potential risk to the ecological environment as a result of the discharge of groundwater to the Housatonic. Monitoring wells from previous investigations exist in this area, but additional wells are proposed to supplement the sampling at depths not sampled by existing wells (e.g. proposed intermediate well WC2-3I at existing shallow well locations WC-4S and deep well PZ-4D, Figure GSPA-1)

**Preliminary RI Findings:** None to date.

**Existing Monitoring Well(s):** None

**Proposed Additional Monitoring Wells (8 total):** WO2-1S through WO2-4S and WO2-1I through WO2-4I. (Figure GSPA-1).

### **Groundwater Investigation Area 3 (Off-site Area)**

**Rationale/DQO:** Based on the distribution of chlorinated compounds found in existing monitoring wells, the degradation pathways of the chlorinated compounds found, and inferred groundwater flow directions, contaminants detected at existing monitoring well locations WC-20 and WC-21 near Frash Pond are likely the result of off-site sources west of



the SAEP. In addition, groundwater contour maps suggest that groundwater may be flowing on-site from off-site in the vicinity of the airport. Dissolved contamination from potential off-site locations west of the SAEP may be influenced by this suggested groundwater flow regime.

Additional monitoring wells are proposed to provide information needed to evaluate groundwater chemistry and flow relationship of on-site groundwater to off-site groundwater at the airport; one well cluster to better define 1) the existence of an off-site contaminant source south and west of the SAEP and 2) potential contaminant migration from off-site sources onto the SAEP. Based on the flow gradients indicated by sampling these wells, more wells may be needed to establish the relationship between on and off-site sources and on and off-site groundwater flow.

**Preliminary RI Findings:** Preliminary RI data indicate RSR exceedances of Lead, Vanadium and Chromium in borings in West Parking Lot.

**Existing Monitoring Wells (2 total):** WC-19S and WC-19D1 (Figure GSPA-1).

**Proposed Additional Monitoring Wells (2 total):** WO3-1S and WO3-1I (Figure GSPA-1).

#### **Groundwater Investigation Area 4 (Off-site Area)**

**Rationale/DQO:** The DQOs for the groundwater investigation in this area are similar to those for Area 3 above: Information is needed to evaluate groundwater chemistry and flow relationship of off-site groundwater at the airport to on-site groundwater and Frash Pond. Based on the flow gradients indicated by sampling these wells, more wells may be needed to establish the relationship between on and off-site sources and on and off-site groundwater flow.

**Preliminary RI Findings:** No soil borings were proposed for this area.

**Existing Monitoring Wells (6 total):** WC-20S, WC-20D1, WC-20D2, WC-21S, WC-21D1, WC-21D2 (Figure GSPA-1).

**Proposed Additional Monitoring Wells (2 total):** WO4-1S and WO4-1I (Figure GSPA-1).

### **Groundwater Investigation Area 5 (Plant Area)**

**Rationale/DQO:** This area consists mainly of Buildings 2 and 3 in which there is considerable potential for as yet unidentified potential sources of groundwater contamination. Most of the proposed well locations, however, are on the perimeter to supplement existing monitoring well locations with wells at a different depth below ground surface (e.g. shallow well WC5-1S proposed at locations of existing deep well PZ-17D). Depending on the number and type of soil/source areas identified during the current soils investigation, additional wells may be needed, particularly within Buildings 2 and 3 (B-2 and B-3). This determination will be made after the proposed wells are installed and sampled and the data are evaluated in context of other soil and groundwater site data with the GIS/GMS.

**Preliminary RI Findings:** None to date.

**Existing Monitoring Wells (7 total):** ECD-4, PZ-9D, PZ-11D, PZ-17D, WC-9S, WC-10S and WC-11S (Figure GSPA-1).

**Proposed Additional Monitoring Wells (7 total):** WC5-1S through WC5-4S, WC5-1I and WC5-2I, and WC5-1D (Figure GSPA-1).

### **Groundwater Investigation Area 6 (Plant Area)**

**Rationale/DQO:** The main DQO for investigating groundwater in this area is to evaluate groundwater chemistry and flow relationship of on-site groundwater to the drainage ditch. With the existing lagoon closure wells, there are an adequate number of existing shallow wells. Intermediate and deep wells are proposed to supplement existing monitoring well network and define deeper stratigraphy and evaluate groundwater quality at bedrock surface.

**Preliminary RI Findings:** Preliminary data indicate RSR exceedances of Lead, Chromium, Vanadium and some SVOCs at borings northeast of the Wastewater Treatment Plant. Preliminary data indicate a RSR exceedance of PCBs at a boring east of the WWTP.

