

HONEYWELL
Jersey City, New Jersey

LONG-TERM MONITORING PLAN
DEEP OVERBURDEN AND BEDROCK
GROUNDWATER REMEDY
HONEYWELL STUDY AREA 7

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SECTION 1

INTRODUCTION

1.1 OBJECTIVES AND SCOPE

This Long-term Monitoring Plan (LTMP) has been prepared in accordance with Section 6 of the Engineering Report for the Deep Overburden and Bedrock Groundwater Extraction and Treatment remedy (Groundwater Remedy) for the Honeywell Study Area 7 (SA-7) site. The purpose of this plan is to define the objectives and components of periodic monitoring to assess the performance and operation of the approved Groundwater Remedy. Since the primary objective of the remedy is downgradient hydraulic containment, the LTMP focuses on hydraulic monitoring of the deep overburden and bedrock zones. The frequency of hydraulic monitoring will be at its maximum during system startup and gradually decreased as confidence in the capture zones is established. Groundwater quality monitoring is included on a less frequent basis to track any long-term changes in the horizontal and vertical extent of the plume. Short term changes in the plume's horizontal extent are not expected from the operation of the downgradient pumping system.

The LTMP has been developed based on the site characterization presented in the Final Groundwater Investigation Report (HydroQual, 2007) and has adopted similar terminology with respect to various site conditions. For example, the term "Study Area" refers to the entire region of investigation including all of SA-5, SA-6, and SA-7, and the portion of the Hackensack River from the Routes 1 & 9 bridge to Upper Newark Bay. As shown on Figure 1-1, the subsurface environment has been defined in terms of both geologic strata, such as the "S-1 Lacustrine Sand", and hydro-stratigraphic intervals such as the "Intermediate Zone". Hydro-stratigraphic intervals are useful for mapping and monitoring groundwater levels and groundwater quality data and have been defined based on the position of monitoring well screened intervals. The following hydro-stratigraphic intervals are referenced in this monitoring plan.

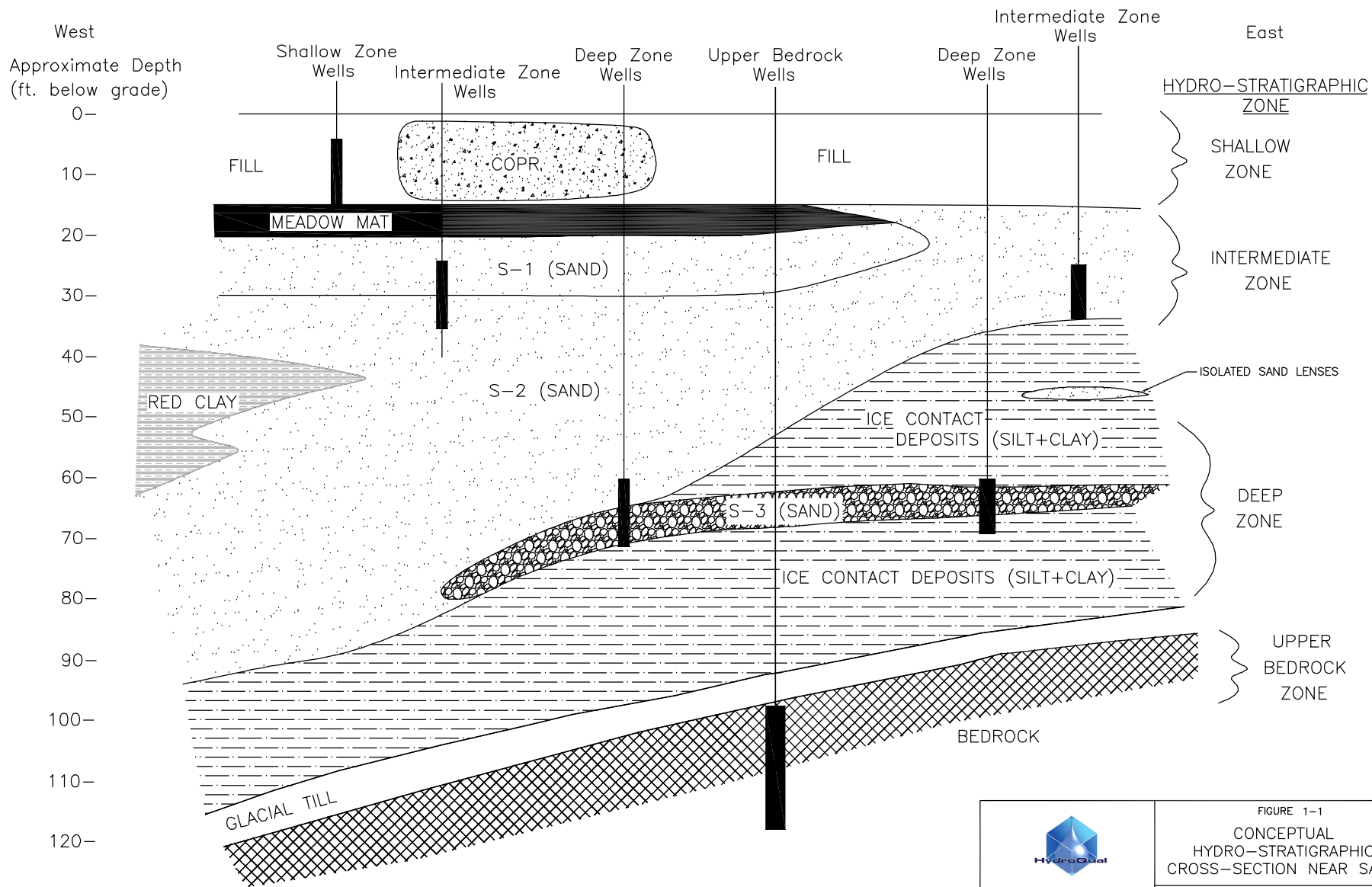
Hydro-stratigraphic Interval	Geologic Strata	Well Screen Interval	Approximate Depth below Grade	Typical Well ID suffix
Shallow Zone	Fill and COPR	Above Meadow Mat	10 to 20 feet	"S" or no suffix
Intermediate Zone	S-1 and upper S-2 Lacustrine Sands	Just below Meadow Mat	20 to 40 feet	"D" or no suffix
Deep Zone	Lower S-2 and S-3 Lacustrine Sands	In S-3 Sand where present, otherwise bottom of S-2.	60 to 90 feet	"T" or no suffix
Bedrock	Top of Bedrock	Upper 20 to 30 feet of bedrock	80 to 130 feet	"BR"

