BETHPAGE NWIRP

MODFLOW / MODPATH
COMPUTER MODELING SUMMARY

Technical Review Comittee Meeting.

March 10, 1993

COMPUTER MODELING OBJECTIVES:

1) **CONCEPTUAL MODEL:**
DEVELOP CONCEPTUAL MODEL WHICH INCORPORATES MAJOR HYDROGEOLOGIC FEATURES OF THE NATURAL GROUND WATER FLOW SYSTEM. DEVELOP *MODFLOW* GROUND WATER MODEL.

2) **MODEL CALIBRATION:**
SIMULATE PUMP TEST #1 AND #2 WITH THE FLOW MODEL. DETERMINE FINAL MODEL PARAMETERS DURING CALIBRATION.

3) **MODEL VERIFICATION**:
SIMULATE WATER TABLE ELEVATIONS DURING HIGH AND LOW PUMPING CONDITIONS. CHECK MODEL OUTPUT AGAINST MEASURED DATA.

4) **PREDICTION:**
USE PARTICLE TRACKING PROGRAM *MODPATH* TO IDENTIFY POTENTIAL WELL CAPTURE ZONES AND DIRECTIONS OF PARTICLE MOVEMENT.

1) **CONCEPTUAL MODEL:**

THE CONCEPTUAL MODEL INCORPORATES THE MAJOR FEATURES OF THE GROUND WATER MODEL, INCLUDING:

- GROUND WATER FLOW DIRECTION IS TO THE SOUTH-SOUTHEAST.
- AQUIFER IS UNCONFINED.
- AQUIFER GENERALLY SHOWS DECREASING CONDUCTIVITY WITH DEPTH, WITH THE EXCEPTION OF THE LOWER MAGOTHY AQUIFER (PRODUCTION WELL INTERVAL).
- WATER TABLE FLUCTUATES APPROXIMATELY 4 FEET PER YEAR.

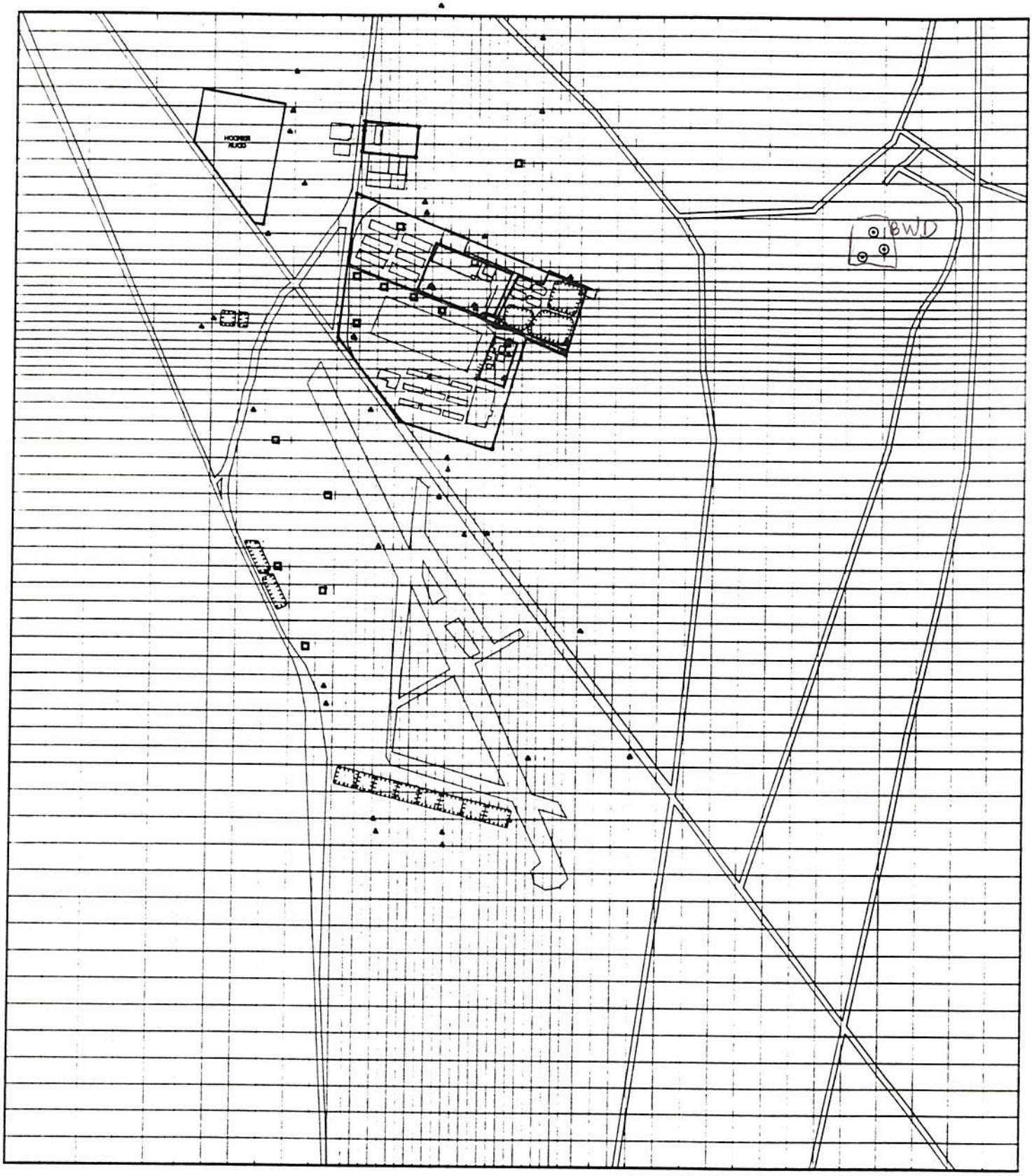
FLOW MODEL DEVELOPMENT:

- U.S.G.S. *MODFLOW* GROUND WATER MODEL WAS CHOSEN FOR MODELING BECAUSE IT IS WELL VALIDATED, VERSATILE, AND CAN BE USED FOR PARTICLE TRACKING AND CONTAMINANT TRANSPORT.