**Existing Monitoring Wells (2 total):** WC-14S and WC-15S (Figure GSPA-1).

**Proposed Additional Monitoring Wells (2 total):** WC6-1I and WC6-1D (Figure GSPA-1).

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**Groundwater Investigation Area 7 (Off-site Area)**

**Rationale/DQO:** The purpose of the proposed monitoring wells in this area is to provide information needed to evaluate groundwater chemistry and flow south of the Site and bound the groundwater conditions (both flow and contamination characteristics) downgradient of contaminated groundwater in Area 6.

**Preliminary RI Findings:** See Area 6.

**Existing Monitoring Well(s):** None.

**Proposed Additional Monitoring Wells (2 total):** WO7-1S and WO7-1I (Figure GSPA-1).

## **SECTION 2 – SUMMARY OF TIDAL/MUD FLAT GROUNDWATER QUALITY INVESTIGATION**

The remedial investigation work plan indicates that four shallow monitoring wells and four intermediate monitoring wells in cluster configuration will be installed in the tidal/mud flats located to the northeast of the site. During subsequent project meetings with regulators and site personnel, concern was raised regarding ice buildup in the tidal/mud flats area. The ice buildup in the mud/tidal flats can lead to the destruction of the monitoring wells installed in the mud/tidal flats.

To address the DQOs for this Groundwater Investigation Area **a modification to the remedial investigation work plan is proposed** (shown in *Italics*):

- The tidal/mud flat monitoring wells will be installed as per the work plan using drive point piezometers in shallow and intermediate cluster configurations. Locations for these monitoring wells are shown in Figure GSPA-1.
- *These monitoring wells will be installed in the spring following the melting of the ice in the tidal/mud flat area; sampled twice in the period between April and October, 1999; and removed/abandoned in November 1999.*

Monitoring wells will be installed at four locations in the intertidal flats with a shallow (less than 5 feet deep) and intermediate (15 to 25 feet deep) monitoring well at each location and shorter screen lengths (less than five feet for the shallow and 5 feet for the deeper wells).

This approach to the installation of the tidal/mud flat monitoring wells and the subsequent collection of groundwater samples from these locations will achieve the following requirements for the DQOs for this area:

1. Vertical hydraulic gradients from the sediment/soil to the tidal/mud flat area will be measured.
2. Mass flux can be calculated from the groundwater quality data collected at these locations.

### **SECTION 3 – TIDAL STUDY DESIGN**

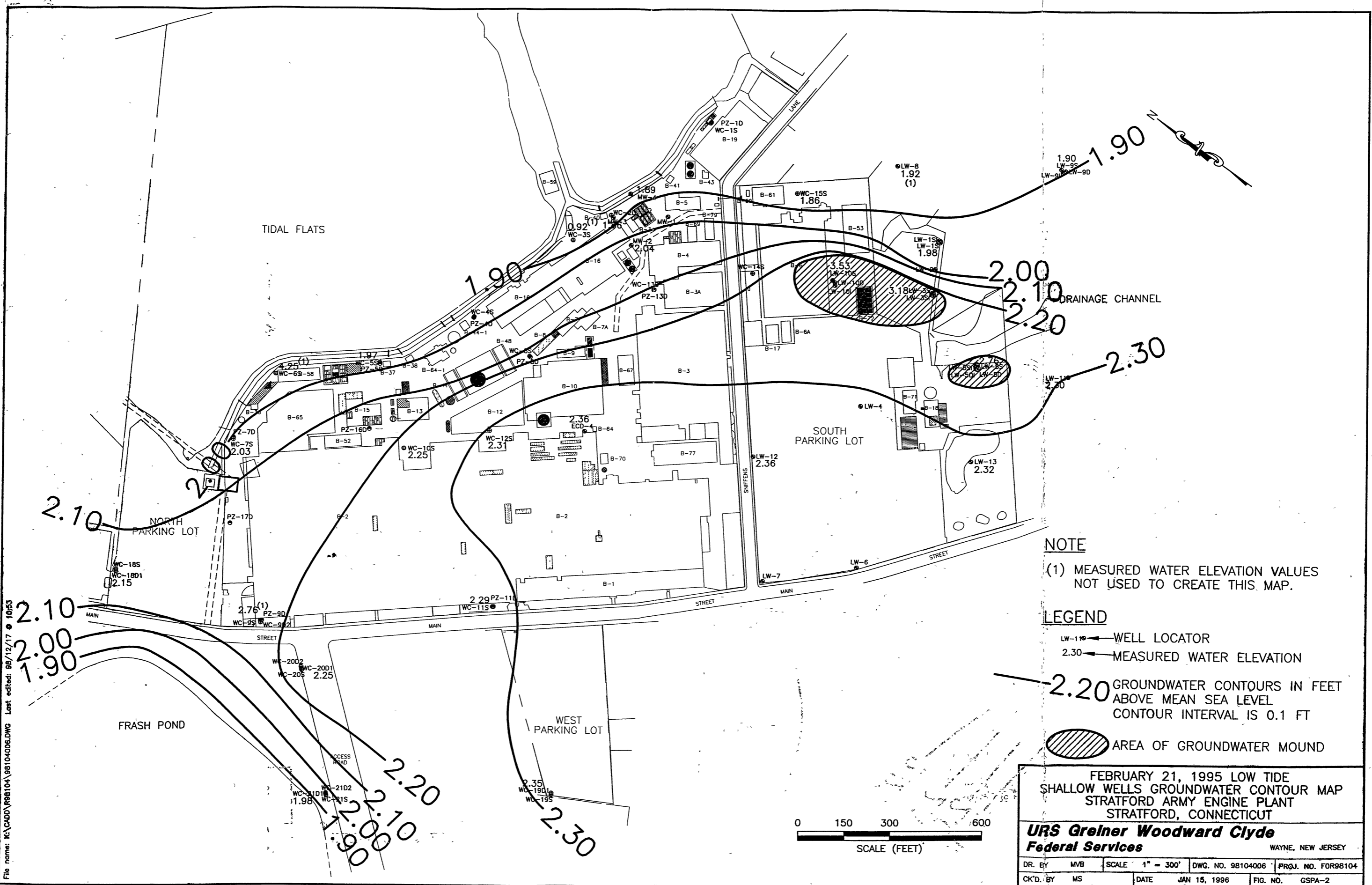
The tidal study will consist of continuous groundwater elevation monitoring at 15 wells for a period of seven days using down-hole pressure transducers attached to data loggers (e.g. Hermit or equivalent). A 72-hour continuous record will be extracted from the seven days of groundwater elevation data to determine mean elevations using a geostatistical filtering methodology<sup>1,2</sup>.

