Northrop Grumman Corporation

Outpost Monitoring Network Design Modeling

October 22, 2002

Bethpage, New York

Purpose of Outpost Monitoring Well Network

- Wells will be used to monitor groundwater quality between the leading edge of the VOC plume and the supply wells potentially in the path of the plume.
- Well locations have been chosen to provide approximately 5 years "warning".
  - Detection of groundwater plume at least 5 years before supply well is impacted.

Evaluation Process

- Forward Particle Tracking:
  - Determine potential for impact, time to impact and fastest moving portion of plume.
- Solute Transport Modeling:
  - Determine level of impact (VOCs greater than 0.5 µg/L within 30 years), and confirm time to impact.
- Reverse Particle Tracking:
  - Determine supply well capture zone and distance from well for 5 years warning.
- Combine particle tracking results to select outpost well screen zones:
  - Selected to detect both fastest moving portion of plume and secondary impacts.

Determination of Supply Wells at Risk

- Based on Forward Particle Tracking, following wells were determined to be at risk:
  - 6150, 4043, 5148 South Farmingdale Water District
  - 8480, 9338 New York Water Service
  - Although forward particle tracking did not indicate an impact at 5303 Town of Hempstead [Levittown], an outpost well location was developed for this well.

Table 1. Groundwater travel time (in years) from plumes leading edge in each model layer to municipal supply wells, Northrop Grumman Regional Groundwater Model.

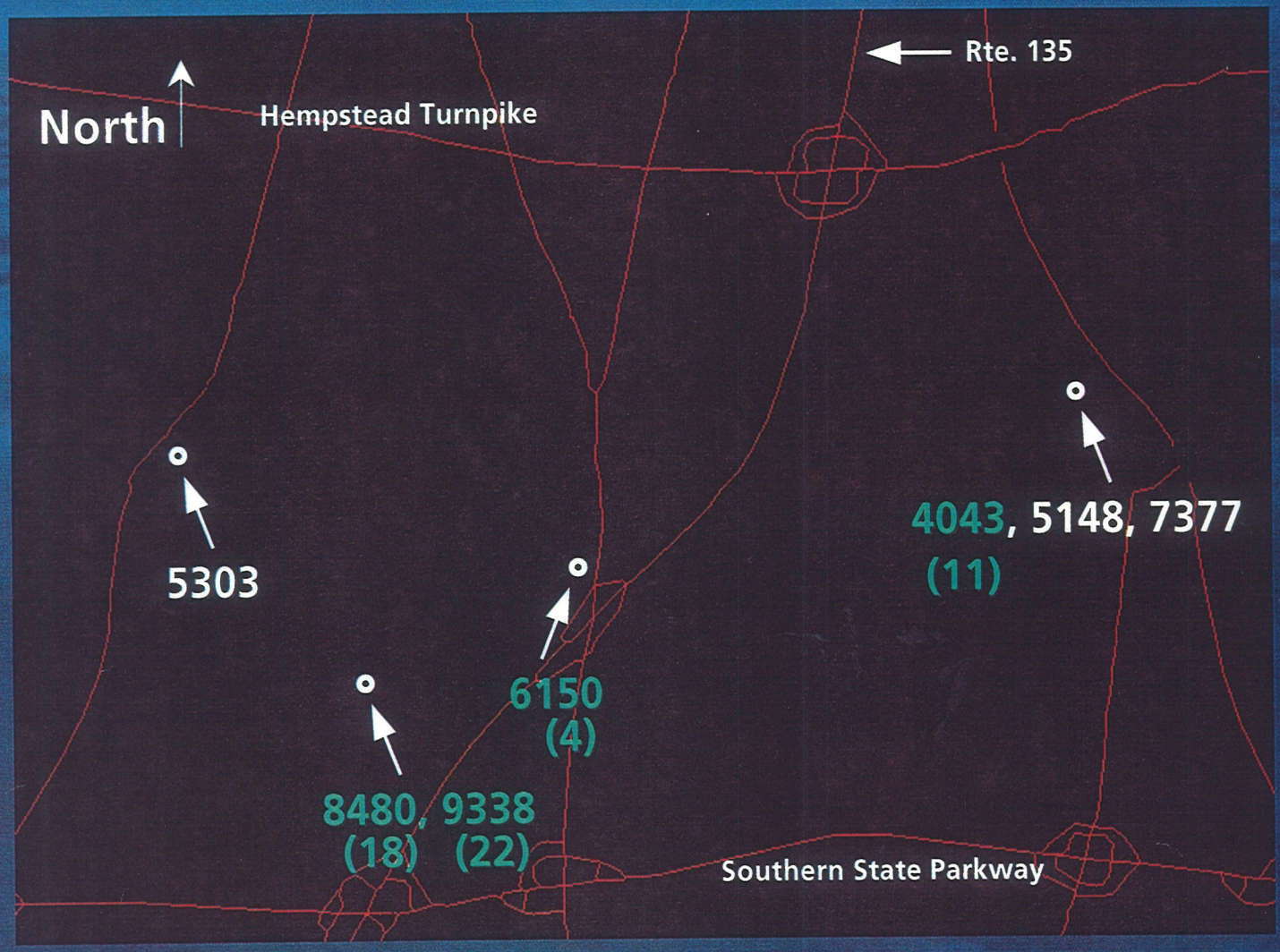
	Model Layer									
Well ID	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
South Farmingdale Well Field 1										
4043	**21**	**22**	**12**	**12**	**12**	**--**	**--**	**--**	**--**	**--**
5148	**27**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
7377	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
South Farmingdale Well Field 3										
6150	**--**	**--**	**--**	**12**	**8**	**>30**	**>30**	**>30**	**>30**	**--**
New York Water Service 3S and 4S										
8480	**23**	**25**	**17**	**24**	**24**	**>30**	**>30**	**>30**	**>30**	**>30**
9338	**--**	**30**	**23**	**27**	**24**	**>30**	**>30**	**>30**	**>30**	**>30**
Town of Hempstead (Levittown) 13										
5303	**--**	**--**	**--**	**--**	**>30**	**--**	**>30**	**--**	**--**	**--**