- MODFLOW MODEL DEVELOPMENT INCORPORATED THE MAJOR HYDROGEOLOGIC FEATURES IDENTIFIED IN THE CONCEPTUAL MODEL.

LATERAL AND VERTICAL EXTENT OF THE MODEL:

- MODEL GRID ENCOMPASSES BETHPAGE NWIRP PROPERTY. THE MODEL GRID CONTAINS 53 COLUMNS AND 63 ROWS.
- MODEL GRID EXTENDS UP AND DOWN GRADIENT OF THE SITE.
- MODEL GRID EXTENDS EAST TO ENCOMPASS BETHPAGE WELLS 6078, 8767 AND 8768.
- MODEL GRID EXTENDS WEST TO ENCOMPASS THE HOOKER-RUCO SITE.



0 1500 3000

SCALE IN FEET

FIGURE X–X

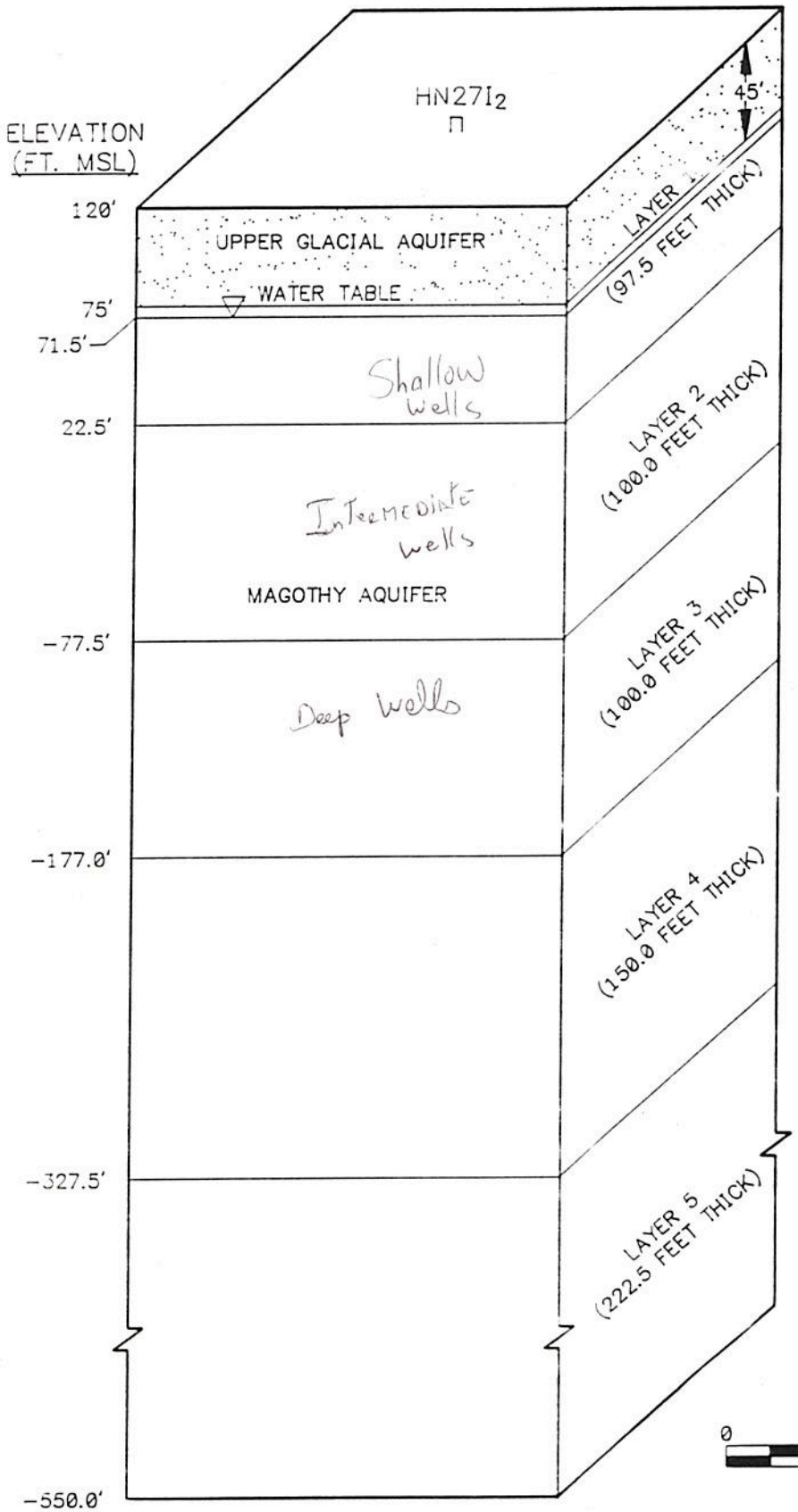
BASE MAP WITH
WITH FINITE–DIFFERENCE GRID
BETHPAGE NWIRP

PRELIMINARY

HALLIBURTON NUS
Environmental Corporation

ACAD: 1953\BASE.DWG MB 3/9/93 (P–1500) (M–1500DWG)

- VERTICALLY, THE MODEL EXTENDS FROM GROUND SURFACE TO BOTTOM OF MAGOTHY AQUIFER (THE TOP OF REGIONAL CONFINING LAYER).
- THE MODEL HAS 5 LAYERS.



