CDM Camp Dresser & McKee

Addendum to OU-1 Final Design Report

Description of Model Simulations

Lockheed Martin
Great Neck, New York
NYSDEC Site No. 130045

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Addendum to OU-1 Final Design Report
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1.0 INTRODUCTION

This Addendum to the OU-1 Final Design Report was compiled by Camp Dresser & McKee, Inc. (CDM) to document the results of groundwater flow and mass transport simulations performed in support of the OU-1 groundwater remediation system design for the Lockheed Martin facility in Great Neck, New York.

The groundwater flow and mass transport models developed for the site were used to evaluate the hydraulic capture zone of the OU-1 remediation system and to estimate dissolved total volatile organic compound (TVOC) mass removal rates.

2.0 MODEL BACKGROUND

The development, calibration, and application of the groundwater flow and mass transport models has been presented to the New York State Department of Environmental Conservation (NYSDEC) previously during progress meetings in February 1998 and July 1998. An overview of the models and their application is presented below.

Groundwater flow and mass transport models have been developed as part of an investigation of groundwater flow and contaminant migration pathways near the Lockheed Martin Great Neck site. The groundwater flow model was developed using DYNFLOW, a fully three-dimensional, finite element groundwater flow model. The flow model was based on the existing stratigraphy and hydrogeologic properties represented in the Nassau County regional model (NCRM) and the Great Neck model (GNM), and supplemented with local site data from boring logs. The NCRM was also used to provide boundary conditions for the Lockheed Martin model.

The model domain covers an area of approximately 39 square miles and extends south and east from the site approximately 2 miles. To the north, the model domain extends to Long Island Sound, including all of the Great Neck Peninsula. The model extends somewhat further from the site to the west than the east to account for a slight westward component of groundwater flow near the site.

The flow model consists of eight layers which represent the major formations beneath the site including the Upper Glacial, Magothy, Raritan, and Lloyd formations, as well as the more complex stratigraphy beneath the Great Neck peninsula. Public supply and non-municipal well withdrawals are simulated in the model. Operation of onsite IRM groundwater pumping and reinjection (diffusion) is also represented in the model. A nonuniform areal groundwater recharge distribution based on the NCRM is assigned to the model and accounts for variations in land use, sewering and pipe leakage. The model was calibrated to steady state conditions, as well as transient conditions observed during pumping tests conducted at the site.

Once calibrated, the groundwater flow model was used to simulate OU-1 remediation pumping and reinjection. For these simulations, average groundwater recharge and average 1996 pumping rates were assigned to public supply wells and non-municipal wells.

The mass transport of the groundwater TVOC plume was simulated for the proposed OU-1 remedy using DYNTRACK, a three-dimensional mass transport simulation code. TVOC was defined as the sum of PCE, TCE, cis-1, 2-DCE and vinyl chloride concentrations. The mass transport model used estimates of the TVOC distribution based on October 1997 water quality data as the starting condition, plus a representation of a diminishing source at the dry well area, for simulating future plume migration and mass removal by the OU-1 remediation system. The mass transport model does not account for decay of the mass of TVOC in the aquifer, which results in a conservative estimate of mass in the system. The retardation factor used was 1.0.

3.0 OU-1 FINAL DESIGN GROUNDWATER EXTRACTION SIMULATIONS

The groundwater extraction remedy specified in the Record of Decision (ROD) for the site (NYSDEC, March 1997) consists of five groundwater extraction wells pumping a total of 1,800 gpm (Figure 1). The proposed extraction wells include existing wells EW-1, RW-1 and EW-3, and new wells RW-1A and RW-3. Under the proposed groundwater remedy, once the groundwater is extracted and treated, it will be discharged to the subsurface via five diffusion (recharge) wells which will be located along the southern property line.

Model simulation of the ROD remedy indicated that the operation of extraction well EW-3 would draw part of the existing groundwater plume eastward, and may cause groundwater concentrations in the eastern portion of the site to increase. Based on a review of these modeling results, CDM and Lockheed Martin concluded that it would be undesirable to operate extraction well EW-3 as part of the OU-1 groundwater remedy because of the potential for spreading the lateral extent of the high-concentration areas of groundwater plume into less contaminated areas.

As a result, the OU-1 groundwater remedy was revised to consist of four wells (EW-1, RW-1, RW-1A and RW-3) pumping at the same combined rate of 1,800 gpm as the original remedy. For the modified remedy, groundwater extraction rates were increased by twenty percent at each well (i.e., EW-1, RW-1, RW-1A and RW-3). The location and number of the diffusion wells did not change. Table 1 lists the components of the original and final OU-1 groundwater extraction remedies.

The final groundwater remedy was compared to the original remedy using steady-state capture zone analysis. Figure 2 shows the simulated capture zones for the original and final OU-1 groundwater remedy for the basal Magothy, upper Magothy and Upper Glacial model layers. The capture zones are based on a 30-year simulation period. A comparison of the simulated capture zones indicates that the hydraulic capture achieved by the two groundwater pumping scenarios is generally similar. The final OU-1 remedy imposes hydraulic control over a slightly larger area to the north and west of the site than the ROD remedy, particularly in the basal Magothy aquifer. The capture zone for the final OU-1 remedy extends slightly less far to the east of the site, where TVOC concentrations are lower than north of the site.

The mass transport simulations were performed to evaluate TVOC mass removal by the original ROD and final OU-1 remedy. Simulated maximum aquifer TVOC concentrations after 10 and 20 years are shown in Figure 3. The simulated mass removal for the two scenarios were compared over a projected operation period of twenty years. The results of this comparison are presented in the table below and shown graphically in Figure 4. Comparison of simulated mass removal indicates that the final OU-1 groundwater remedy removes slightly more contaminant mass from the groundwater system. More contaminant mass is removed by the modified remedy due to increased groundwater pumping in the high TVOC concentration area of the groundwater plume.

Simulated Mass Removed
(Percent of Estimated Total Mass)

Scenario	5 Years	10 Years	15 Years	20 Years
ROD Remedy	44%	62%	67%	69%
Final OU-1 Remedy	49%	64%	70%	72%

Based on the estimated current plume extent, neither remedy will achieve 100 percent removal of the contaminant mass in the groundwater, because a portion of the groundwater plume is offsite and not within the capture zone of either the ROD remedy or the proposed final OU-1 remedy.

As a result of the analysis described above, the modified groundwater remedy was selected for implementation for OU-1 groundwater remediation.

4.0 ADDITIONAL SIMULATIONS

In addition to the simulation results for the proposed OU-1 remedy, the NYSDEC also requested model simulation results for the following remediation pumping scenarios:

- Final OU-1 remedy with no onsite groundwater recharge

- Remediation pumping at final OU-1 remediation wells and in dry well area
- Final OU-1 remedy with increased pumping at nearby Manhasset-Lakeville Water District Wells N-03905, N-04243, N-05710
- Final OU-1 remedy with increased pumping at Garden City Park Water District Wells N-07512 and N-10612

Simulated capture zones, TVOC plume extent at 10 and 20 years, and TVOC mass removal for these scenarios are presented below.

4.1 FINAL OU-1 REMEDY WITH NO ONSITE GROUNDWATER RECHARGE

The groundwater flow model was used to simulate final OU-1 groundwater remediation pumping without onsite groundwater recharge of the treated water. For this simulation, remediation pumping rates were the same as those listed in Table 1 for the final OU-1 remedy. The simulated capture zones for the basal Magothy, upper Magothy and upper Glacial model layers for this scenario are shown in Figure 5. Comparison of these capture zones to those computed for the final OU-1 remedy (Figure 2), which includes onsite groundwater recharge, indicates that without onsite recharge, the hydraulic capture zone of the remediation pumping wells is greater, particularly north, west and south of the site.

Mass transport simulations were performed to evaluate the mass removal and TVOC plume extent after 20 years of operation under this scenario. Mass transport simulation results suggest that approximately 73 percent and 82 percent of the estimated initial TVOC mass is removed after 10 and 20 years, respectively, for this scenario. Figure 6 shows the simulated maximum aquifer TVOC concentrations after 10 and 20 years.

4.2 REMEDIATION PUMPING AT FINAL OU-1 REMEDIATION WELLS AND IN DRY WELL AREA

The groundwater flow model was also used to evaluate the hydraulic influence of remediation pumping in the dry well area. For this simulation, the original ROD remediation pumping rates (Table 1) were assigned for extraction wells EW-1, RW-1, RW-1A and RW-3. The pumping previously assigned to well EW-3 was shifted to an upper Magothy well in the same location as RW-2. The total extraction rate for this simulation was 1,800 gpm. Onsite groundwater recharge of 1,800 gpm to the final OU-1 design diffusion wells was also simulated.

The simulated capture zones for this scenario are presented in Figure 7. North of the site, where groundwater TVOC concentrations are higher, the capture zones in the upper Glacial and upper Magothy are slightly smaller for this scenario than those for the final OU-1 remedy. Simulation results indicate that 64 percent and 69 percent of the estimated initial TVOC mass is removed after 10 and 20 years, respectively. The simulated mass removal for this scenario is generally comparable to that achieved by the final OU-1 remedy after 10 years, and slightly less than that achieved by the final OU-1 remedy after 20 years. Figure 8 shows the simulated maximum TVOC concentrations in the groundwater for this scenario after 10 and 20 years.

4.3 FINAL OU-1 REMEDY WITH INCREASED PUMPING AT NEARBY MANHASSET-LAKEVILLE WATER DISTRICT WELLS

The public supply well pumping assigned to the model for the OU-1 remediation simulations was based on average 1996 pumping rates. The average 1996 pumping rates for Manhasset-Lakeville Water District wells N-03905, N-04243, and N-05710, which are located approximately 1200 feet north of the site, were 23 gpm, 3 gpm and 215 gpm, respectively. During a meeting with NYSDEC on September 19, 1998, the Department requested that the groundwater flow model be used to simulate the operation of the final OU-1 remedy with wells N-03905, N-04243, and N-05710 pumping at a combined rate of 2,600 gpm, the estimated capacity of the treatment system for these wells. In addition, the Department requested that the pumping be concentrated at wells N-03905 and N-04243 (Parkway wells).