The principal components of this LTMP include the following:

- Hydraulic Monitoring.
- Groundwater Quality Monitoring.
- In-situ Groundwater Sampling Beneath the Hackensack River.
- Plume Diversion Area Monitoring.
- Subsurface Containment Barrier Outward Gradient Monitoring.
- Reporting.

1.2 SUMMARY OF APPROVED GROUNDWATER REMEDY

The Groundwater Remedy consists of deep overburden and bedrock groundwater extraction using three existing recovery wells, with treatment of the extracted water at Honeywell's treatment plant. The extraction wells include 087-PW-1 (deep overburden zone), 087-PW-2 (intermediate overburden zone), and 115-MW-203BR (bedrock). The two overburden wells are located near the downgradient end of the deep overburden plume and are intended to contain the plume from further off-site migration. Initially, 087-PW-1 and 087-PW-2 will be pumped at approximately 40 and 15 gpm, respectively in order to reverse hydraulic gradients in the deep overburden beneath the Hackensack River and pull back the river-ward portion of the plume. Once this has been accomplished, pumping rates may be reduced to maintain landward containment of the plume. The bedrock extraction well is located in the southwest corner of Site 115 and will be pumped at about 7 gpm to contain the bedrock plume.



HYDROQUAL, INC.
1200 MACARTHUR BOULEVARD
MAHWAH, NEW JERSEY 07430
(201) 529-5151 F: 529-5728

FIGURE 1-1
CONCEPTUAL
HYDRO-STRATIGRAPHIC
CROSS-SECTION NEAR SA-7

HONEYWELL STUDY AREA 7
JERSEY CITY, NJ

SECTION 2

HYDRAULIC MONITORING

2.1 OBJECTIVES

The objectives of the hydraulic monitoring portion of the LTMP include the following:

- 1) Confirm the magnitude and extent of drawdown in the vicinity of the extraction wells during the startup period. This information will be compared to model predictions and the results used to re-affirm the extent of the capture zones in the various water-bearing zones.
- 2) Track long-term changes in the direction of groundwater flow within the regional study area. Long-term changes may be caused by seasonal fluctuations in recharge from precipitation, remedial actions such as capping and the installation of subsurface barriers, changes in stormwater runoff patterns/infiltration areas due to re-development, changes to sewer lines, completion of the SA-7 excavation remedy, etc.
- 3) Monitor tidal fluctuations in the Hackensack River during water level measurement rounds for use in normalizing groundwater elevation measurements.
- 4) Document the rate and total volume of groundwater that is extracted and treated from the three recovery wells.

2.2 GROUNDWATER LEVEL MONITORING

Groundwater level monitoring will include both short and long-term programs as described below.

2.2.1 Short-term Monitoring at Startup

Water level monitoring during the startup of the Groundwater Remedy will consist of a pre-pumping round of groundwater levels from all available wells within the Study Area. These wells are shown on Drawing A-1 in Attachment A. This round is intended to document the “static” or base-case conditions and will be used as a point of comparison to calculate the drawdown due to pumping.

During the first 30 days of operation, automatic data loggers will be used to provide near-continuous water level data in the following key monitoring well clusters.

- SA6-MW-AA1D, SA6-MW-AA1T, SA6-MW-5BR-1
- 087-OBS-1D, 087-OBS-1T

- 087-MW-W25D, 087-MW-W25T, 087-MW-35
087-MW-O29D, 087-MW-29T, 087-OBS-4T

In addition, manual water level measurements will be collected from the wells shown on Figure 2-1 on a daily basis for the first week after startup, and then once per week for the first three months.

2.2.2 Long-term Monitoring

The long-term hydraulic monitoring program will be conducted quarterly for the first five years of operation, semi-annually during years five through ten, and on an annual frequency thereafter. This proposed frequency will be reassessed after the first five years of operation based on the available data. A five-year period was selected to cover the anticipated re-development activities within SA-5 and SA-6 that may influence groundwater flow. As confidence in the capture zones is developed and re-development activities at SA-5 and SA-6 subside, the frequency may be modified accordingly.

Each water level round will include shallow, intermediate, deep and bedrock monitoring wells and piezometers, and available pumping wells. The shallow zone wells have been included in this plan to provide information on how the three-dimensional groundwater flow regime may be impacting groundwater quality within the deep overburden. These data will be corrected for tidal influences as discussed in Section 2.3 and used to develop groundwater elevation contour maps of the Shallow, Intermediate, and Deep overburden zones as well as the upper bedrock. The wells to be included in each round are shown on Drawing A-1 in Appendix A.