0 100

SCALE IN FEET
VERTICAL SCALE

0 100

SCALE IN FEET
HORIZONTAL SCALE

ACAD: 1953\BLOCK.DWG 3/2/93 MB

PRELIMINARY

MODFLOW LAYERS AT
GRID BLOCK: 22, 30
BETHPAGE NWIRP

HALLIBURTON NUS
Environmental Corporation

2) **MODEL CALIBRATION:**

- MODEL CALIBRATION WAS PERFORMED TO SIMULATE TRANSIENT (STRESSED) CONDITION ON THE AQUIFER WHICH OCCURRED BECAUSE OF PUMPING.

- DURING THE CALIBRATION PROCEDURE, MODEL PARAMETERS SUCH AS HORIZONTAL CONDUCTIVITY, VERTICAL CONDUCTIVITY, AND STORATIVITY WERE ADJUSTED.

CRITERIA USED FOR CALIBRATION AND VERIFICATION:

GENERALLY, MODELING SIMULATIONS ARE CONSIDERED TO BE CALIBRATED WHEN THE DIFFERENCE BETWEEN THE MODELED WATER ELEVATION AND THE MEASURED WATER ELEVATION IS LESS THAN THE ANNUAL FLUCTUATION OF THE WATER TABLE.

THE WATER TABLE FLUCTUATES APPROXIMATELY 4 FEET PER YEAR IN THIS AREA.

- A VERIFICATION CRITERIA OF +/- 2.O FT WAS USED FOR MODEL VERIFICATION.

- A MORE STRINGENT CALIBRATION CRITERIA OF +/- 1.0 FT WAS USED FOR PUMP TEST SIMULATION BECAUSE AQUIFER PARAMETERS WERE DETERMINED DIRECTLY FROM THE PUMPING TESTS, AND THE PUMPING TESTS EFFECTED A LOCALIZED AREA OF THE MODEL GRID.

CALIBRATION RESULTS FOR PUMP TEST #1:

- CALIBRATION FOR PUMP TEST #1 WAS PERFORMED FOR THE PUMPING WELL (HN27I2) AND 5 OBSERVATION WELLS.

- CALIBRATION FOR THIS PUMP TEST WAS WITHIN CALIBRATION CRITERIA FOR ALL WELLS, WITH EXCEPTION OF ONE WELL (HN27I1).

- HN27I1 IS LOCATED BETWEEN THE PUMPING WELL AND THE ACTIVE RECHARGE BASIN.

BETHPAGE NWIRP
PUMP TEST #1
HN27I2 PUMPING AT 448 GPM FOR 4100 MINUTES

MODFLOW PUMP TEST #1 CALIBRATION SUMMARY

Well	Layer	Location (Row)	Location (Column)	Measured Drawdown (ft)	Modeled Drawdown (ft)	Difference (ft)
HN-27S2	1	23	30	1.32	1.08	0.24
HN-27S3		24	30	1.03	0.83	0.2
HN-26I1	2	19	26	0.26	0.18	0.08
HN-27I1		22	30	3.51	1.93	-1.58
HN-27I2		23	30	5.95	5.83	0.12
HN-28I		26 27	29+30 29+30	0.59	0.49	0.1

NOTE: CALIBRATION CRITERIA +/- 1.0 FT

PRELIMINARY

CALIBRATION FOR PUMP TEST #2:

- CALIBRATION FOR PUMP TEST #2 WAS PERFORMED FOR THE PUMPING WELL (PW-11) AND FOR 10 OBSERVATION WELLS.

- CALIBRATION FOR THIS PUMPING TEST WAS WITHIN CALIBRATION CRITERIA FOR ALL WELLS.

BETHPAGE NWIRP
PUMP TEST #2
PW-11 PUMPING AT 890 GPM FOR 4250 MINUTES

MODFLOW PUMP TEST #2 CALIBRATION SUMMARY

Well	Layer	Location (Row)	Location (Column)	Measured Drawdown (ft)	Modeled Drawdown (ft)	Difference (ft)
HN-25S	1	21	16	0.08	0.22	0.14
HN-27S2		23	30	0.11	-0.65	-0.76
HN-25I	2	16 17	21+22 21+22	0.07	0.36	0.29
HN-26I1		19	26	0.04	0.14	0.1
HN-27I2		23	30	0.12	-0.45	-0.57
HN-28I		26 27	29+30 29+30	0.17	-0.19	-0.36
HN-29I		26 27	26+27 26+27	0.21	0.05	-0.16
HN-25D	3	16	21	0.17	0.52	0.35
NH-29D		26 27	26+27 26+27	0.27	0.10	-0.17
PW-10	5	17 18	19+20 19+20	< 0.5	0.65	0.65
PW-11		19	23	1.03	1.85	0.82

NOTE: CALIBRATION CRITERIA +/- 1.0 FT.