-- No model predicted impact.
>30 Model predicts impact after 30 years.

Determination of Supply Wells at Risk (continued)

- Previously conducted solute transport modeling indicated impacts of 0.5 µg/L within 30 years as follows:
  - 4043 (11 years)
  - 6150 (4 years)
  - 8480 (18 years)
  - 9338 (24 years)

Potentially Impacted Supply Well Locations



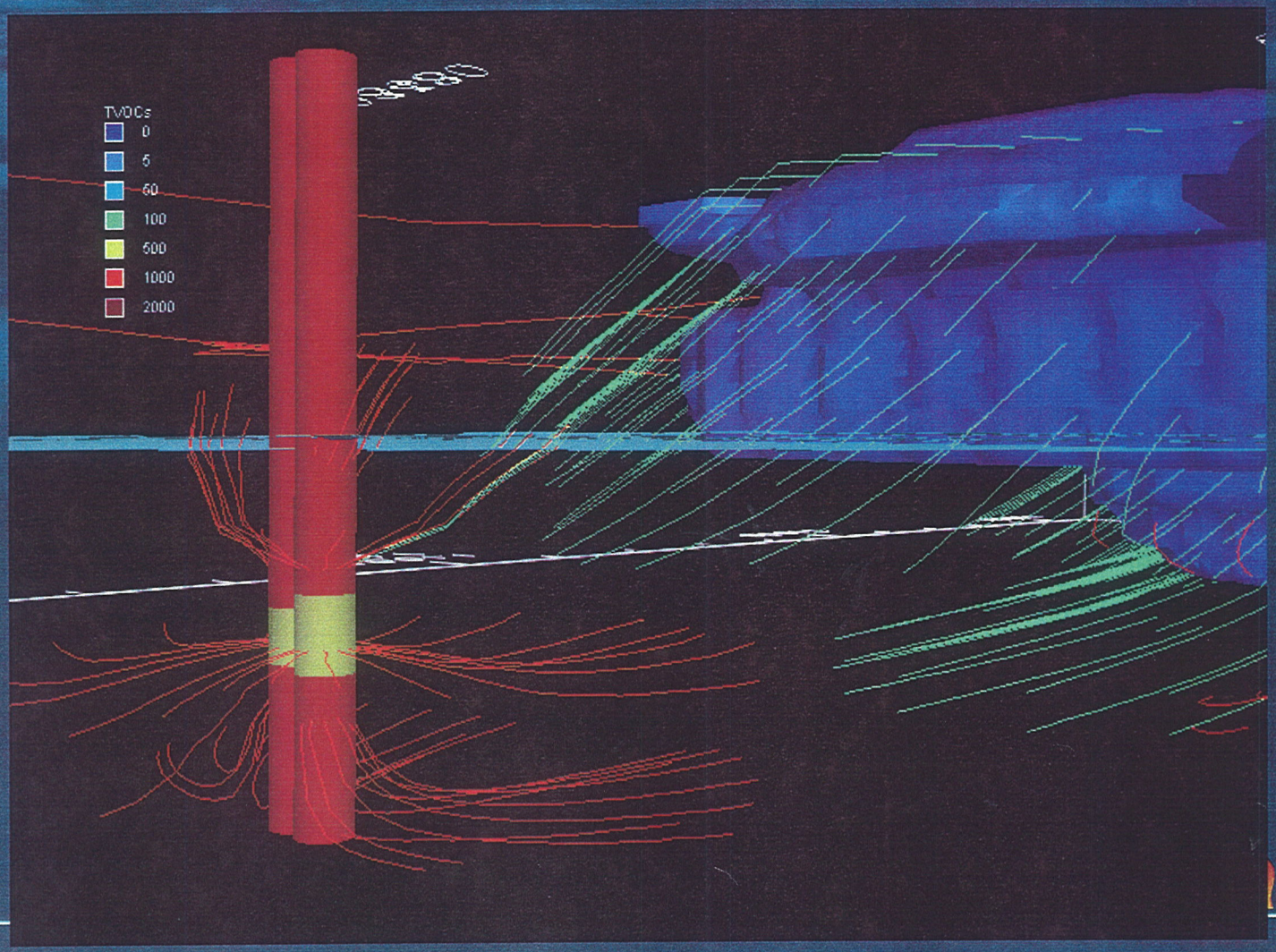
Selection of Outpost Monitoring Well Location