For this simulation, wells N-03905 and N-04243 were each assigned a pumping rate of 1,050 gpm and well N-05710 was assigned a rate of 500 gpm. Final OU-1 design groundwater remediation pumping and recharge (Table 1) were simulated.

The simulated capture zones for the OU-1 remediation system in this scenario are shown in Figure 9. In comparison to the OU-1 design simulation (Figure 2), the extent of hydraulic capture by the onsite remediation wells is reduced north of the site in upper Glacial and upper Magothy model layers when the Parkway wells are pumping at a higher rate. In the basal Magothy, hydraulic capture by the onsite remediation wells is almost completely eliminated. Mass transport results for this scenario indicate that the remediation wells extract 54 percent and 58 percent of the estimated initial TVOC mass after 10 and 20 years, respectively. Figure 10 shows simulated maximum aquifer TVOC concentrations after 10 and 20 years.

Based on historical data for the period 1990 to 1996, groundwater withdrawals from wells N-03905, N-04243 and N-05710 have not been nearly as high as those specified for the simulation discussed above. Between 1990 and 1996, average annual pumping was highest at these wells in 1994 when the combined pumpage was 793 gpm (Parkway wells: 377 gpm; N-05710: 416 gpm), which is less than one third of the estimated treatment capacity.

A second simulation of the final OU-1 groundwater remediation system was performed with wells N-03905, N-04243, and N-05710 pumping at average 1994 pumping rates. The simulated remediation well capture zones for this scenario are shown in Figure 11. For this scenario, mass transport results indicate that at the end of 10 and 20 years, respectively 63 percent and 69 percent of the starting TVOC mass is removed. The mass removal for this scenario is not significantly different from that estimated from the OU-1 final design simulation where the above listed public supply wells were pumping at average 1996 rates. Simulated maximum TVOC concentrations at the end of 10 and 20 years are shown in Figure 12.

4.4 FINAL OU-1 REMEDY WITH INCREASED PUMPING AT GARDEN CITY PARK WATER DISTRICT WELLS

In a telephone conversation on January 15, 1999, the Department also requested that the hydraulic capture zone of the proposed OU-1 remediation system be evaluated with increased pumping at Garden City Park District wells N-07512 and N-10612. The OU-1 design simulations include average 1996 pumping rates, which at wells N-07512 and N-10612 totaled 829 gpm. Based on pumpage data from the period 1990 to 1996, the highest average annual pumpage was recorded in 1994 when wells N-07512 and N-10612 pumped a total of 1286 gpm.

Simulations of the OU-1 remediation system with increased pumping at wells N-07512 and N-10612 were perfromed to evaluate whether any changes in the OU-1 remediation system capture may result from increased pumping at these public supply wells located east of the site. Figure 13 shows the capture zone simulation results for this scenario. The capture zones presented in this figure are not siginificantly different from those presented for the OU-1 design simulations (Figure 2). Mass transport simulation results indicate that 65 percent and 72 percent of the initial TVOC mass is removed after 10 and 20 years respectively. The simulated mass removal for this scenario is essentially the same as for the OU-1 design simulation (Section 3). The simulated maximum aquifer TVOC concentrations for this scenario are presented in Figure 14.

5.0 SUMMARY

The groundwater flow and mass transport models developed for the site were used to evaluate and refine the OU-1 groundwater extraction system. In addition, model simulations were used to evaluate the hydraulic impact of no onsite recharge and different pumping rates at nearby public supply wells.

The final OU-1 remedy will consist of four wells pumping at a combined rate of 1,800 gpm. The resulting capture zone will extend across the Great Neck site, and will include some off-site areas to the north, east, and west. Over a period of approximately twenty years, approximately two thirds of the estimated mass of the TVOC plume may be captured by the OU-1 remedial system.

OU-1 REMEDIATION
Pumping Information

Extraction Well	Pumping Rate (gpm)	
	Original ROD Remedy	Final OU-1 Remedy
EW-1	400	480
EW-3	300	0
RW-1	400	480
RW-1A	400	480
RW-3	300	360
Total Extraction (gpm)	1,800	1,800
Diffusion Well	**Injection Rate (gpm)**	
	Original ROD Remedy	**Final OU-1 Remedy**
DW-10	300	300
DW-12	300	300
DW-13	400	400
DW-14	400	400
DW-15	400	400
Total Diffusion (gpm)	1,800	1,800

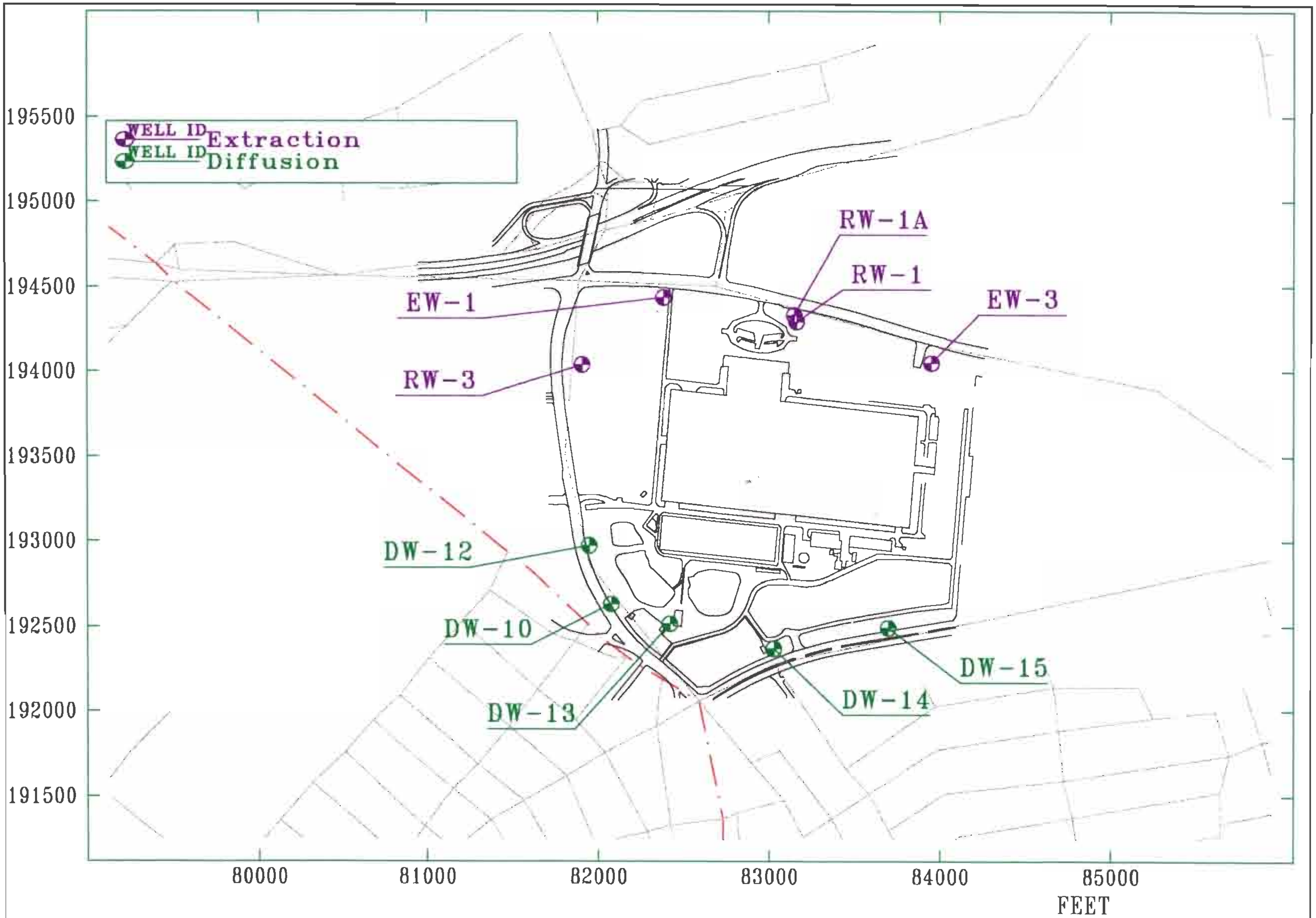

FIGURE 1	Remediation Well Locations Extraction Wells and Diffusion Wells Lockheed Martin Great Neck, New York	CDM *environmental engineers, scientists, planners, & management consultants*