PRELIMINARY

3) **MODEL VERIFICATION:**

THE VERIFICATION PROCESS INVOLVED SIMULATING TWO PUMPING SITUATIONS:

- LOW PUMPING PERIOD DURING FEBRUARY, 1992.
- HIGH PUMPING PERIOD DURING AUGUST, 1992.

FOR BOTH LOW AND HIGH PUMPING CONDITIONS:

- THE PUMPING RATES FOR ON-SITE PRODUCTION WELLS ARE KNOWN.

- WATER LEVEL INFORMATION FOR WELLS ACROSS THE SITE WERE MEASURED.

MODEL VERIFICATION WAS CONDUCTED BY COMPARING MEASURED WATER ELEVATIONS AND MODELED WATER ELEVATIONS AT 35 WELLS ACROSS THE MODELED AREA UNDER LOW PUMPING AND HIGH PUMPING CONDITIONS.

A VERIFICATION CRITERIA OF +/- 2.0 FEET USED.

TO DATE, MODEL VERIFICATION IS APPROXIMATELY 70% COMPLETE.

BETHPAGE NWIRP
LOW PUMPING CONDITIONS - FEB.21, 1992 WATER ELEVATIONS

WELL	GRID LOCATION (R,C,L)	FEB. 21, 1992 WATER ELEVATION	MODELED WATER ELEVATION	MODELED - MEASURED (FT)
G + M MONITORING WELLS				
GM-2I	6, 33, 2	74.09	72.62	-1.47
GM-3I	6, 9, 2	74.05	72.56	-1.49
GM-6I	11, 21, 2	68.06	71.04	2.98
GM-7S	13, 27, 1	73.16	70.92	-2.24
GM-7I	13, 27, 2	73.07	70.85	-2.22
GM-7D	13, 27, 3	72.16	70.71	-1.45
GM-8S	15, 37, 1	73.77	71.84	-1.93
GM-8I	15, 37, 2	73.31	71.65	-1.66
GM-10I	21, 6, 2	71.75	69.05	-2.70
GM-12S	29, 15, 1	71.11	68.46	-2.65
GM-12I	29, 15, 2	70.82	68.40	-2.42
GM-13D	34, 22, 3	69.01	67.30	-1.71
GM-14I	36, 25, 2	69.17	66.95	-2.22
GM-15I	48, 40, 2	66.04	64.04	-2.00
GM-16S	36, 16, 1	69.79	66.66	-3.13
GM-16I	36, 16, 2	69.75	66.60	-3.15
GM-17S	38, 9, 1	71.22	66.00	-5.22
GM-18I	44, 11, 2	67.74	64.51	-3.23
GM-19S	48, 33, 1	66.41	64.59	-1.82
GM-19I	48, 33, 2	66.46	64.39	-2.07
GM-20I	51, 16, 2	65.54	63.10	-2.44
GM-20D	51, 16, 3	64.68	62.84	-1.84
GM-21I	51, 23, 2	64.52	63.44	-1.08
GM-22S	51, 31, 1	65.88	63.37	-2.51
GM-22I	51, 31, 1	64.87	63.37	-1.50
HALLIBURTON NUS MONITORING WELLS				
HN-8D	17, 37, 3	70.95	71.38	0.43
HN-24S	13, 22, 1	71.69	70.62	-1.07
HN-24I	13, 22, 2	71.18	70.80	-0.38
HN-25S	16, 21, 1	72.40	70.03	-2.37
HN-25I	16+17, 21+22, 2	72.23	69.90	-2.33
HN-25D	16, 21, 3	71.21	69.71	-1.50
HN-26S	18, 26, 1	74.23	70.45	-3.78
HN-26I	19, 26+27, 2	73.28	70.33	-2.95
HN-27S	22, 30, 1	74.21	71.48	-2.73
HN-27I1	22, 30, 2	73.61	70.94	-2.67
HN-28S	26+27, 29+30, 1	72.10	70.09	-2.01
HN-28I	26+27, 29+30, 2	71.28	69.89	-1.39
HN-29S	26+27, 26+27, 1	72.15	69.64	-2.51
HN-29I	26+27, 26+27, 2	71.19	69.54	-1.65
HN-29D	26+27, 26+27, 3	69.42	69.31	-0.11
HN-30S	22, 36, 1	73.00	75.91	2.91
HN-30I	22, 36, 2	72.50	72.63	0.13

NOTE: VALIDATION CRITERIA +/- 2.0 FT.