- Distance from supply well
  - Reverse particle tracking was used to develop supply well capture zones and determine the distance from the supply well corresponding to a minimum of 5 years travel from outpost well to supply well.
- Selection of screen zone
  - Forward particle tracking was used to determine which portion of the plume moved fastest as it approached the supply well.
    - The model layer through which the fastest moving portion of plume passed was targeted to be monitored by the outpost well.

Northrop Grumman Corporation
Updated Regional Groundwater Model

Supply Well 8480

looking northwest along model layer 7

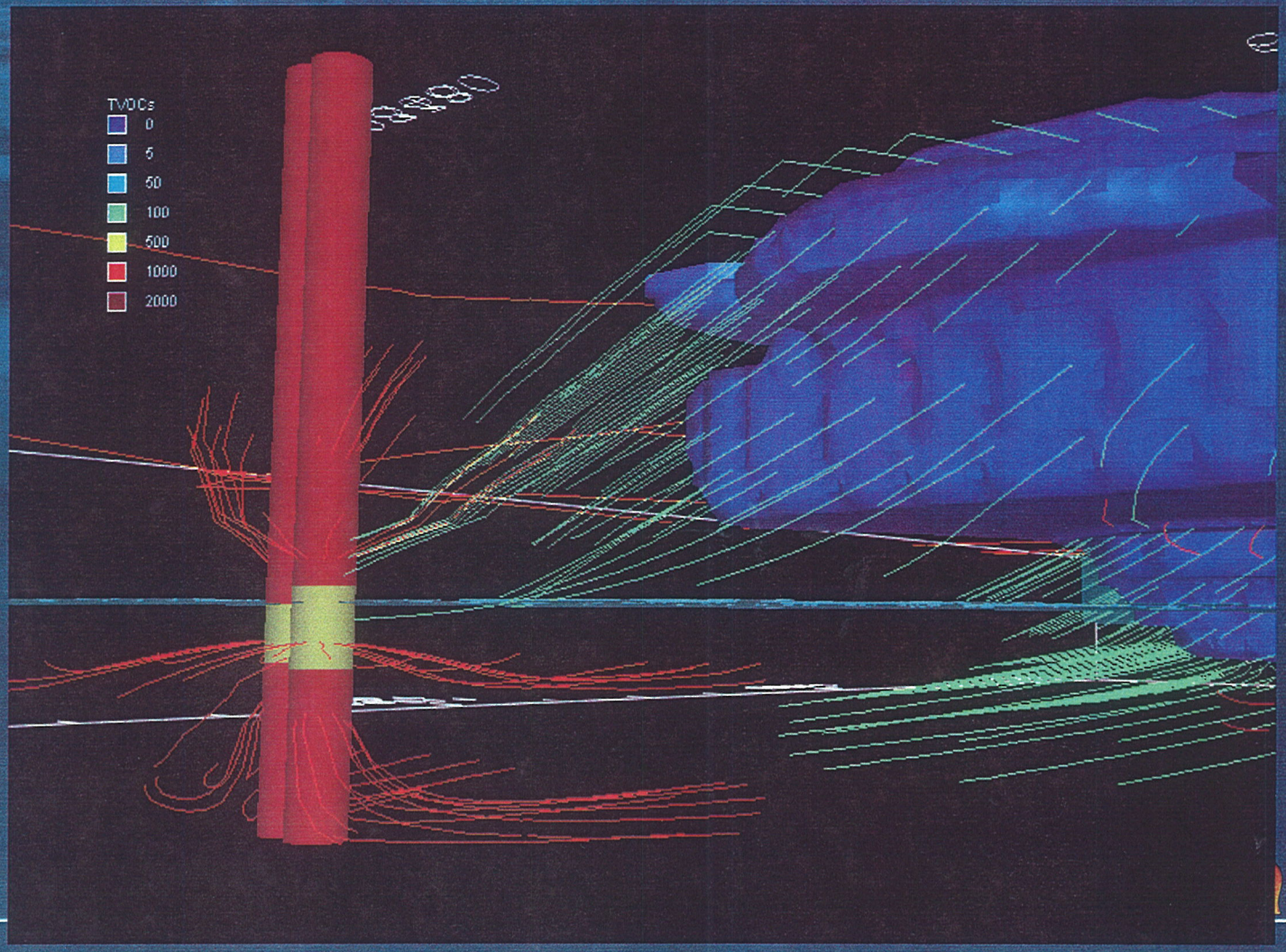


ARCADIS

Northrop Grumman Corporation
Updated Regional Groundwater Model

Supply Well 8480

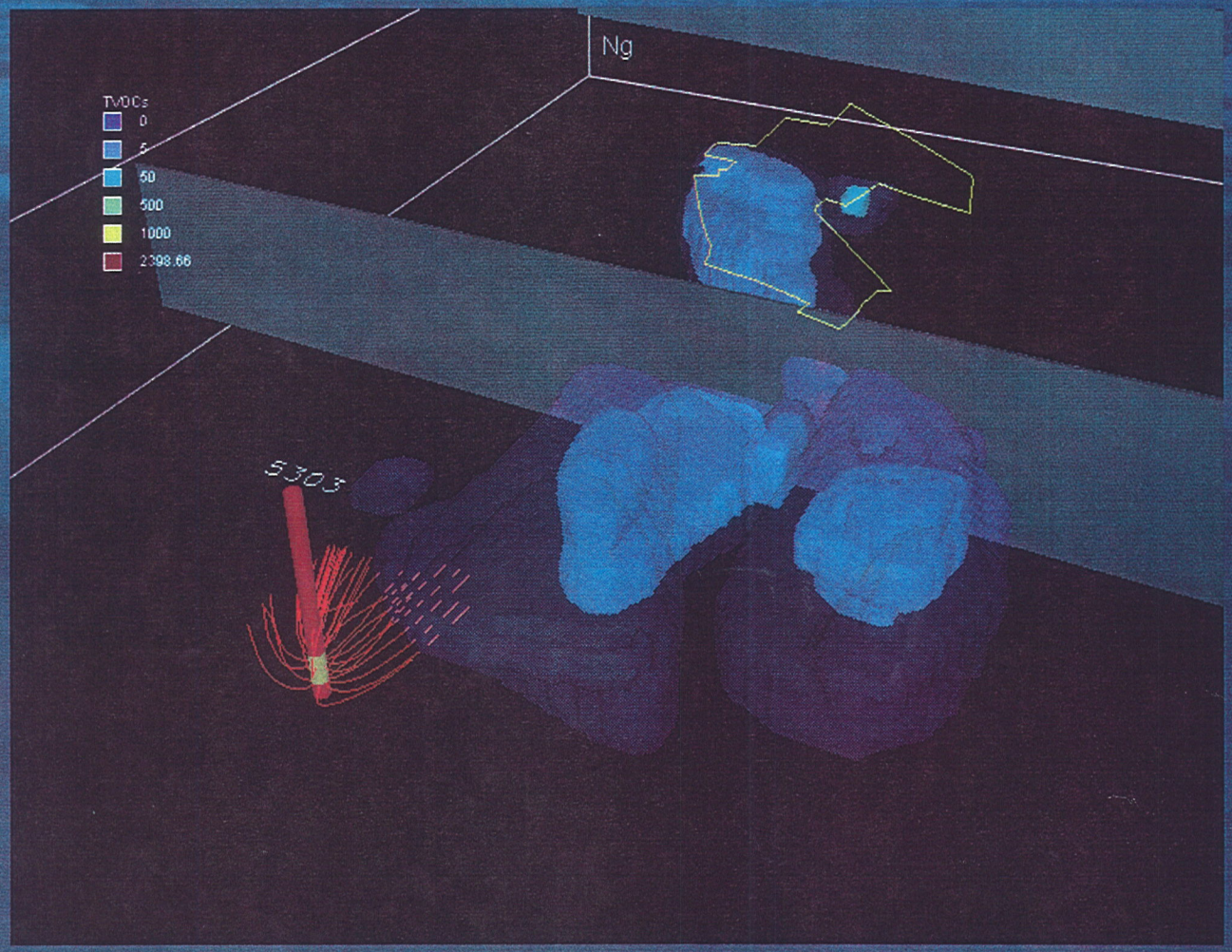
looking northwest along model layer 9



ARCADIS

Northrop Grumman Corporation
Updated Regional Groundwater Model