The study will be performed following the installation of the additional 33 monitoring wells and will include continuous monitoring in nine shallow monitoring wells, three intermediate monitoring wells, and three deep monitoring wells. These monitoring points will be setup to determine groundwater flow gradients and direction from 1) the site to the tidal/mud flats; 2) the site to Frash Pond; and 3) the site to the drainage ditch along the southern parking lot. The monitoring wells used in the tidal study will be derived from Groundwater Investigation Areas 1, 2, 4 and 6.

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<sup>1</sup> Serfes, M.E. 1991. Determining the mean hydraulic gradient of ground water affected by tidal fluctuations. *Groundwater*. vol. 29, no. 4, pp 549-555.

<sup>2</sup> Marquis, S.A., Jr., and Smith, E.A. 1994. Assessment of ground-water flow and chemical transport in a tidally influenced aquifer using geostatistical filtering and hydrocarbon fingerprinting. *Groundwater*. vol. 32, no. 2, pp 190-199.



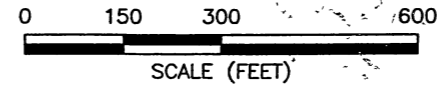
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**NOTE**  
 (1) MEASURED WATER ELEVATION VALUES NOT USED TO CREATE THIS MAP.

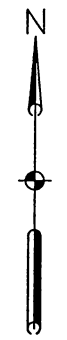
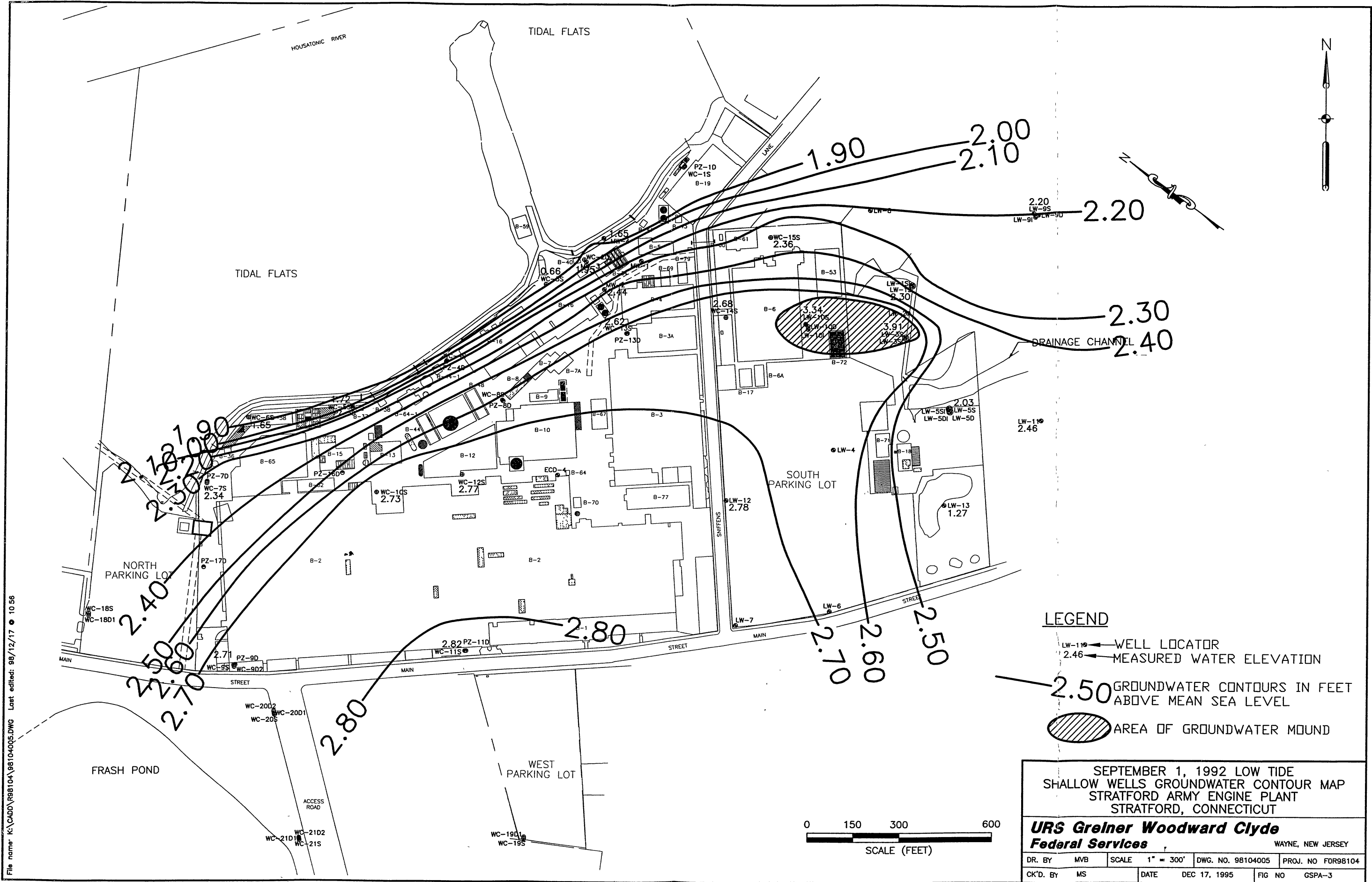
**LEGEND**  
 LW-110 ← WELL LOCATOR  
 2.30 ← MEASURED WATER ELEVATION  
 — 2.20 GROUNDWATER CONTOURS IN FEET ABOVE MEAN SEA LEVEL  
 CONTOUR INTERVAL IS 0.1 FT  
 (Hatched Area) ← AREA OF GROUNDWATER MOUND

FEBRUARY 21, 1995 LOW TIDE  
 SHALLOW WELLS GROUNDWATER CONTOUR MAP  
 STRATFORD ARMY ENGINE PLANT  
 STRATFORD, CONNECTICUT

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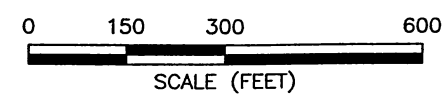


DR. BY	MVB	SCALE	1" = 300'	DWG. NO.	98104006	PRQJ. NO.	FOR98104
CK'D. BY	MS	DATE	JAN 15, 1996	FIG. NO.	GSPA-2		



**LEGEND**

- LW-110 ◉ WELL LOCATOR
- 2.46 ◉ MEASURED WATER ELEVATION
- 2.50 GROUNDWATER CONTOURS IN FEET ABOVE MEAN SEA LEVEL
- ◉ AREA OF GROUNDWATER MOUND



SEPTEMBER 1, 1992 LOW TIDE  
SHALLOW WELLS GROUNDWATER CONTOUR MAP  
STRATFORD ARMY ENGINE PLANT  
STRATFORD, CONNECTICUT

**URS Greiner Woodward Clyde**  
*Federal Services* WAYNE, NEW JERSEY

DR. BY	MYB	SCALE	1" = 300'	DWG. NO.	98104005	PROJ. NO.	FOR98104
CK'D. BY	MS	DATE	DEC 17, 1995	FIG NO	GSPA-3		

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