2.2.3 Monitoring of Outward Gradient Across Subsurface Containment Barrier (SCB)

The long-term hydraulic monitoring program will include an assessment of the required outward gradient from SA-7. This will be accomplished through monitoring of the head in each of the ten “perimeter pools” and comparing these data to groundwater elevations in the eight shallow piezometers located just outside of the SCB. These piezometers include E1-SO through E5-SO around the east cell, and W1-SO through W3-SO around the west cell. Water level elevations from monitoring wells located outside of the SCB on SA-6 north and south will also be included in the assessment. Sampling frequency will coincide with long-term hydraulic monitoring events.

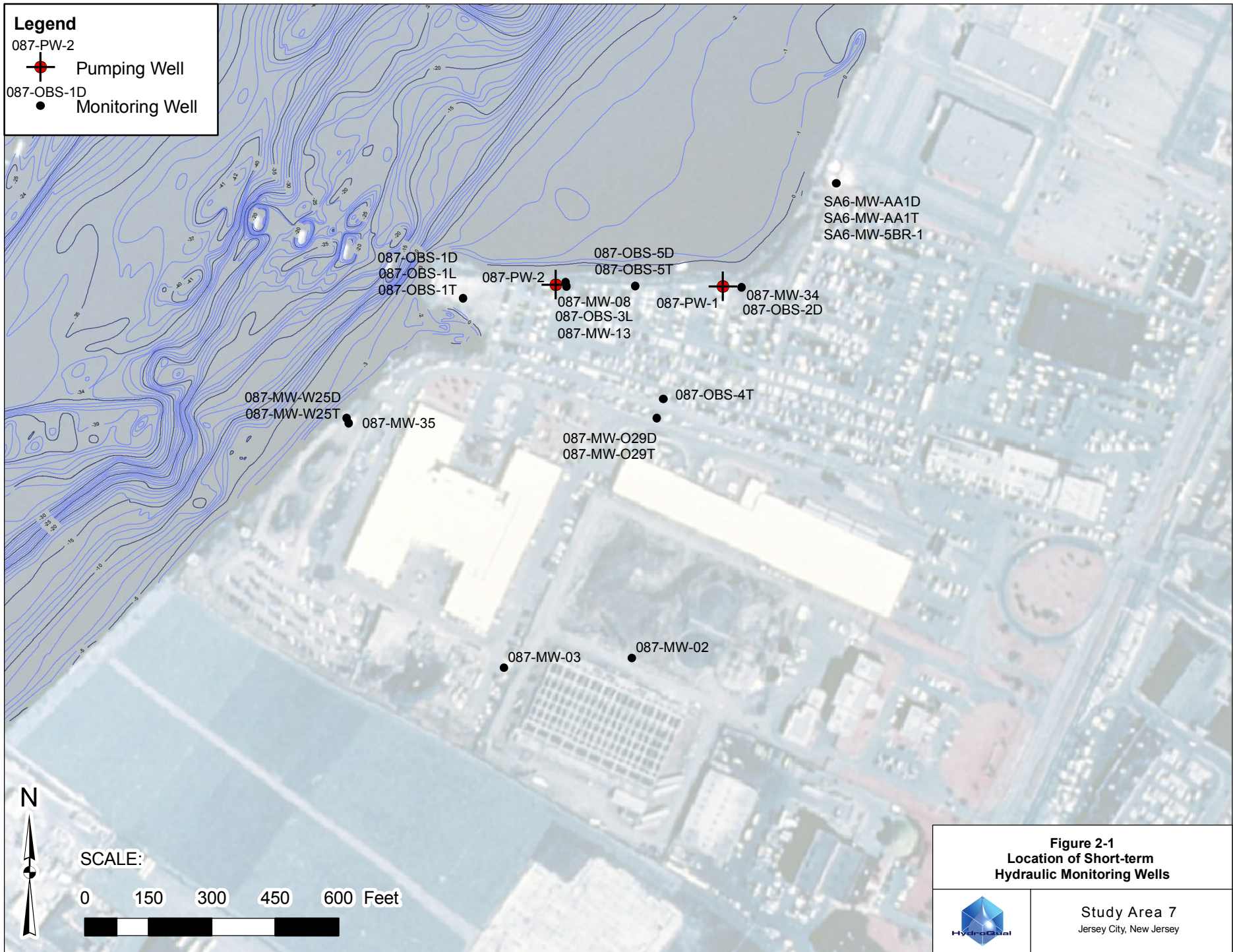
2.3 TIDAL MONITORING

During the first three months after startup of the pumping system, tidal monitoring will be conducted using the existing automatic data recorder located on the SA-7 bulkhead. This tide gauge is maintained by Ocean Surveys Inc. (OSI) and will be downloaded on a monthly frequency during this three-month period. These data will be used to correct

groundwater elevations for tidal influences and to define the capture zones. Subsequent to this three-month period, river stage data will be collected on an as-needed basis during each of the site-wide hydraulic monitoring events. A temporary staff gauge will be established on the SA-7 bulkhead and a pressure transducer used to monitor river elevations. All tidal monitoring data will be automatically recorded every six minutes in NGVD-29 datum.

2.4 FLOW RATE MONITORING

Flow rate monitoring will be conducted on each of the three force mains using flow meters located on the piping after it enters the treatment plant, prior to flow equalization. The flow rate will be controlled by a flow control valve, operated via a Programmable Logic Controller (PLC), located in the treatment plant. Flow data in gallons per minute will be automatically recorded every hour and periodically downloaded to a database for inclusion in the performance monitoring report.