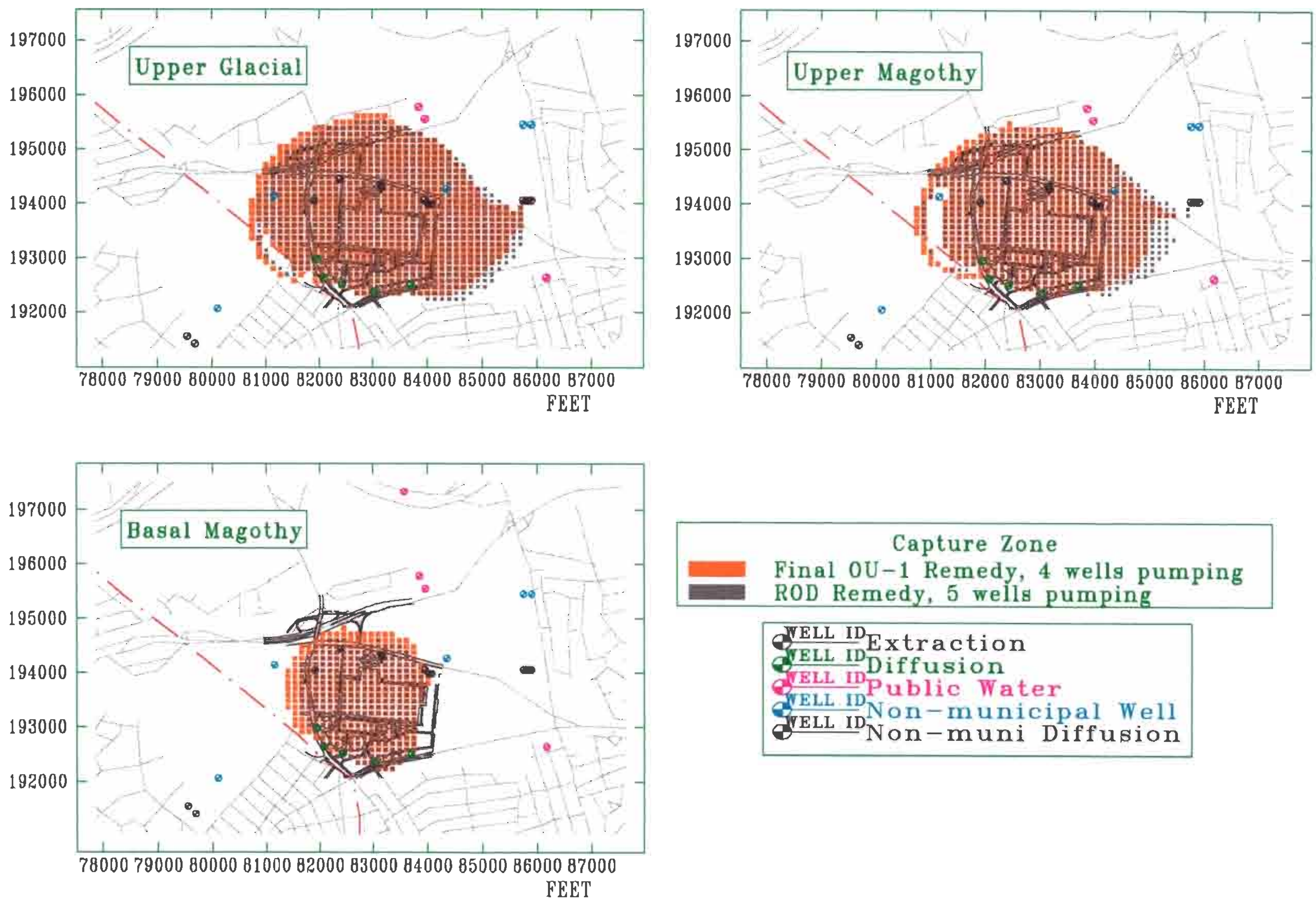

FIGURE 2

Capture Zone Analysis
Final OU-1 Remedy vs. ROD Remedy
OU-1 Groundwater Remediation
Lockheed Martin, Great Neck, New York

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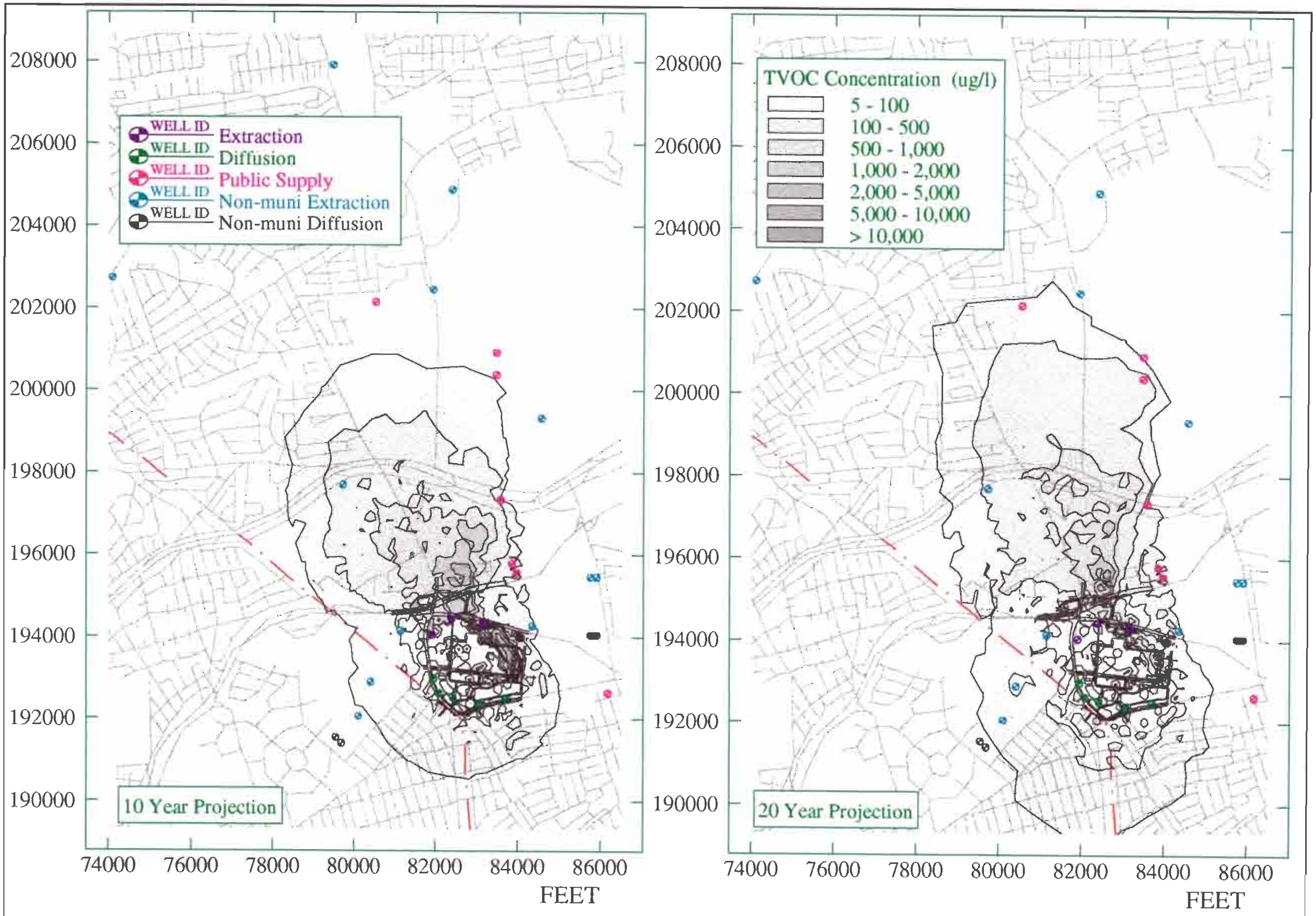

FIGURE
3

Projected Maximum TVOC Concentrations (ug/L)
For All Model Layers
OU-1 Design Remedy, With Onsite Recharge
Lockheed Martin - Great Neck, New York

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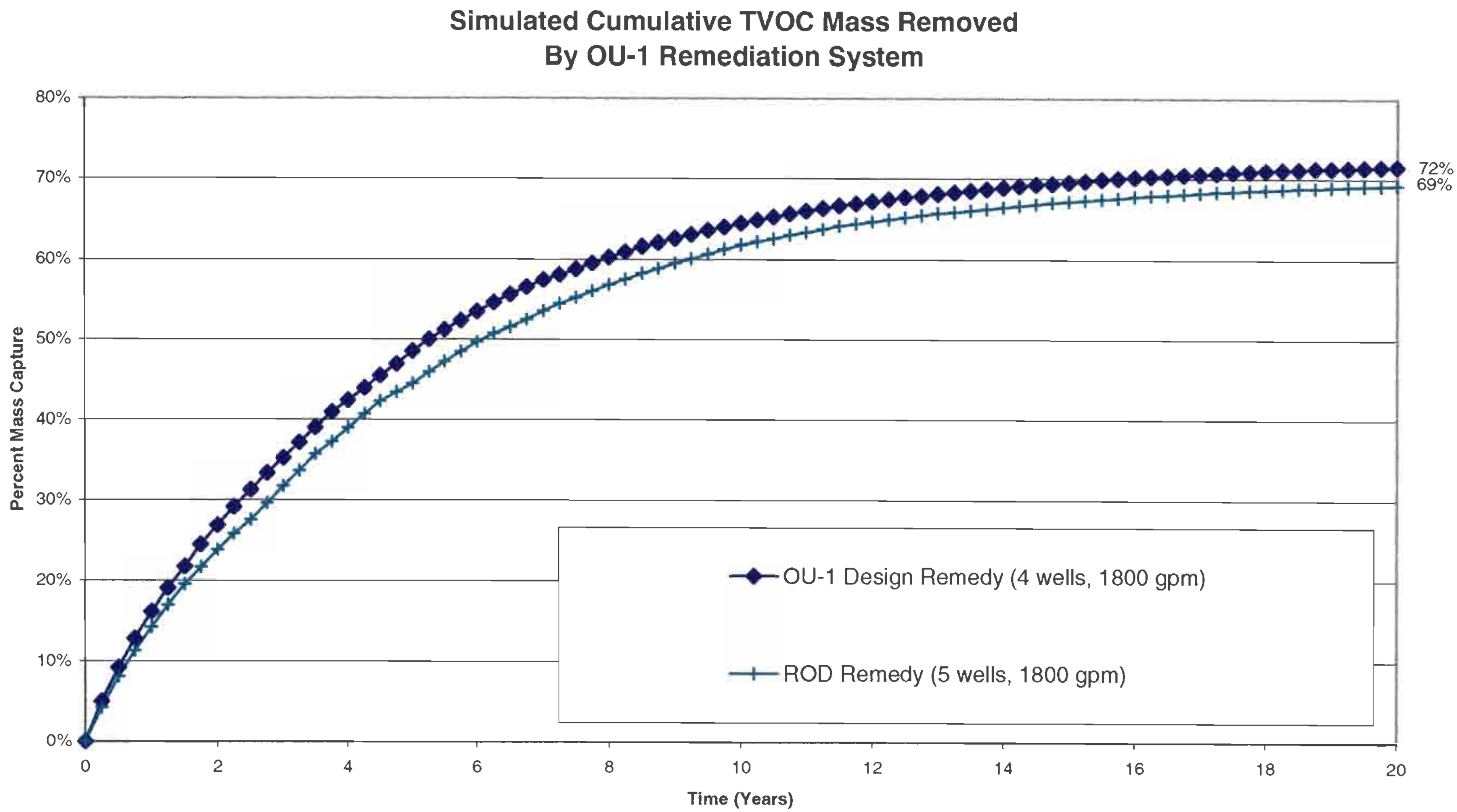

TVOC has been defined as the sum of PCE, TCE, cis-1,2-DCE, and vinyl chloride concentrations.
Mass removal is based on the starting TVOC plume estimated from October 1997 water quality data.