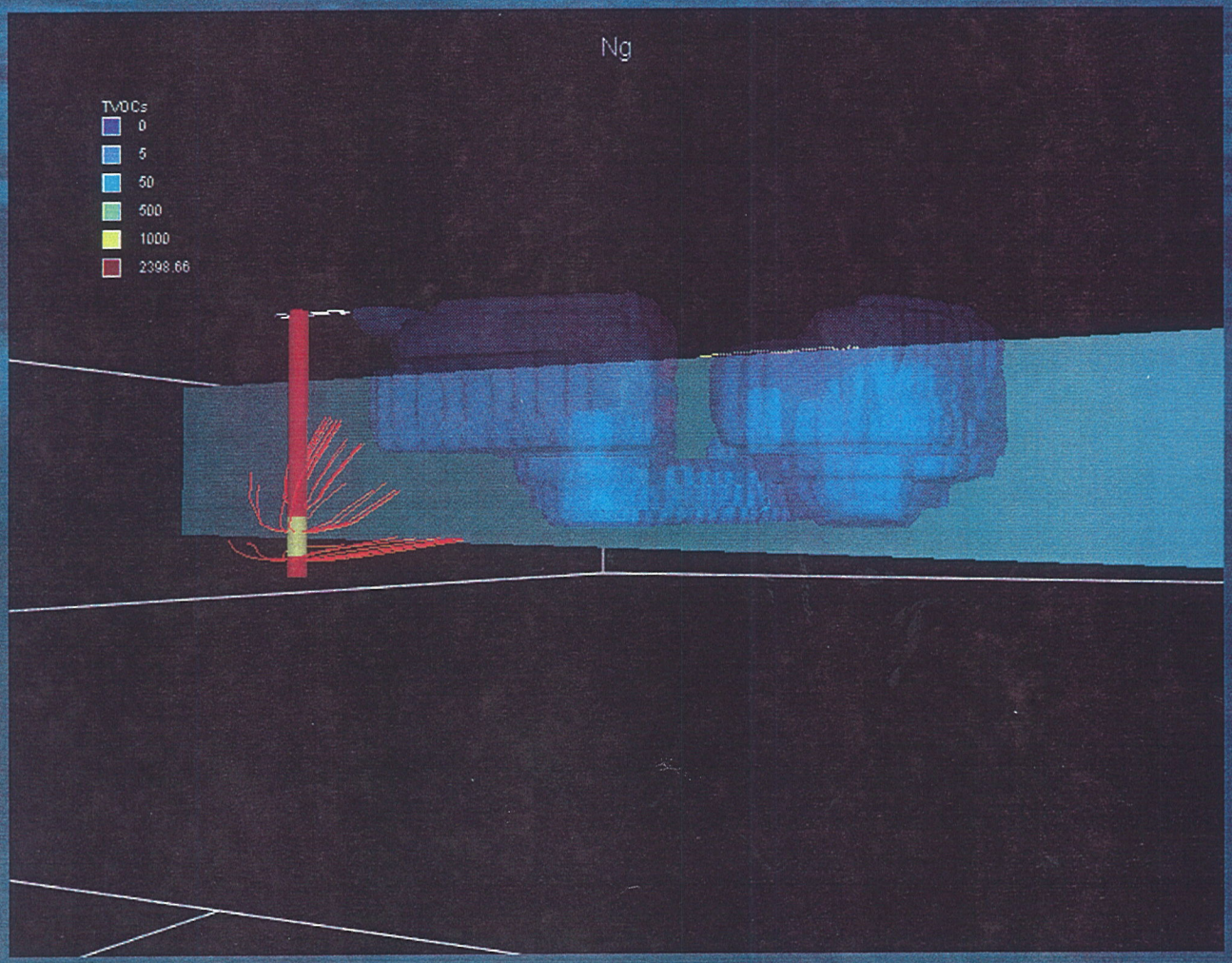
Supply Well 5303
looking northwest



ARCADIS

Northrop Grumman Corporation
Updated Regional Groundwater Model

Supply Well 5303
looking northwest



ARCADIS

Modeling Results

- The installation of four clusters of outpost monitoring wells is recommended.
  - Clusters will consist of two or three wells each.
  - Clusters will afford 5 years or more warning for supply wells 4043 and 8480.
  - Model predicted impact to 6150 will occur in about 4 years.
  - No impact to 5303 is predicted by model.

Table 2. Proposed Outpost Monitoring Well Cluster Screen Zones, Northrop Grumman Regional Groundwater Model.

Well ID	Proposed Screen Top Elevation	Proposed Screen Bottom Elevation	Length	Well Field Monitored	Supply Well Nos.
OW1-1	-122	-162	40	South Farmingdale Well Field 1	4043, 5148, 7377
OW1-2	-200	-240	40	South Farmingdale Well Field 1	4043, 5148, 7377
OW1-3	-295	-325	40	South Farmingdale Well Field 1	4043, 5148, 7377