SECTION 3

GROUNDWATER QUALITY MONITORING

3.1 OBJECTIVES

The objectives of the groundwater quality monitoring portion of the LTMP include the following:

- 1) Establish baseline groundwater quality by sampling each of the 45 wells identified in the water quality monitoring plan prior to system startup.
- 2) Confirm that the horizontal and vertical extent of the plume is within the capture zone of the Groundwater Remedy. This will be accomplished by monitoring wells around the perimeter of the plume.
- 3) Monitor the effluent quality of the discharged water from each of the three extraction wells. This will be used to determine the relative contribution of chromium and other parameters to the treatment plant from each of the wells.
- 4) Periodically assess the effectiveness of the Groundwater Remedy at pulling back the river-ward portion of the deep overburden plume. This will be accomplished through the collection of in-situ groundwater samples from beneath the soft riverbed sediments. Prior sample locations will be revisited (using GPS coordinates) in order to directly compare pre- and post-remedy concentrations.
- 5) Monitor the water quality in the vicinity of the “plume diversion area” south of the SA-7 barrier wall. This will be accomplished through monitoring of selected perimeter wells around this portion of the plume.

3.2 MONITORING WELL SAMPLING

A total of 28 existing monitoring wells and the three pumping wells have been included in the groundwater quality monitoring component of the LTMP. These wells monitor the plumes in the Intermediate, Deep, and Upper Bedrock zones and have been organized into the sampling schedule provided on Table 3-1. Well construction details are provided on Table 3-2.

3.2.1 Bedrock Zone

Groundwater quality monitoring of the bedrock will be conducted using ten perimeter wells and the pumping well as shown on Figure 3-1. The perimeter wells will be sampled once prior to startup, biennially during the first five years of operation, and then every five years thereafter. This proposed sampling frequency will be re-assessed at the end of the initial five-year period based on a review of the available data.

3.2.2 Intermediate and Deep Overburden Zones

Groundwater quality monitoring of the overburden water-bearing zone will be conducted using thirteen perimeter wells and the two pumping wells as shown on Figures 3-2 and 3-3 for the Intermediate and Deep hydro-stratigraphic intervals, respectively. These wells will be sampled once prior to startup, biennially during the first five years of operation, and then every five years thereafter. This proposed sampling frequency will be re-assessed at the end of the initial five-year period based on a review of the available data.

3.2.3 Plume Diversion Area

Groundwater quality in the plume diversion area will be monitored by sampling five deep zone wells prior to startup, biennially during the first five years of operation, and then every five years thereafter. This proposed sampling frequency will be re-assessed at the end of the initial five-year period based on a review of the available data. As shown on Figure 3-3, these wells are located around the perimeter of the plume diversion area and, in conjunction with wells 124-MW-102T and 124-MW-107T to be monitored as part of the perimeter program described in Section 3.2.2, will provide complete coverage around this area. The objective of this program is to determine if downgradient movement of this plume is occurring due to the placement of the SA-7 subsurface barrier wall.

3.3 IN-SITU GROUNDWATER SAMPLING BENEATH RIVER

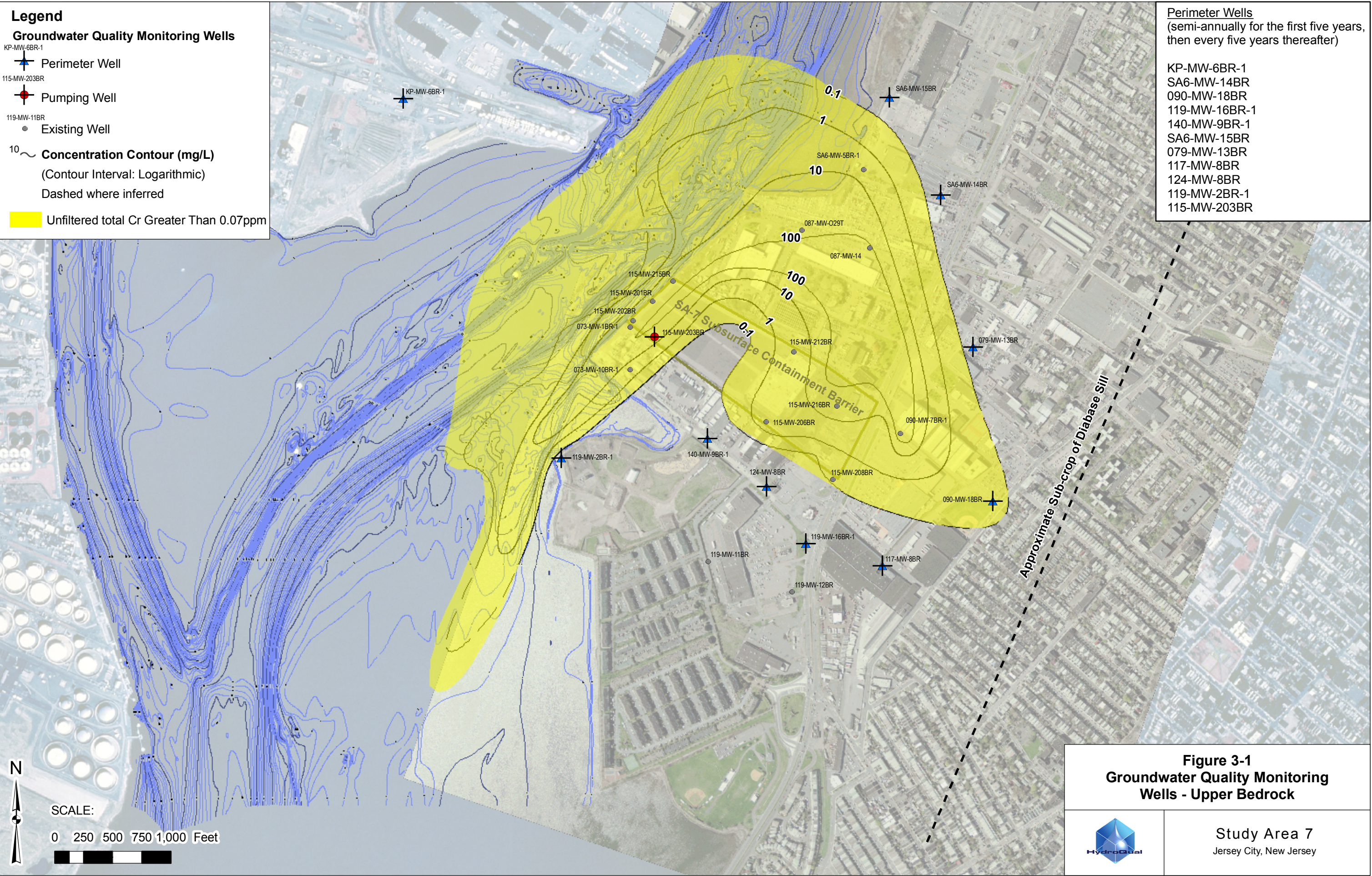
In-situ groundwater samples will be obtained from five locations beneath the Hackensack River as shown on Figure 3-4. These locations coincide with prior groundwater samples collected during the off-site deep overburden investigation in 2005. The prior sample location IDs are provided on the figure for reference, as is the distribution of hexavalent chromium in groundwater in the upper lacustrine sand, directly beneath the soft riverbed sediments (taken from Figure 4.4-4 of the FGIR). Samples will be collected once every five years until the plume has been pulled back due to pumping from 087-PW-1 and 087-PW-2. Plume pull-back will be considered complete when hexavalent chromium concentrations measured at these locations are below the NJGWQC of 0.7 ppm.