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lockhd/desdoc/masscap.xls: Mass Capture (2)
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Figure 4
Simulated Cumulative TVOC Mass Removed By OU-1 Remediation System

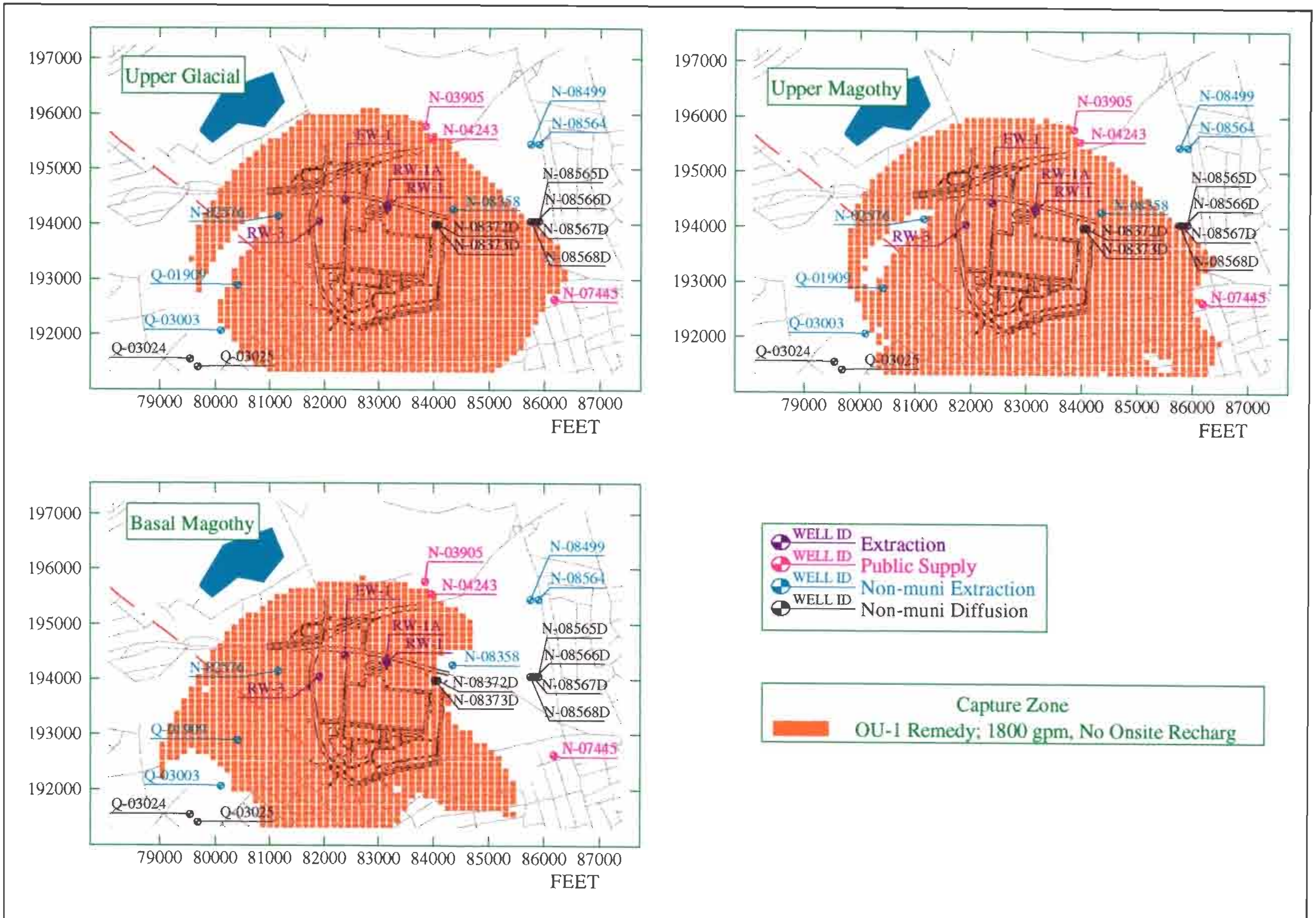

FIGURE 5

Capture Zone Analysis
OU-1 Design Remedy, No Onsite Recharge
OU-1 Groundwater Remediation
Lockheed Martin - Great Neck, New York

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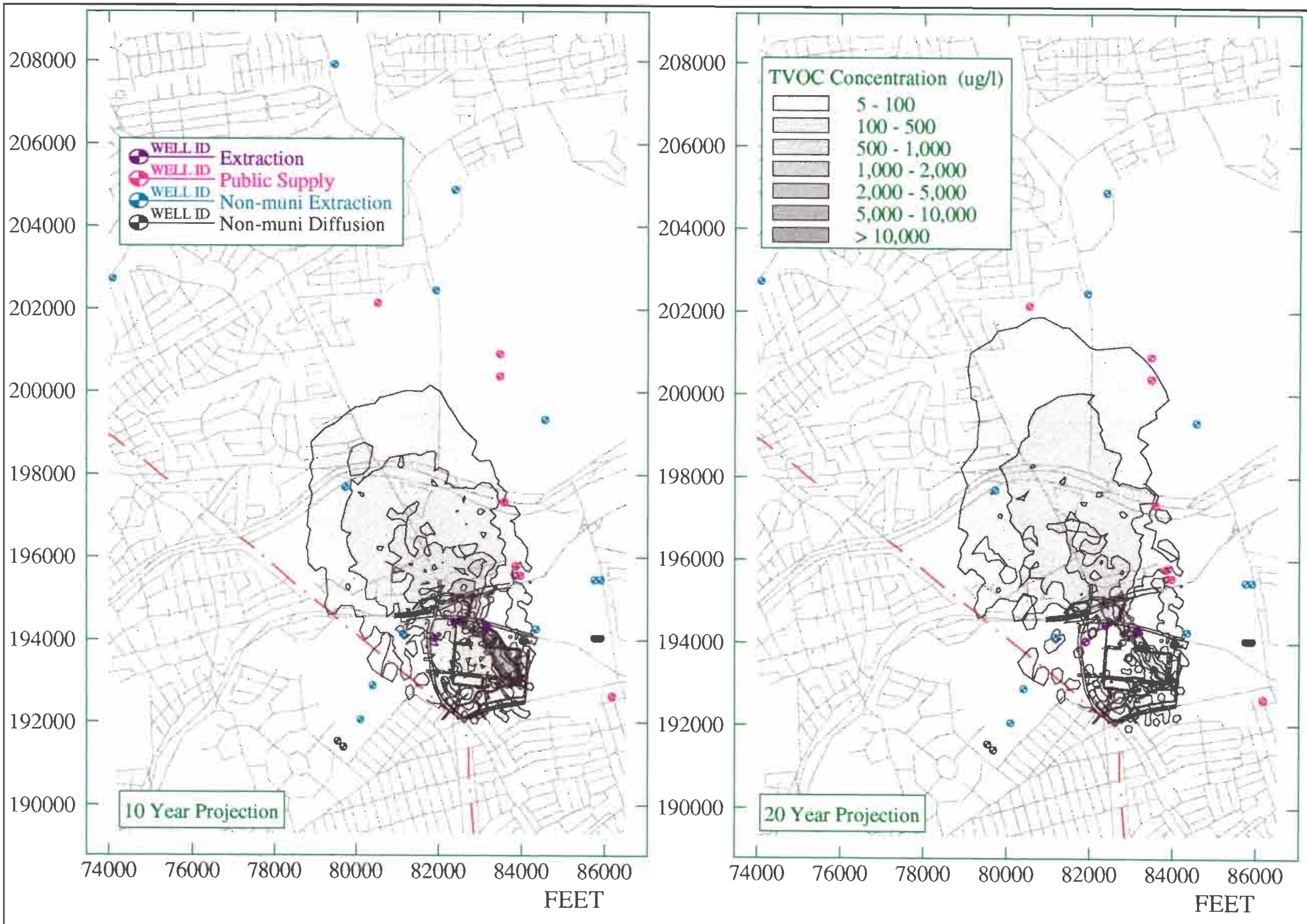

FIGURE 6	Projected Maximum TVOC Concentrations (ug/L) For All Model Layers OU-1 Design Remedy, No Onsite Recharge Lockheed Martin - Great Neck, New York	CDM environmental engineers, scientists, planners, & management consultants