OW2-1	-290	-320	40	South Farmingdale Well Field 3	6150
OW2-2	-376	-406	40	South Farmingdale Well Field 3	6150
OW3-1	-374.5	-404.5	40	New York Water Service 3S and 4S	8480, 9338
OW3-2	-581	-611	40	New York Water Service 3S and 4S	8480, 9338
OW4-1	-586.5	-616.5	40	TOH Water District (Levittown) 13	5303
OW4-2	-665	-695	40	TOH Water District (Levittown) 13	5303

Elevations are given in feet relative to mean sea level.

Table 3. Outpost Monitoring Well Trigger Values, Northrop Grumman Regional Groundwater Model.

Well ID	Distance from Supply Well (feet)	Nearest Intersection	Trigger Value (ppb)	Time to Trigger Value Impact in Outpost Well (years)	Time to Impact in Municipal Well (years)
4043	625	Lawrence Street & Pine Tree Drive	0.638	6.09	11.13
6150	320	Harriet Road & Gloria Road	--	--	4.11
8480	975	Red Maple Drive East & Red Maple Drive North	1.45	13.15	18.17
5303	850	Elm Drive West & Eve Lane	--	--	--

Time to Impact is number of years before detection of 0.5 ppb in municipal well.
Trigger Value is concentration at outpost well 5 years before model predicted impact of 0.5 ppb at municipal well.
Given the limited Time to Impact for 6150, an appropriate Trigger Value and Outpost Well Location could not be determined.
-- for 6150, travel time is too brief to determine trigger value, impact is immenent.
-- for 5303 trigger value and time to impact cannot be determine because model does not predict impact to occur based on current plume delineation.

Recommended Monitoring Frequency

- Based on 5 years warning, the following groundwater sampling and water level monitoring schedule is recommended:
  - Years 1 and 2, annual sampling.
  - Years 3 and 4, semi-annual sampling.
  - Years 5 through impact to supply well, quarterly sampling.
    - If VOCs are detected in years 1 through 4, sampling frequency should be increased to quarterly to confirm detection.