Each sample will be obtained using a GeoProbe sampler from a boat in the same manner as that used in the prior investigation. The sampling boat will be positioned over the location using the on-board GPS navigation system. Based on the accuracy of this system, the new location is expected to be within 2 to 4 feet of the prior location. A GeoProbe sampling tool will then be lowered to the top of the riverbed sediments and pushed through the soft organic muds to the top of the native lacustrine sand. The probe will be driven approximately four feet into the sand using a weighted hammer on a tripod. A small diameter solid rod will be inserted through the hollow drive rods and used to hold the bottom of the sampler in position while the outer sheath is pulled back approximately 18 inches, exposing the stainless steel screen. A peristaltic pump will then be attached to

flexible polypropylene tubing placed down the temporary well to a position across from the well screen. The well will be pumped until the discharge runs clear, or its turbidity has stabilized. Groundwater samples will be directed from the sample tubing into appropriate containers. The pH, salinity, turbidity, yield, and color of the discharged water will be monitored in the field during purging.

3.4 WATER QUALITY PARAMETERS

All groundwater samples will be analyzed for total and hexavalent chromium. Both filtered and unfiltered samples will be collected. Although it is understood that only total chromium in unfiltered samples is currently regulated, knowing the percentage of hexavalent chromium in the sample and the degree to which the total chromium concentration is reduced due to field filtering aids in the understanding of the mechanisms involved in plume migration. This is especially pertinent for the in-situ samples collected from beneath the river, which are often turbid due to the nature of sample collection. Samples collected from the three pumping wells will be analyzed for total and hexavalent chromium (filtered and unfiltered), volatile organic compounds, and TAL metals.