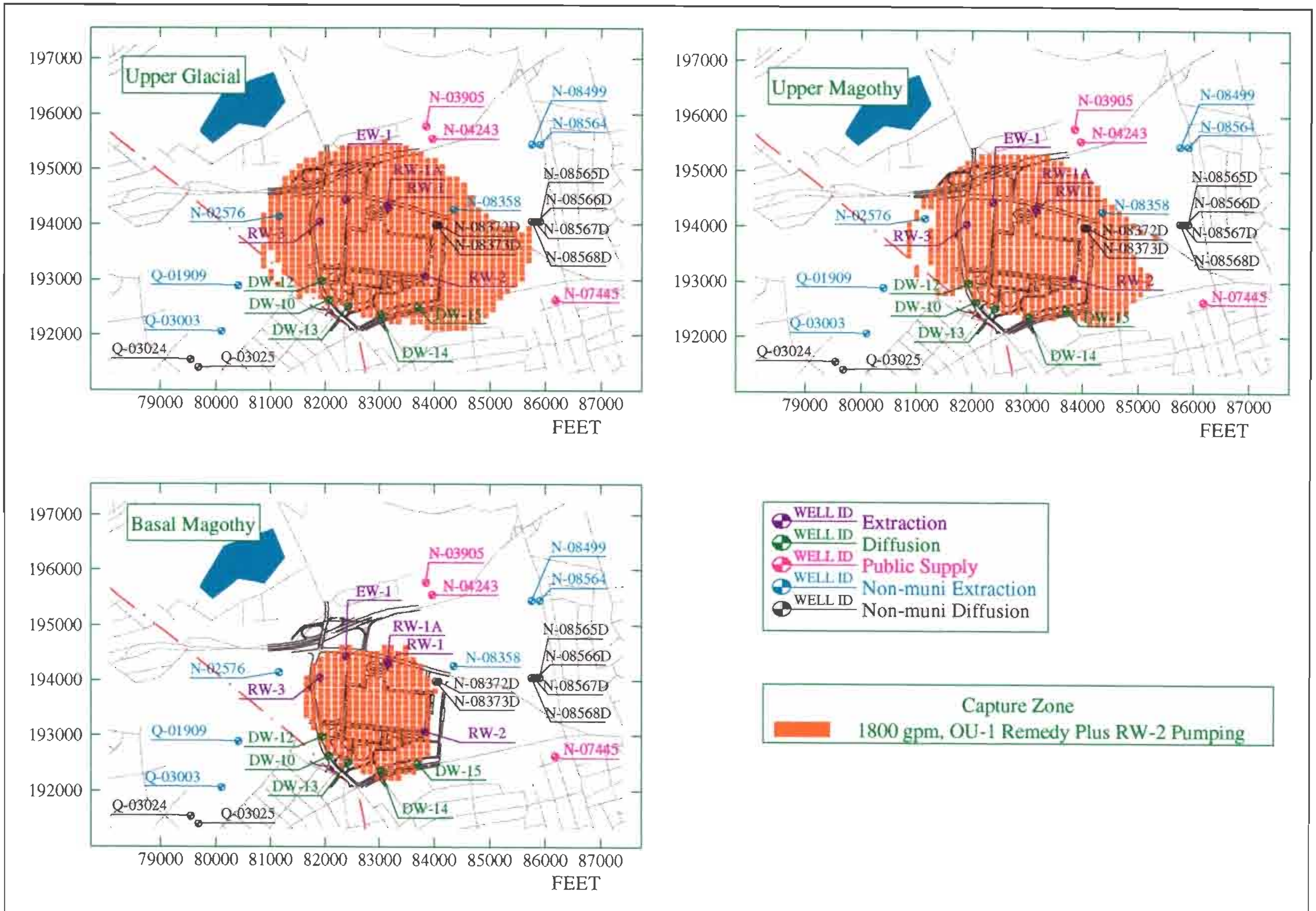

FIGURE 7	Capture Zone Analysis OU-1 Design Remedy, With Pumping at RW-2 Location OU-1 Groundwater Remediation Lockheed Martin - Great Neck, New York	CDM environmental engineers, scientists, planners, & management consultants

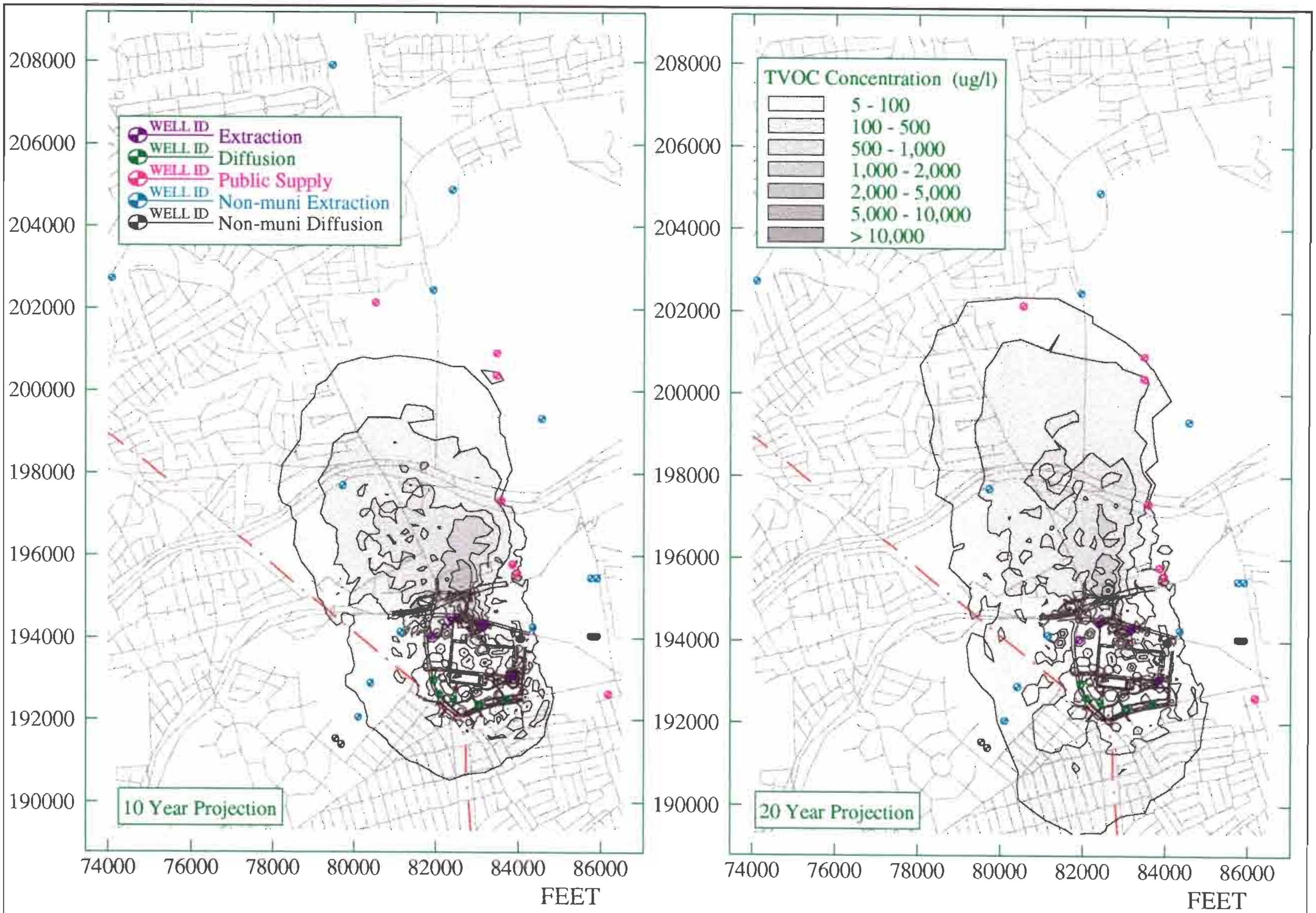

FIGURE 8

Projected Maximum TVOC Concentrations (ug/L)
For All Model Layers
OU-1 Design Remedy, With Pumping at RW-2 Location
Lockheed Martin - Great Neck, New York

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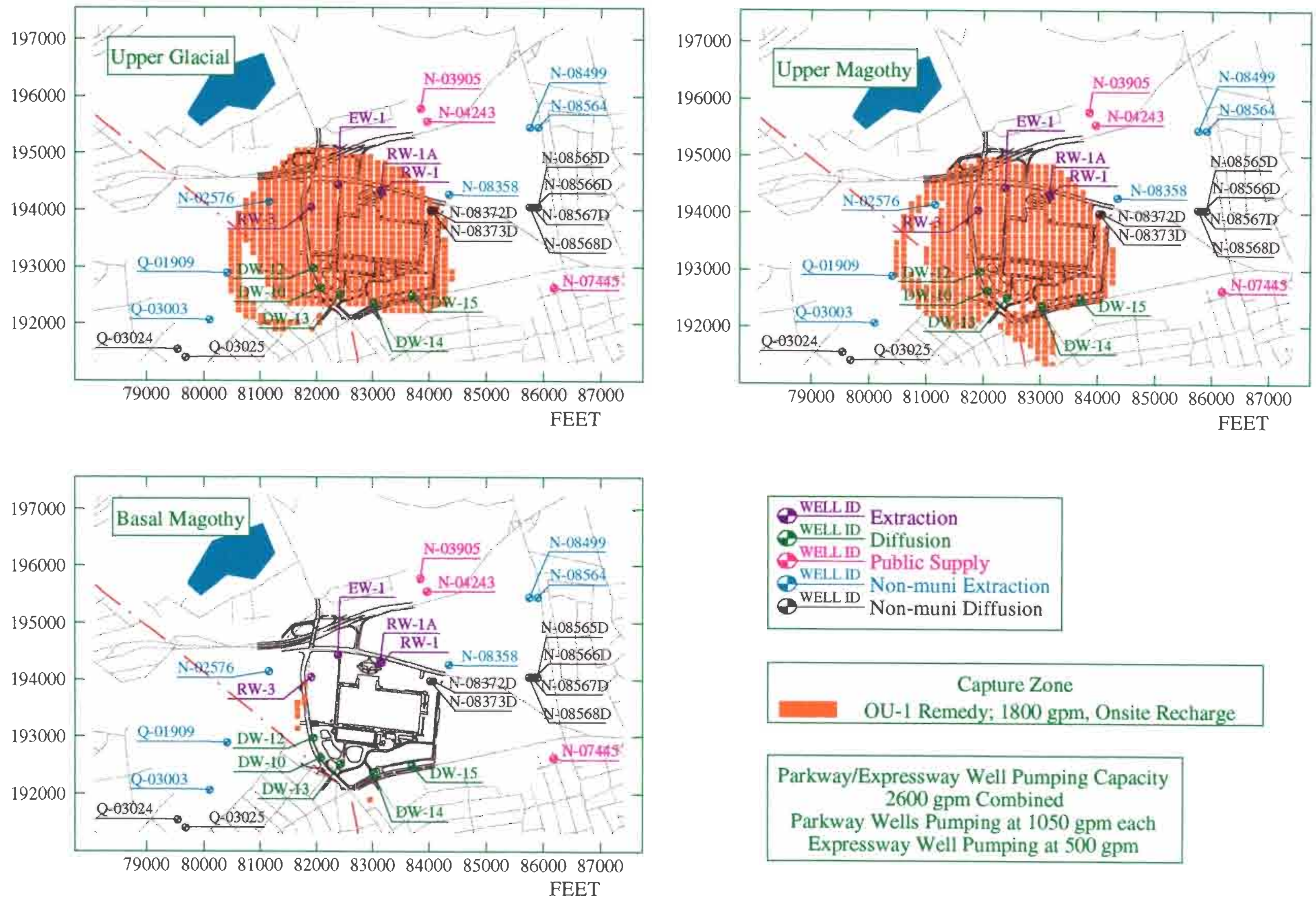