PRELIMINARY

BETHPAGE NWIRP
HIGH PUMPING CONDITIONS - AUG. 28, 1992 WATER ELEVATIONS

WELL	GRID LOCATION (R,C,L)	AUG. 28, 1992 WATER ELEVATION	MODELED WATER ELEVATION	MODELED - MEASURED (FT)
G + M MONITORING WELLS				
GM-2I	6, 33, 2	71.28	72.76	1.48
GM-3I	6, 9, 2	74.96	72.34	-2.62
GM-6I	11, 21, 2	64.72	70.47	5.75
GM-7S	13, 27, 1	70.73	71.94	1.21
GM-7I	13, 27, 2	70.52	71.67	1.15
GM-7D	13, 27, 3	68.41	70.97	2.56
GM-8S	15, 37, 1	74.87	76.38	1.51
GM-8I	15, 37, 2	72.84	74.91	2.07
GM-10I	21, 6, 2	67.37	69.33	1.96
GM-12S	29, 15, 1	68.78	69.00	0.22
GM-12I	29, 15, 2	68.29	68.93	0.64
GM-13D	34, 22, 3	67.05	68.48	1.43
GM-14I	36, 25, 2	66.04	68.26	2.22
GM-15I	48, 40, 2	64.99	65.30	0.31
GM-16S	36, 16, 1	68.54	67.80	-0.74
GM-16I	36, 16, 2	68.44	67.73	-0.71
GM-17S	38, 9, 1	72.29	67.67	-4.62
GM-18I	44, 11, 2	67.22	66.03	-1.19
GM-19S	48, 33, 1	66.24	66.17	-0.07
GM-19I	48, 33, 2	66.24	65.97	-0.27
GM-20I	51, 16, 2	66.46	65.46	-1.00
GM-20D	51, 16, 3	64.90	64.80	-0.10
GM-21I	51, 23, 2	65.82	66.34	0.52
GM-22S	51, 31, 1	66.23	65.84	-0.39
GM-22I	51, 31, 1	65.15	65.84	0.69
HALLIBURTON NUS MONITORING WELLS				
HN-8D	17, 37, 3	70.55	74.54	3.99
HN-24S	13, 22, 1	69.47	70.41	0.94
HN-24I	13, 22, 2	68.10	69.59	1.49
HN-25S	16, 21, 1	69.83	69.99	0.16
HN-25I	16+17, 21+22, 2	69.41	69.67	0.26
HN-25D	16, 21, 3	66.83	68.80	1.97
HN-26I	19, 26+27, 2	71.02	73.43	2.41
HN-27S	22, 30, 1	75.64	79.70	4.06
HN-28S	26+27, 29+30, 1	72.41	73.42	1.01
HN-28I	26+27, 29+30, 2	70.05	73.15	3.10
HN-29S	26+27, 26+27, 1	71.50	71.68	0.18
HN-29I	26+27, 26+27, 2	69.56	71.43	1.87
HN-29D	26+27, 26+27, 3	67.24	71.07	3.83
HN-30I	22, 36, 2	74.36	79.32	4.96

NOTE: VALIDATION CRITERIA +/- 2.0 FT.

PRELIMINARY

4) **PREDICTION:**

PREDICTION USED THE MODPATH PARTICLE TRACKING PROGRAM TO SIMULATE PARTICLE MOVEMENT IN THE AQUIFER.

- MODPATH IS A PORTION OF THE MODFLOW GROUND WATER MODEL.

- MODPATH DETERMINES THE MOVEMENT OF A PARTICLE FROM A RELEASE POINT TO AN END POINT AND DISPLAYS THE PATH OF THE PARTICLE AS A LINE.

- PARTICLE TRACKING LINES CAN BE USED TO REPRESENT POTENTIAL CONTAMINANT PATHWAYS.

- POTENTIAL CAPTURE ZONES OF WELLS CAN BE SIMULATED.

- MODPATH SIMULATES ADVECTIVE TRANSPORT, AND DOES NOT SIMULATE CONTAMINANT CONCENTRATIONS.

MODPATH SIMULATIONS CONDUCTED:

TWO FLOW SIMULATIONS WERE CONDUCTED AND PARTICLE TRACKING WAS PERFORMED FOR EACH SIMULATION.

AVERAGE PUMPING CONDITIONS:

ALL BETHPAGE PRODUCTION WELLS RUNNING AT 1992 AVERAGE PUMPING RATE. ALL WATER PUMPED IS RECHARGED INTO LAYER 1 THROUGH RECHARGE BASINS. BETHPAGE WELLS 6078, 8767 AND 8768 PUMPING AT 1000 GPM.