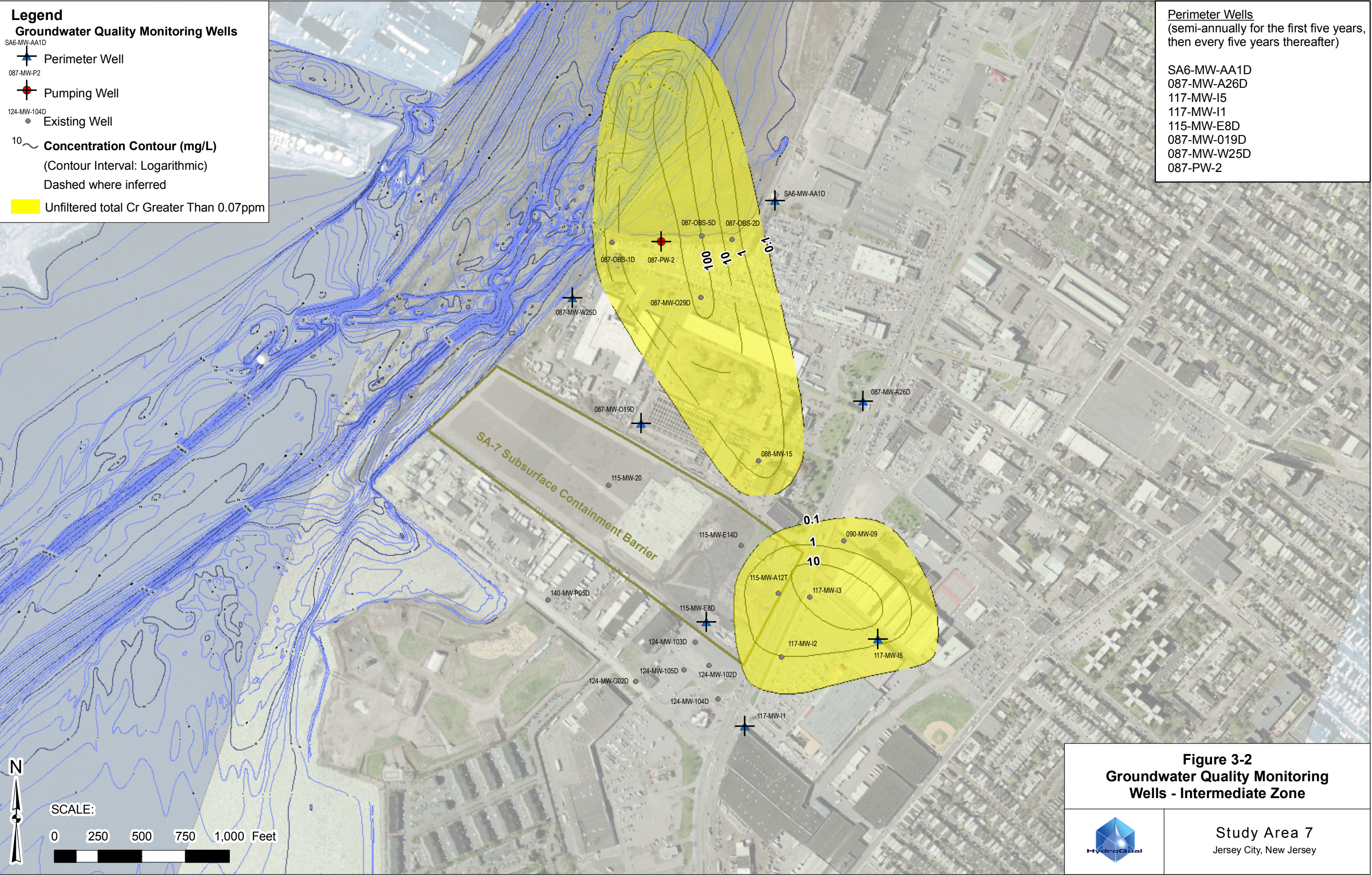





Figure 3-2
Groundwater Quality Monitoring
Wells - Intermediate Zone



Study Area 7
Jersey City, New Jersey

Legend

- PW-003-050  Insitu Groundwater Sample Location obtained using GeoProbe sampler samples collected beneath riverbed muds.
- 087-PW-2  Pumping Well
- 10  Hexavalent Chromium Concentration Contour (Contour Interval: Logarithmic)

In-situ Sample Locations

PW003-050
PW003-600
PW009-450
PW009-750
PW010-150

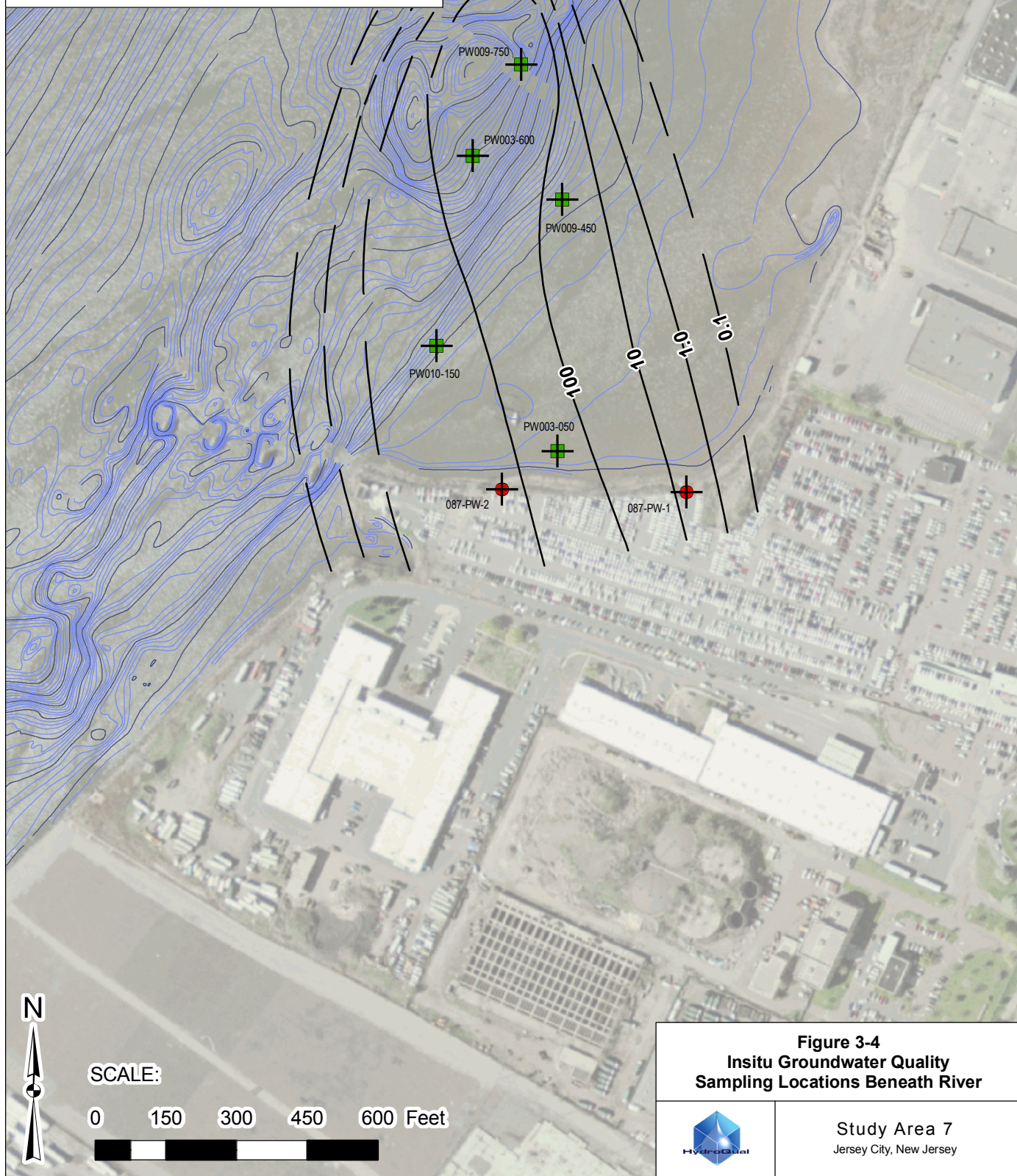


TABLE 3-1
SUMMARY OF GROUNDWATER SAMPLING LOCATIONS

<u>Pumping Wells</u>	<u>Perimeter Wells</u>	<u>Plume Diversion Wells</u>	<u>GeoProbe Samples</u> <u>Beneath River</u>
Intermediate <u>Zone</u>	Intermediate <u>Zone</u>	Intermediate <u>Zone</u>	<u>Beneath River Sediments</u>
087-PW-2	SA6-MW-AA1D 087-MW-A26D 087-MWO19D 087-MW-W25D 115-MW-E8D 117-MW-I1 117-MW-I5	124-MW-104T 124-MW-106T 124-MW-G02T 119-MW-01T 119-MW-02T	PW003-050 PW003-600 PW009-450 PW009-750 PW010-150
<u>Deep Zone</u>	<u>Deep Zone</u>		
087-PW-1	SA6-MW-AA1T 087-MW-A26T 087-MW-W25T 117-MW-D3 124-MW-102T 124-MW-107T		
<u>Bedrock Zone</u>	<u>Bedrock Zone</u>		
115-MW-203BR	SA6-MW-14BR KP-MW-6BR-1 090-MW-18BR 119-MW-16BR-1 140-MW-9BR-1 SA6-MW-15BR 079-MW-13BR 117-MW-8BR 119-MW-2BR-1 124-MW-8BR		

Table 3-2
Monitoring Well Construction Details

WELL ID	Ref. Pt. Elev. (ft, msl)	Zone	X Coord.	Y Coord.	Ground Elev. (ft, msl)	Inner Casing Diam. (in)	Screen Length (ft.)	Screen Bottom Depth (ft)	Date Installed
087-MW-A26T	9.99	Deep	604020.6	685824.8	10.72	2	15	56	2/27/01
087-MW-W25T	18.49	Deep	602349.3	686408.5	16.42	2	15	91	2/21/01
087-PW-1	(*)	Deep	(*)	(*)	(*)	8	10	69	3/23/07
117-MW-D3	18.85	Deep	604105.3	684456.8	19.11	2	10	80	11/21/06
119-MW-01T	10.78	Deep	602809.6	683982.2	11.13	2	10	62	8/31/06
119-MW-02T	8.8	Deep	603011.1	683786.4	9.08	2	10	70	8/21/06
124-MW-102T	9.33	Deep	603140.1	684303.9	9.61	2	10	75	5/11/05
124-MW-104T	9.305	Deep	603172.8	684122.2	9.545	2	10	68	10/12/05
124-MW-106T	9.24	Deep	602659.2	684430.6	9.69	2	10	78	7/23/06
124-MW-107T	9.08	Deep	602820.9	684581	9.29	2	10	70	8/15/06
124-MW-G02T	9.5	Deep	602695.9	684225.5	9.84	2	10	69	5/5/99
SA6-MW-AA1T	15.31	Deep	603513.6	686981.5	15.88	2	10	70	12/5/00
087-MW-A26D	10.43	Intermediate	604012.3	685824	10.63	2	10	28	2/27/01
087-MW-O19D	13.75	Intermediate	602742.9	685697.7	13.8	2	10	37	10/14/97
087-MW-W25D	18.42	Intermediate	602349.6	686416.9	16.01	2	10	66	2/21/01
087-PW-2	(*)	Intermediate	(*)	(*)	(*)	8	20	48	3/27/07
115-MW-E8D	17.14	Intermediate	603116.3	684560.9	15	2	10	35	10/8/97
117-MW-I1	11.08	Intermediate	603336.2	683965.2	11.34	2	10	22	12/13/06
117-MW-I5	18.76	Intermediate	604098.1	684463.1	19.11	2	15	37	11/27/06
SA6-MW-AA1D	19.36	Intermediate	603509.2	686973.3	19.59	2	10	32	12/1/00
079-MW-13BR-1	13.08	Rock	604496.6	685435.9	12.098	*	10	121	11/10/06
090-MW-18BR	16.36	Rock	604665	684115	16.76	2	15	154	9/21/06
117-MW-8BR	12.94	Rock	603717.3	683557.9	13.12	2	10	125	12/29/04
119-MW-16BR-1	8.61	Rock	603060	683750	9.07	*	15	151	8/8/06
119-MW-2BR-1	8.426	Rock	600960.5	684484.9	9.057	*	15	163	2/2/05
124-MW-8BR	9.7	Rock	602723.3	684240.1	10.02	2	20	133	11/11/05
140-MW-9BR-1	7.32	Rock	602215.6	684650.5	7.92	*	15	153	7/31/06
KP-MW-6BR-1	8.941	Rock	599602.1	687569.6	9.369	*	14	153	3/2/05
SA6-MW-14BR	9.99	Rock	604217.5	686740.4	10.41	2	10	85	10/2/06
SA6-MW-15BR	8.076	Rock	603777.3	687578.4	8.431	6	20	103	10/7/05
115-MW-203BR	8.7	Rock-Upper	601761.4	685524.2	7.34	4	20	162	2/26/04

Notes:

(*) Pending re-survey following remedy construction.