FIGURE 9

Capture Zone Analysis
Parkway/Expressway Wells Pumping at Treatment Capacity
OU-1 Groundwater Remediation
Lockheed Martin - Great Neck, New York

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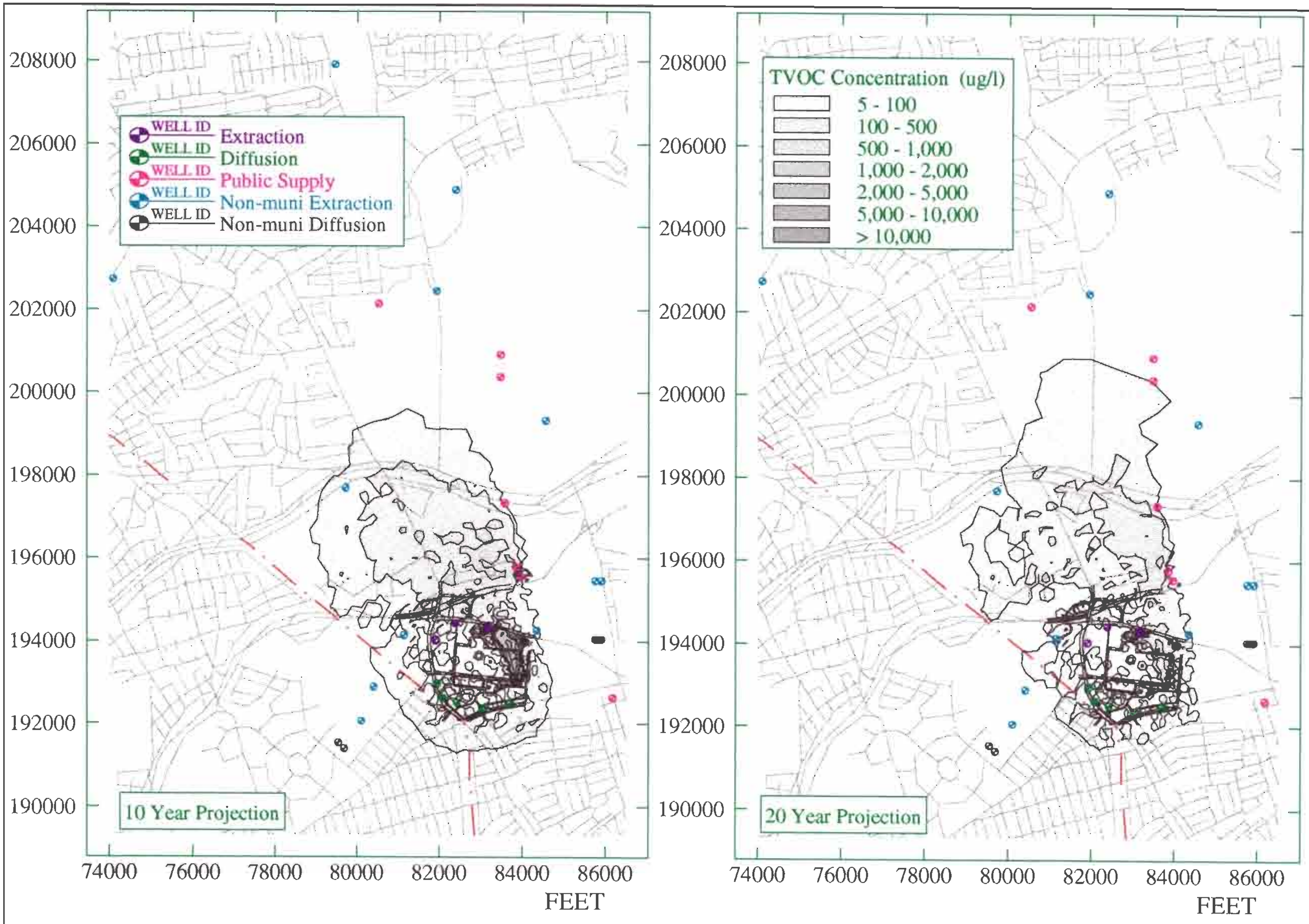

FIGURE 10

Projected Maximum TVOC Concentrations (ug/L)
For All Model Layers
Parkway/Expressway Wells Pumping at Treatment Capacity
Lockheed Martin - Great Neck, New York

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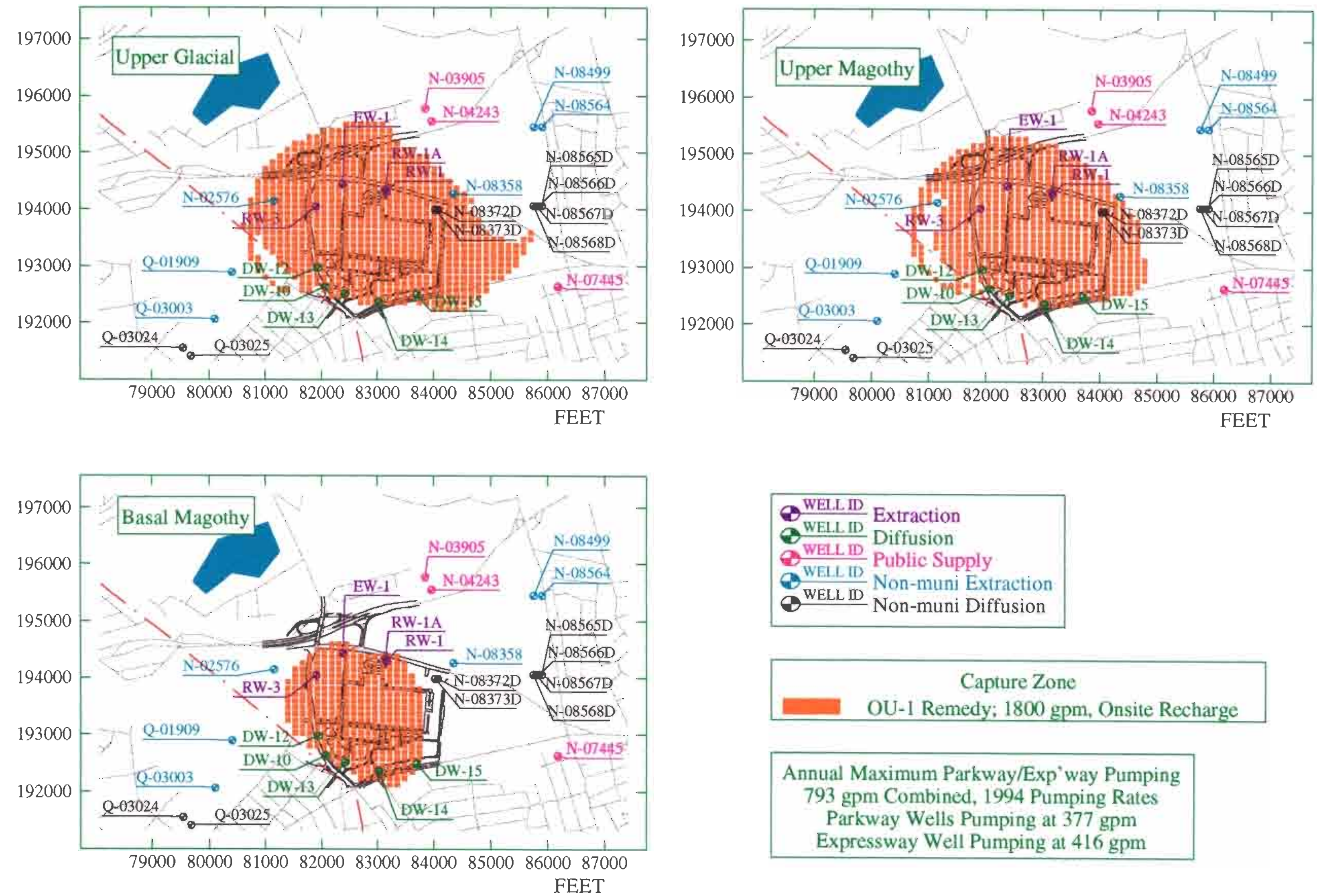

FIGURE 11

Capture Zone Analysis
Average 1994 Pumping at Parkway Wells
OU-1 Groundwater Remediation
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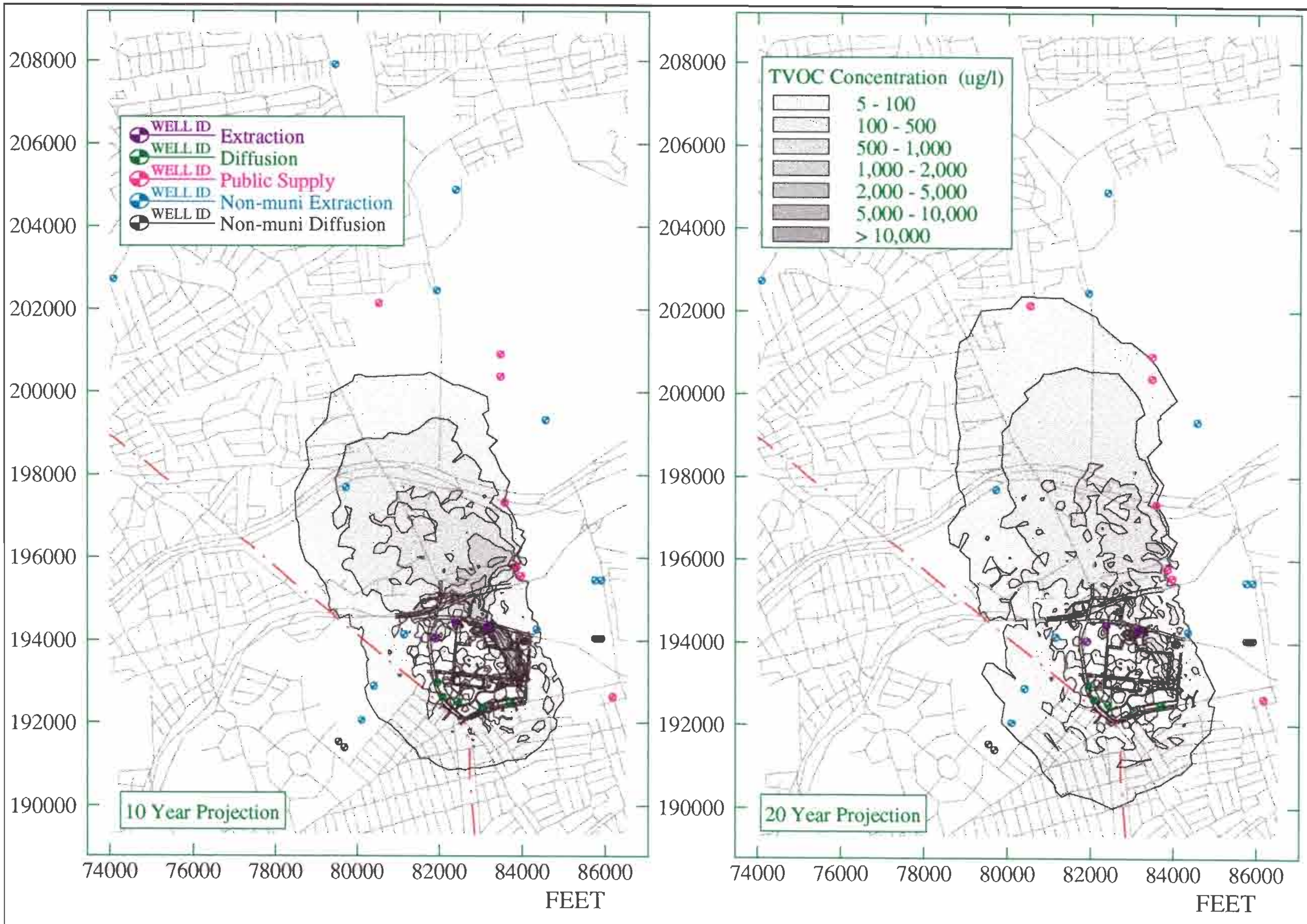

FIGURE 12

Projected Maximum TVOC Concentrations (ug/L)
For All Model Layers
Average 1994 Pumping at Parkway Wells
Lockheed Martin - Great Neck, New York

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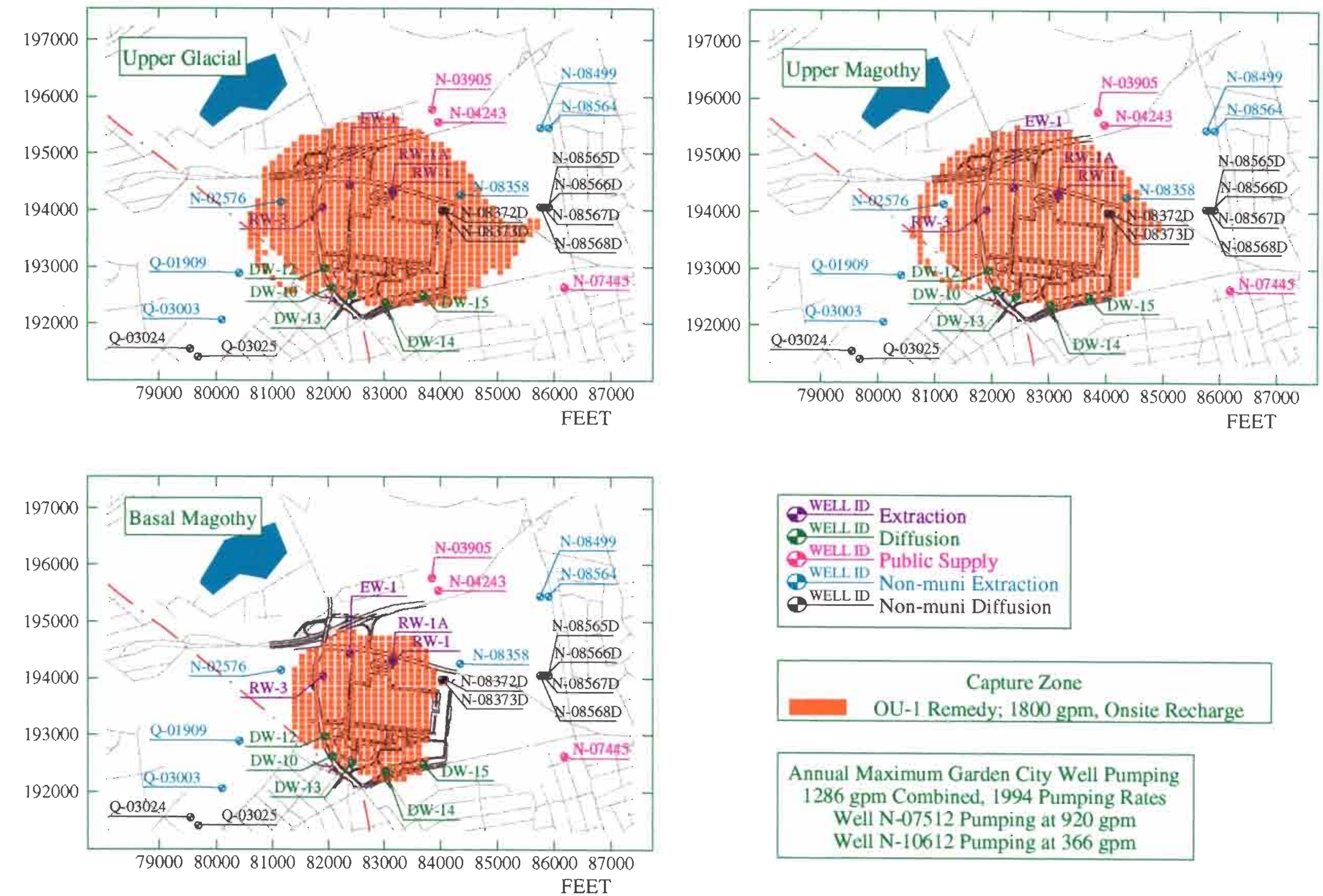

FIGURE 13

Capture Zone Analysis
Average 1994 Pumping at Garden City Wells
OU-1 Groundwater Remediation
Lockheed Martin - Great Neck, New York

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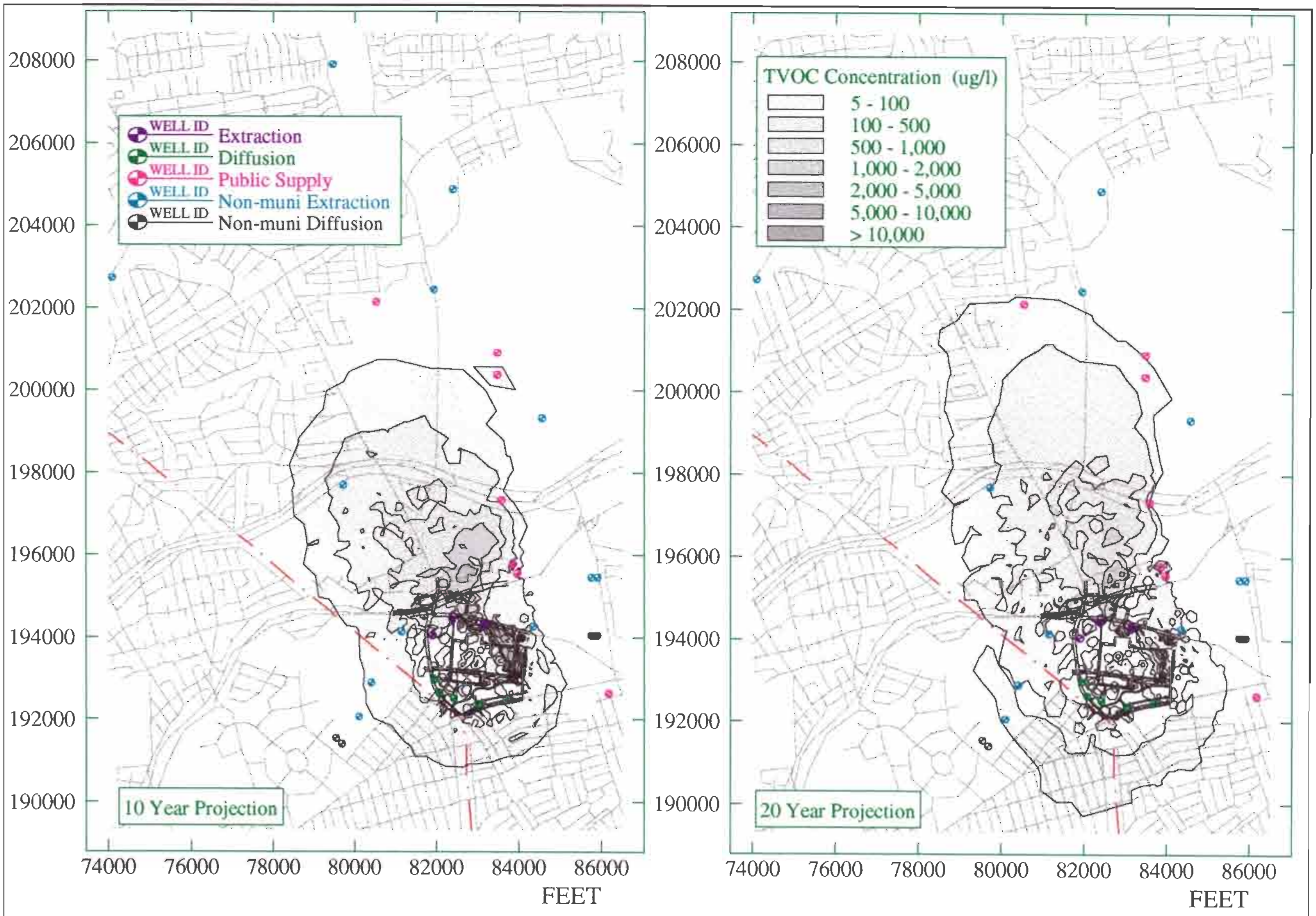

FIGURE 14

Projected Maximum TVOC Concentrations (ug/L)
For All Model Layers
Average 1994 Pumping at Garden City Wells
Lockheed Martin - Great Neck, New York

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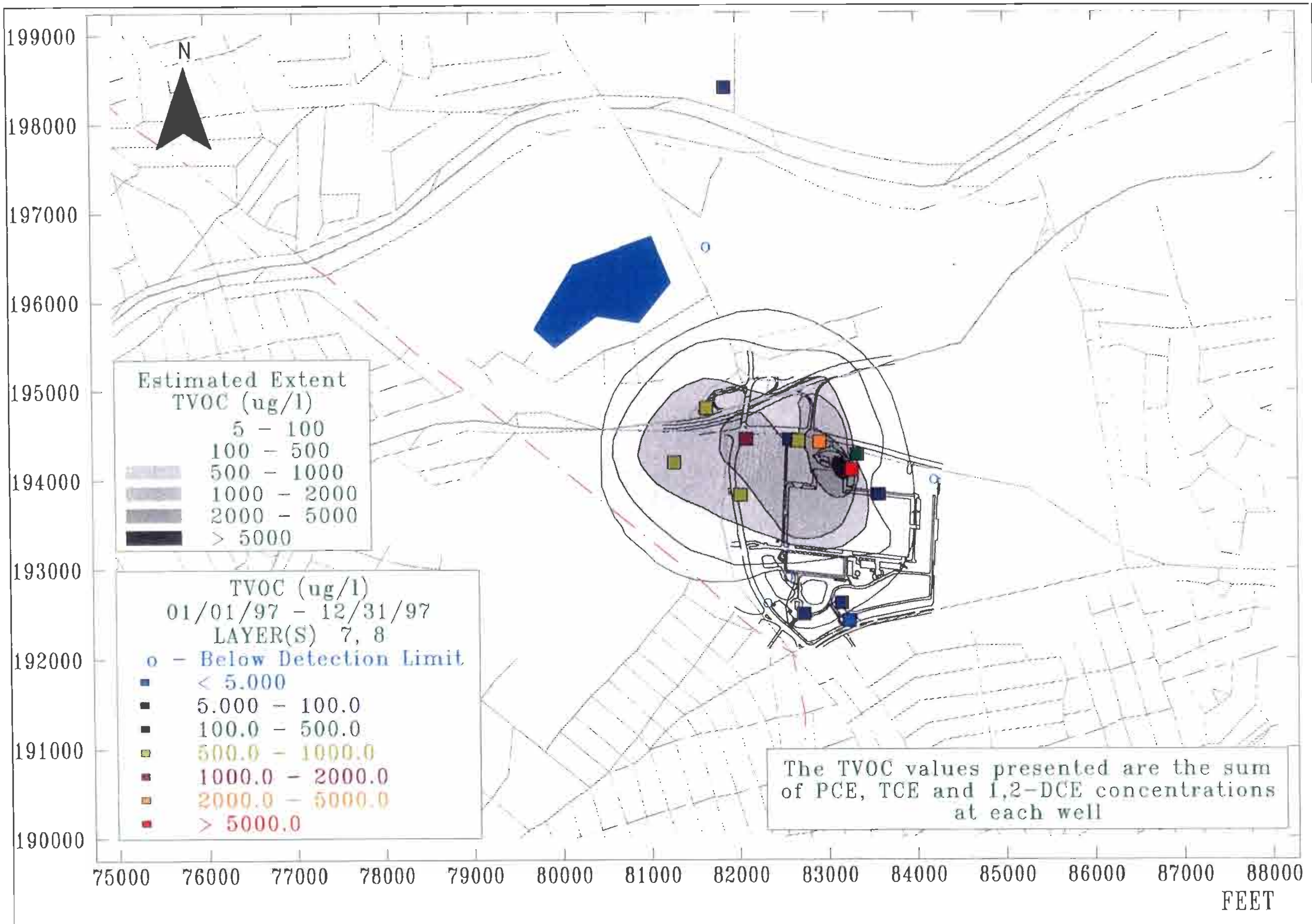

Approximate Upper Glacial TVOC Plume Extent
Summary of Most Recent Data (1994 - 1997)
Lockheed Martin
Great Neck, New York

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Approximate Upper Magothy TVOC Plume Extent
Summary of Most Recent Data (1994 - 1997)
Lockheed Martin
Great Neck, New York

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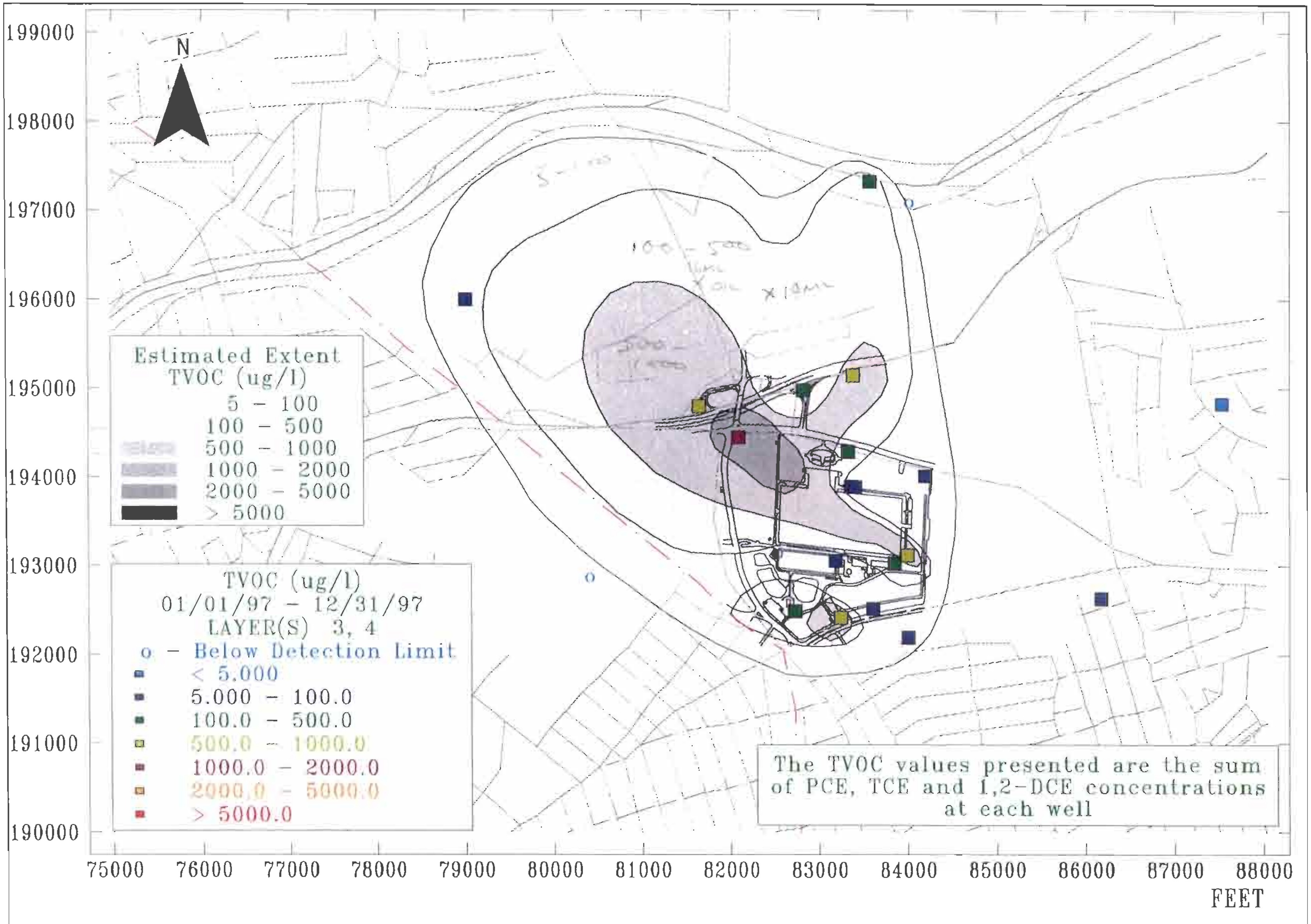

Approximate Lower Magothy TVOC Plume Extent
Summary of Most Recent Data (1994 - 1997)
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Great Neck, New York

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