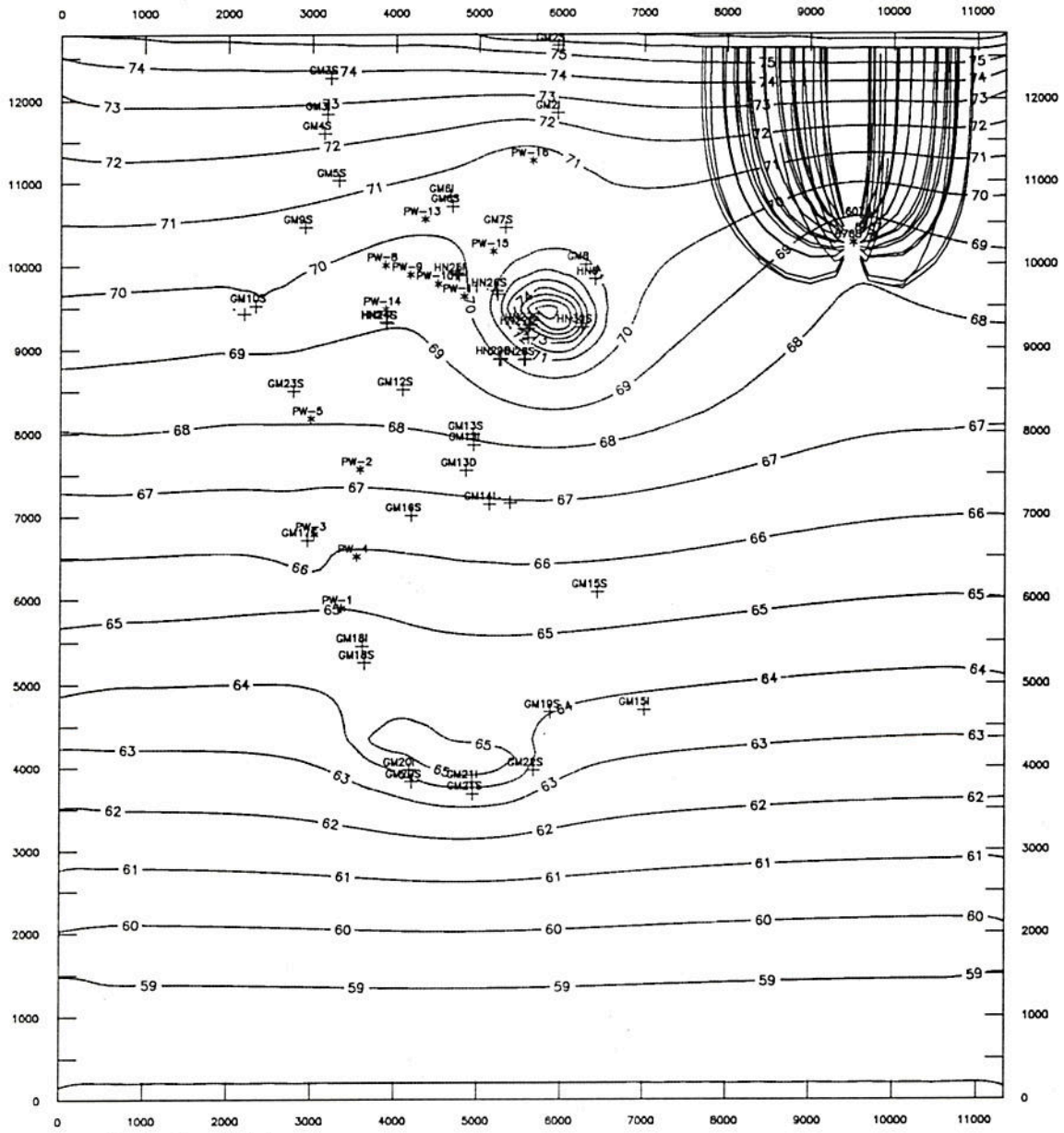
PARTICLE TRACK 1:

PATHLINES SHOW CAPTURE ZONE OF BETHPAGE WELLS 6078, 8767 AND 8768.

PARTICLE TRACK 2:

PATHLINES ILLUSTRATE MOVEMENT OF PARTICLES RELEASED AT NORTH RECHARGE BASINS.

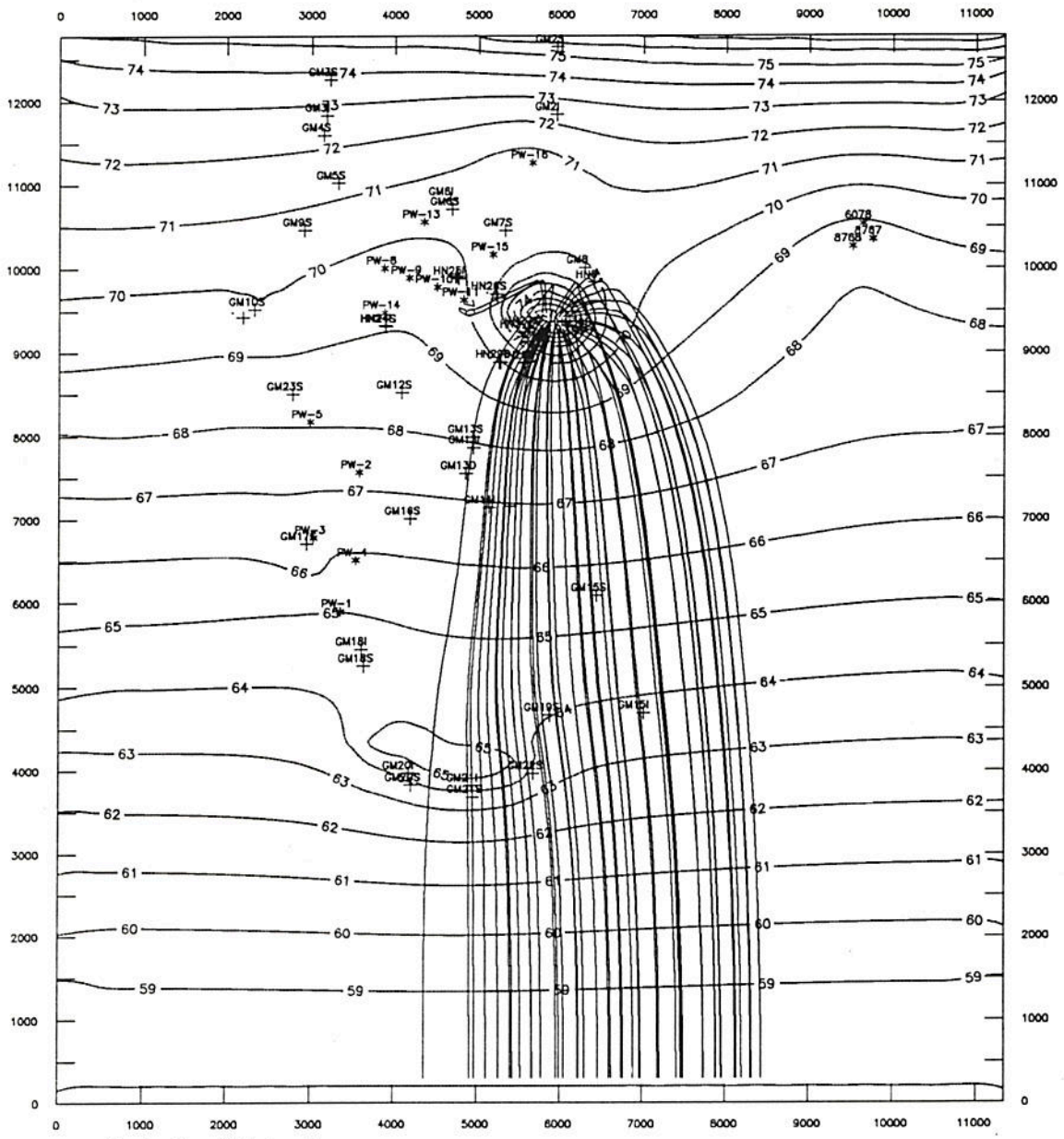
BETHPAGE – AVERAGE PUMPING CONDITIONS – CAPTURE ZONE