SECTION 4

REPORTING

Data collected from implementation of the LTMP will be reported in an annual Progress Report. The report content will vary depending on the type of data collected during the preceding year. Each report will include the following:

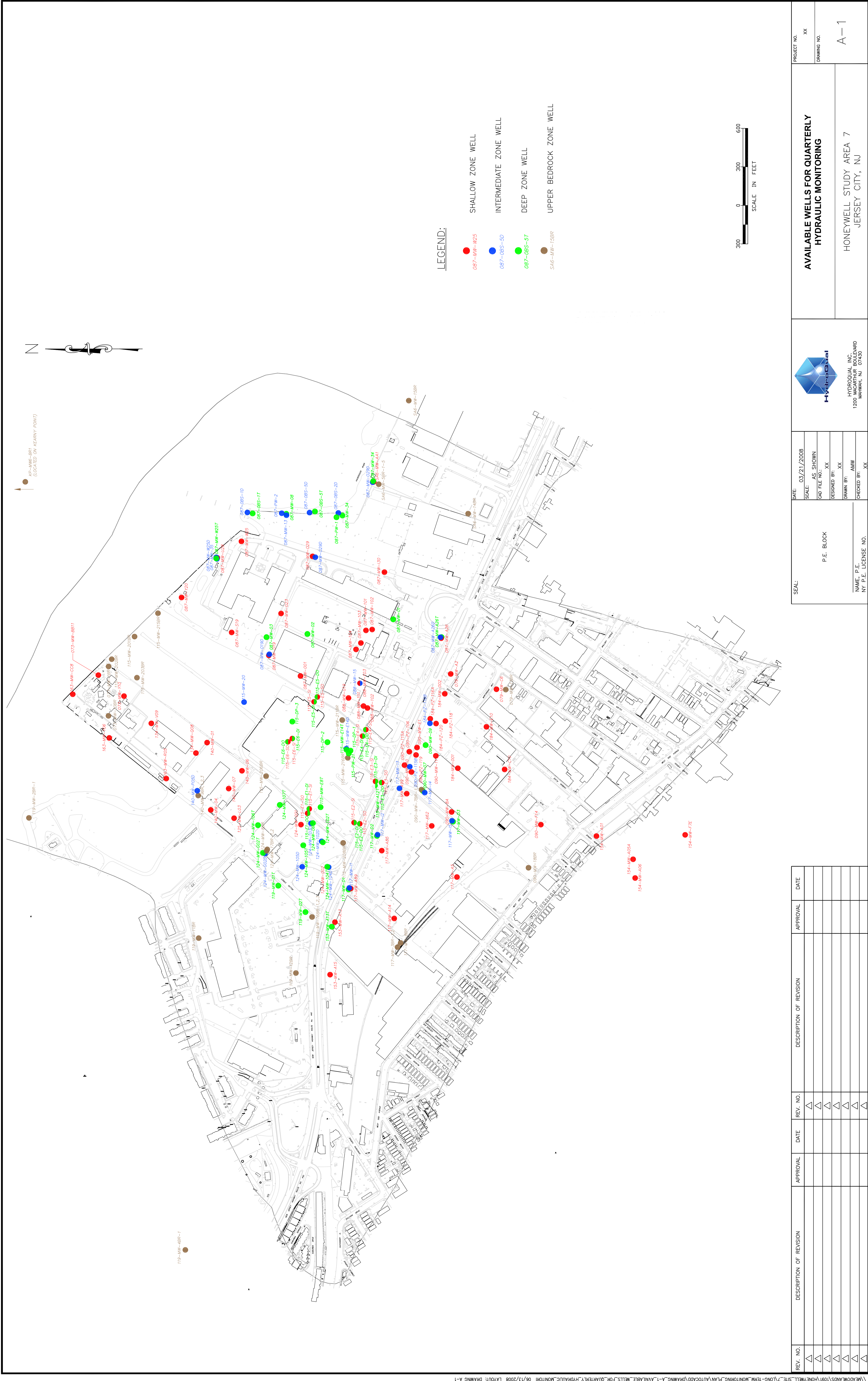
- Groundwater elevation contour maps for each of the four hydro-stratigraphic zones.
- Hydrographs depicting water level elevations through time for selected wells.
- Time-series plots of pumping rates for each of the groundwater extraction wells
- Bar-graphs depicting daily rainfall totals.
- A discussion of the results, noting any changes in the groundwater flow patterns
- Recommendations for modifications to the frequency of monitoring, or other aspects of implementation of the Groundwater Remedy or the LTMP.

During the years in which water quality sampling has been conducted, the annual Progress Report will also include the following:

- Groundwater quality maps depicting the distribution of total and hexavalent chromium in the Intermediate, Deep, and Upper Bedrock zones (one map will be prepared for each zone).
- Groundwater quality plots depicting total and hexavalent chromium concentrations through time in selected wells.
- Comparison of pre- and post remedy chromium concentrations beneath the river (as available).
- A discussion of the results, noting any changes in the extent of the plumes.

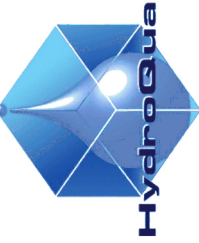
APPENDIX A

DRAWINGS



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		DRAWN BY: AMW
		CHECKED BY: XX

 HYDROQUAL INC. 1200 MACARTHUR BOULEVARD MARTON, NJ 07430	AVAILABLE WELLS FOR QUARTERLY HYDRAULIC MONITORING		PROJECT NO. XX
	HONEYWELL STUDY AREA 7 JERSEY CITY, NJ		DRAWING NO. A-1