PARTICLE TRACK 1:

PRELIMINARY

BETHPAGE – AVERAGE PUMPING CONDITIONS – RELEASE FROM RECHARGE BASIN



* = Production Well Location
\+ = HNUS or Geraghty & Miller Monitoring Well

SCALE 1 inch = 2130 ft

PRELIMINARY

PARTICLE TRACK 2:

GRUMMAN

9

MAXIMUM PUMPING CONDITIONS:

ALL BETHPAGE PRODUCTION WELLS RUNNING AT 900 GPM (75% OF WELL CAPACITY). ALL WATER PUMPED IS RECHARGED INTO LAYER 1 THROUGH RECHARGE BASINS. BETHPAGE WELLS 6078, 8767 AND 8768 PUMPING AT 1000 GPM.

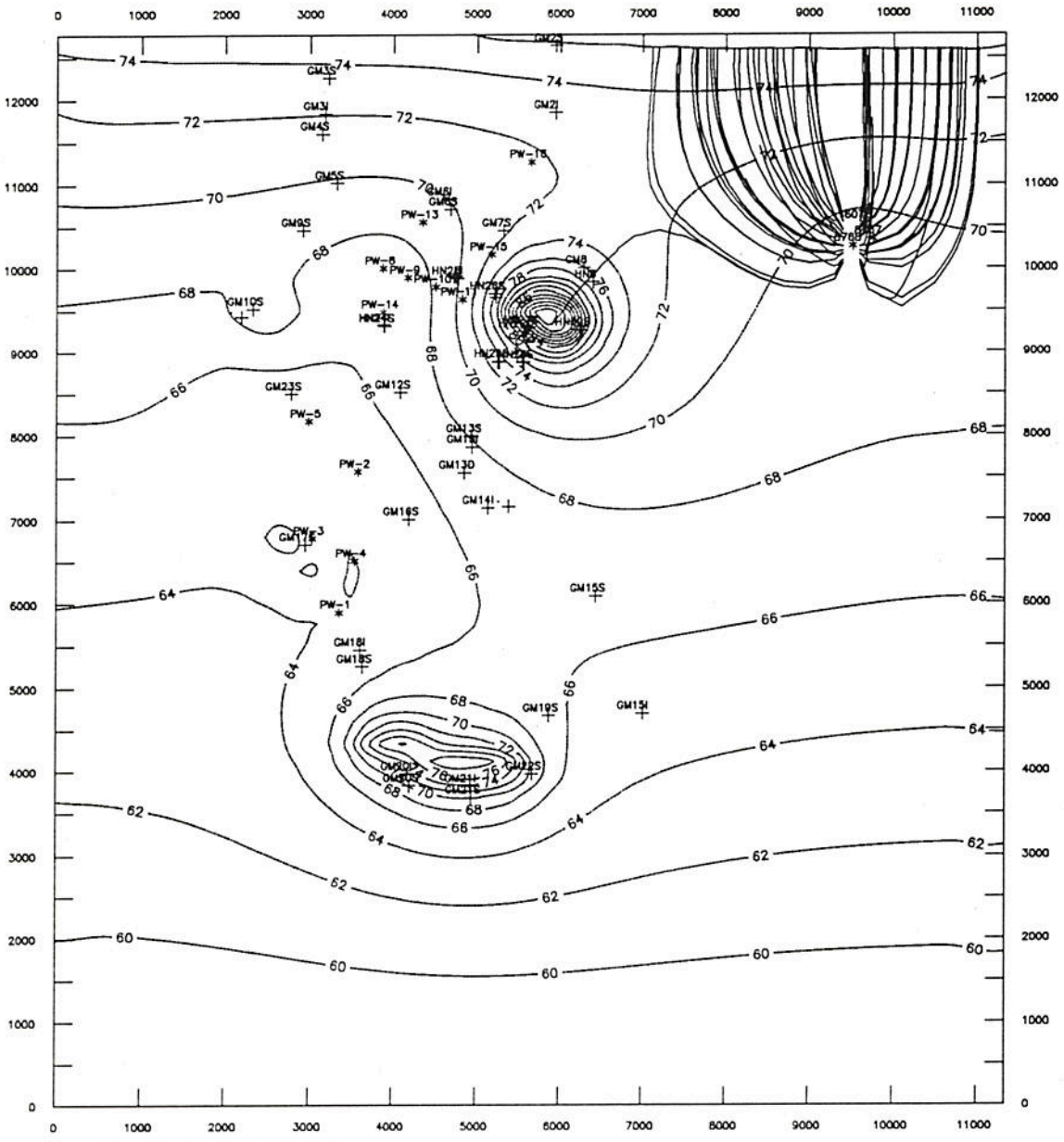
PARTICLE TRACK 3:

PATHLINES SHOW CAPTURE ZONE OF BETHPAGE WELLS 6078, 8767 AND 8768.

PARTICLE TRACK 4:

PATHLINES ILLUSTRATE MOVEMENT OF PARTICLES RELEASED AT SITE 1.

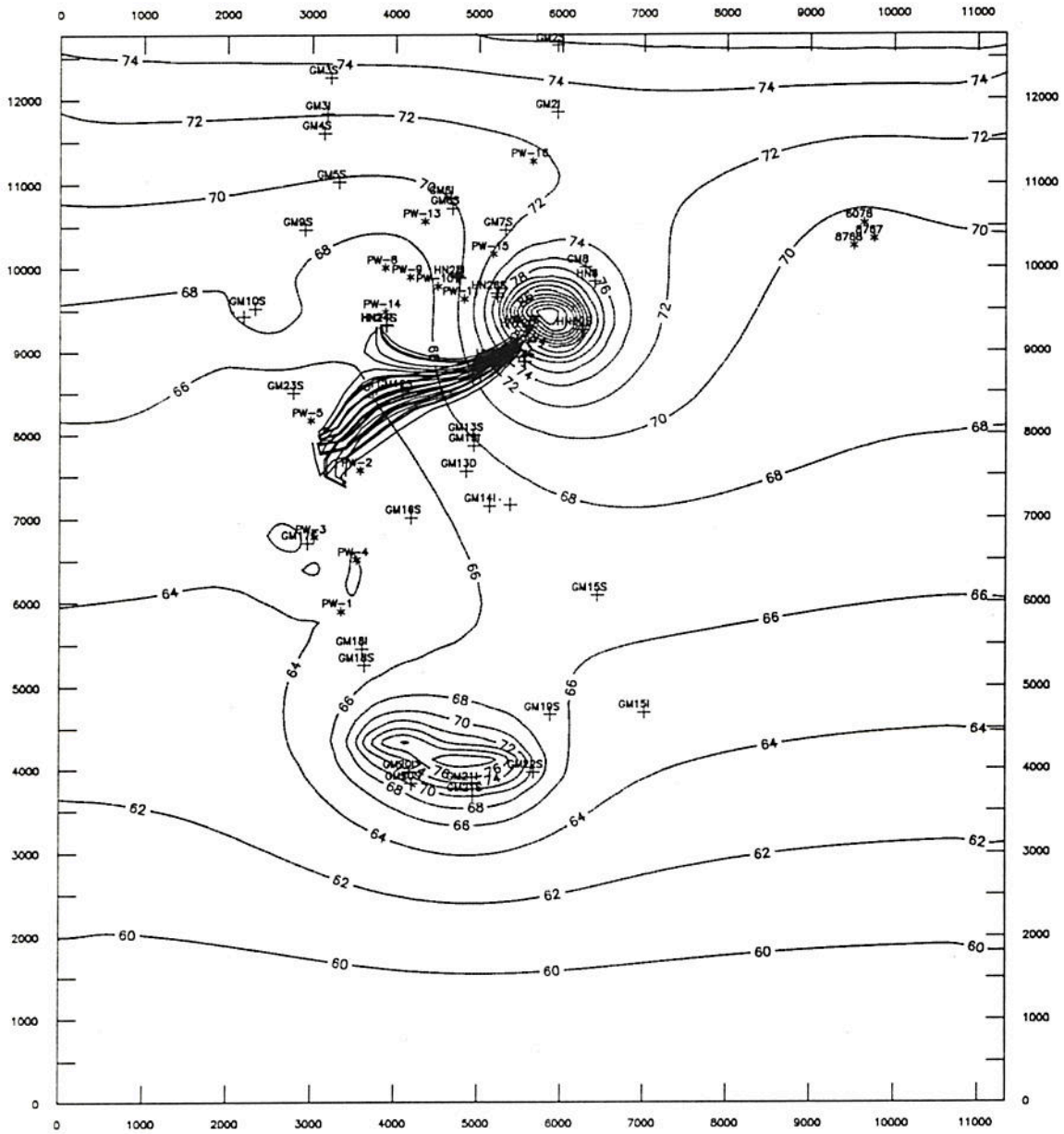
BETHPAGE – MAXIMUM PUMPING CONDITION – CAPTURE ZONE



PARTICLE TRACK 3:

PRELIMINARY

BETHPAGE – MAXIMUM PUMPING CONDITIONS – PARTICLES RELEASED AT SITE 1



PRELIMINARY

PARTICLE TRACK 4: