Ground Water Studies of Neville Chemical Site Mile Point 6.2 of the Ohio River

Part of an Investigation of Toxic Substances in the Ohio River Between River Miles 0 and 90

Ohio River Valley Water Sanitation Commission
August 1992

GROUND WATER MODEL STUDIES OF NEVILLE CHEMICAL SITE
MILE POINT 6.2 OF THE OHIO RIVER

Part of an Investigation of Toxic Substances
in the Ohio River
Between River Miles 0 and 90

Ohio River Valley Water Sanitation Commission
August 1992

TABLE OF CONTENTS

Introduction

An objective of the Ohio River Valley Water Sanitation Commission, under its Toxic Substances Control Program, is to assess the influence of ground water on Ohio River water quality. Increased emphasis on the impact of ground water is based on the results of ORSANCO toxic substances field investigations which show an apparent contribution of toxics from contaminated ground water. Simulation of ground water flow, using mathematical models, is identified as the most efficient method for this evaluation.

The selection of modelling as the assessment method was based on several factors, including:

1) The availability of hydrogeologic data for several sites along the Ohio River.

2) The lack of refined field techniques for measuring flow through the ground water/surface water interface.

Through use of an appropriate model with existing data, flow quantities transferred between ground and surface water can be estimated. Application of the model to a specific site could indicate the likelihood of effects on surface water from contaminated ground water.

Scope of Project

The project included:

1) Identification of an appropriate model

2) Application of the model to a selected site

3) Comparison of model results to actual data

Identification of an Appropriate Model

Model selection includes several considerations: the model should be well accepted and verified, provide flexibility to consider differing levels of complexity, be able to model ground water/stream interfaces, be suitable for execution on a micro computer (286 type machine) and be relatively simple to use.

Consultation with ground water modelers from state government, federal government and a university researcher resulted in the selection of the USGS model MODFLOW, "A Modular Three-Dimensional Finite Difference Ground-Water Flow Model". This model has wide spread acceptance, has been rigorously tested, is very flexible, will run on a personal computer with some limitations), and can handle streams.

Case Study - Neville Chemical Company

Background

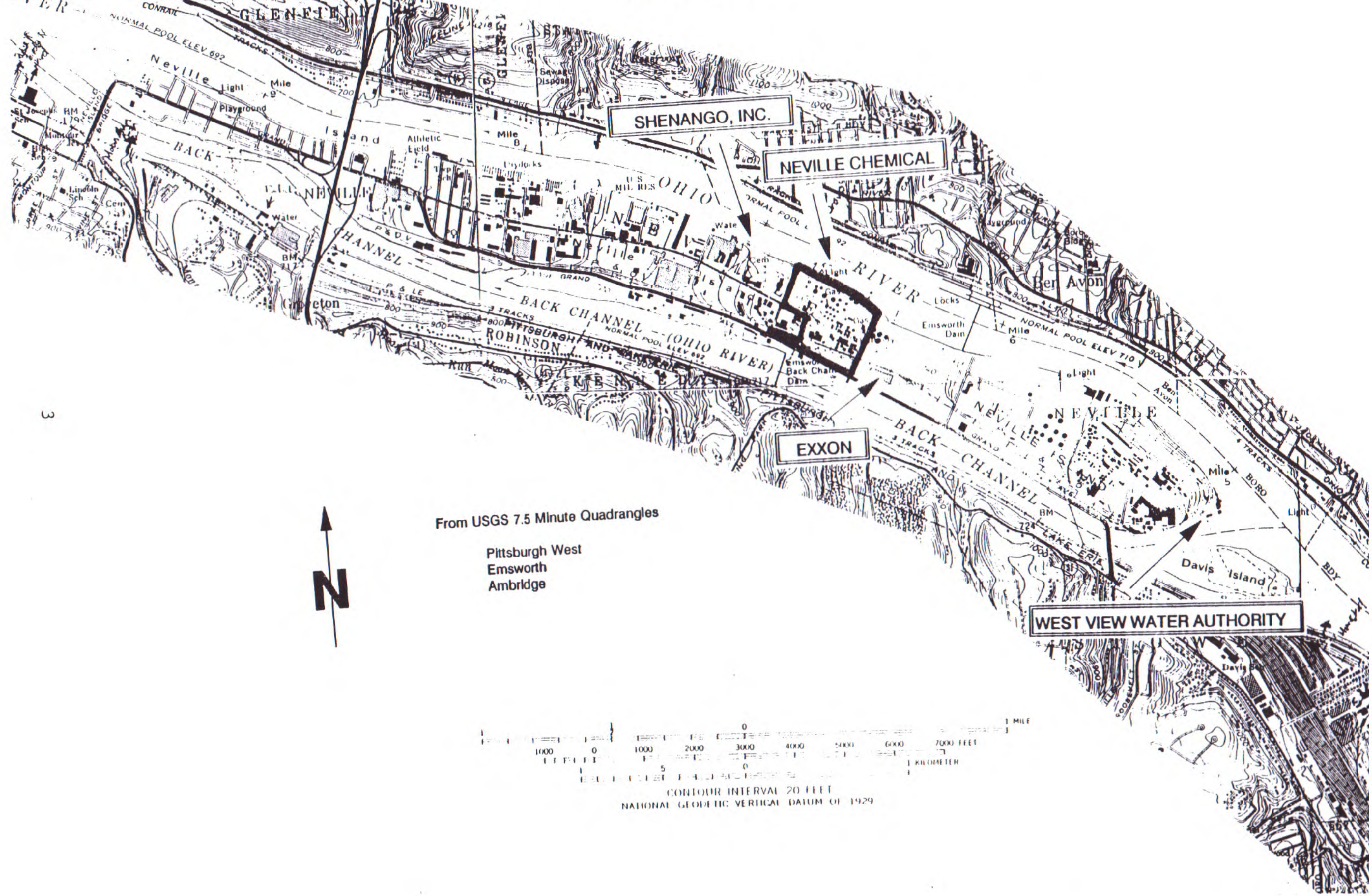
The Neville Chemical Company is located on Neville Island at approximately mile point 7.0 of the Ohio River. Neville Chemical produces thermoplastic resins (SIC 2821), bulk organic chemicals (SIC 2869), and specialty organic chemicals (SIC 2818).

The plant site is approximately 50 acres, bordered on the north and south by the Ohio River, on the east by Shenango Inc. and Exxon and to the west by several industrial service facilities (see Figure 1). Contamination of the ground water in the subsurface of Neville Island has been documented. The West View Water Authority installed water supply wells and had to subsequently abandon them because of existing ground water contamination. The wells were installed close to the Neville Chemical waste lagoon, which was operated from 1925 until the late 1970's.

Investigations by the Pennsylvania Department of Environmental Resources (PA DER) have shown that activities at Neville Chemical are responsible for the contamination at the site. Years of on-site waste disposal, process leaks and accidental spills have resulted in high levels of organic compounds in the ground water.

The Neville Chemical Company has been pumping contaminated ground water and recovering free product since the late 1970's. The company has been under a consent order with PA DER since 1980. Because of inadequacies in the cleanup program PA DER issued an administrative order on January 4, 1989. Subsequent negotiations resulted in a consent order and agreement between Neville Chemical and PA DER. Neville Chemical is currently reassessing the magnitude of the problem based on this agreement. Under the terms of these orders and agreements, the company has been required to collect a considerable amount of data; the data proved sufficient to characterize hydrogeologic conditions on the site.

Figure 1 - Site Location



This site was selected for the modeling based on the following factors:

1) Data availability
2) Long term concern by PA DER
3) Level of ground water contamination (Benzene concentrations greater than 10,000 ppb, Naphthalene concentrations greater than 100,000 ppb)
4) Unique conditions of higher river stage in back channel.

Model Set Up

Figure 2 shows the grid arrangement used for the simulation of the Neville Chemical site. The grid is 18 rows by 23 columns with varying spacing. The spacing was varied to allow more detail near the river banks and pumping wells. The model boundaries were extended 2000 feet to the east and west to reduce the influence of the no flow boundaries. The model was run as one layer, assuming the bedrock underlying the alluvial materials to be impervious. The constant head boundary formed by the Ohio River was defined based on a site plan submitted by the Neville Chemical Company to PA DER.

The model was run under varying conditions to evaluate the input data. Recharge and the hydraulic conductivity were varied. The hydraulic conductivity was varied by one order of magnitude above and below the value reported by the Neville Chemical Company. The model was run with and without recharge for each hydraulic conductivity. PA DER believes very little recharge takes place given the areal extent of concrete and the storm water collection system maintained by Neville Chemical.

Recharge was input as a matrix to allow for differences in the overlying material. Recharge was calculated as the inverse of runoff using the annual average rainfall ($1.1\text{x}10^{-7}$ ft/sec) on the site and the rational coefficient (C) to describe runoff from different types of areas of the site (see Table 1). The rainfall data was from four years of weekly data submitted by the Neville Chemical Company to PA DER. The relation (1-C) was input to describe recharge to each cell. Recharge to each cell was defined as:

$$Recharge=(1-C)*(1.1x10^{-7}\frac{ft}{\sec})$$

Figure 2 - Model Grid

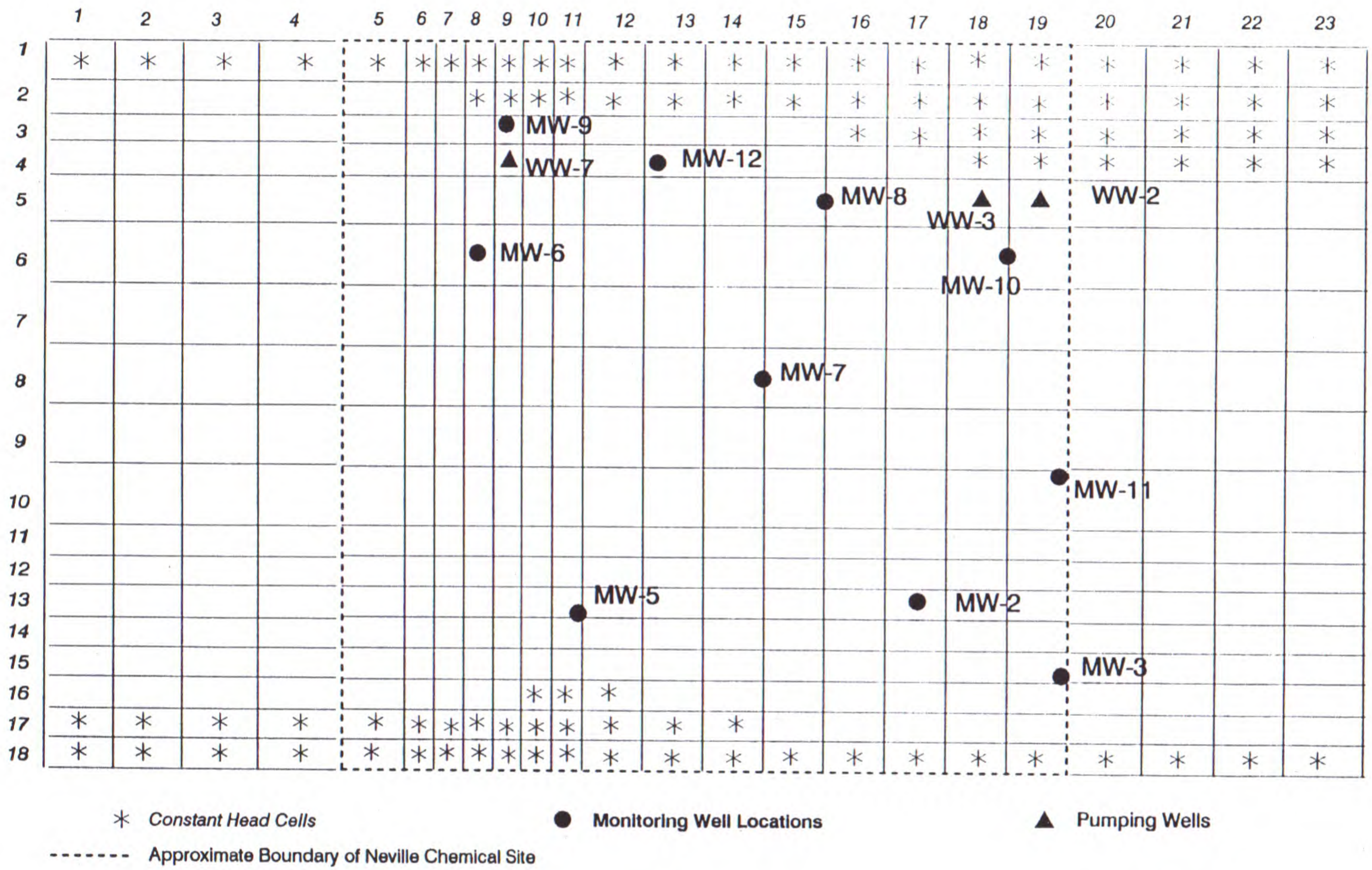


Table 1 shows the model conditions for the initial simulation:

Table 1 - Model Conditions - Detailed Simulation		
Steady State		
Assume Subsurface is isotropic and homogeneous		
Hydraulic Conductivity		= 0.002 ft/sec*
Ohio River is Constant Head Boundary		
Bedrock Elevation		= 660' msl
Annual Average Rainfall		= 1.1×10^{-7} ft/sec@
Pumping Wells (well Id (row,col), pump rate)*		
	WW-2 (5,19)	0.89 cfs
	WW-3 (5,18)	0.84 cfs
	WW-7 (4,9)	0.36 cfs
Rational Coefficients:▸		
	Undeveloped Areas	= 0.15
	Parking Lots/Buildings	= 0.75
	Process Areas	= 0.80
	Tank Farms	= 0.05
River Stage:		
	October 16, 1991	Main Channel 693.3
		Back Channel 711.2

* - From " Ground Water Phase I Report, Neville Chemical Company, Pittsburgh, Pennsylvania", ERM, February 1990.
@ - From Neville Chemical Monitoring Data
▸ - From Water Supply and Pollution Control, Fourth Edition, Viessman, W., & Hammer, M.J., Harper & Row NY, NY.

Status reports submitted by the Neville Chemical Company to PA DER provide water table data as well as river stage data. Data collected on October 16, 1991, was used for the initial runs. These runs were used to establish the appropriate hydraulic conductivity and the influence of recharge on the site. Pumping rates are those reported by Neville Chemical in 1990. The pumping well configuration has changed since, according to PA DER. The volume pumped from each of the wells was not available, therefore the same total volume was assumed with the distribution as above.

The model was then executed using river stage data from December 16, 1991 and Janary 22, 1992. The difference between upper and lower river stages for these two days were 14.8 and 16.2 feet respectively. These runs provide additional information on ground water contribution at varying river stage.

Results

Initially the model was executed for six different cases to determine the effect of recharge and the suitability of the hydraulic conductivity value. Table 2 displays the conditions for each of these six runs.

TABLE 2 - Model Run Conditions

Run	Hydraulic Conductivity	Recharge
Run 1	0.02 ft/sec	Yes
Run 2	0.02 ft/sec	No
Run 3	0.002 ft/sec	No
Run 4	0.002 ft/sec	Yes
Run 5	0.0002 ft/sec	Yes
Run 6	0.0002 ft/sec	No

The output of each run was evaluated by comparing the calculated heads with data from monitoring wells. The predicted heads at the monitor wells were interpolated from the four closest model nodes using the inverse distance method. Results from runs 4 and 5 were not evaluated because the results showed that the cells containing the pumping wells went dry. Table 3 shows the calculated heads vs the measured heads and the differences for the first four runs. Neville Chemical has installed well clusters at many locations and head values for both the shallow (S) and deep (D) wells are displayed.

It is clear that the differences between the predicted and measured values are variable. This indicates that the aquifer is not homogeneous and may not be isotropic. The differences may also be attributed to the dynamic nature of the stage of the Ohio River. The model also cannot predict the vertical gradient observed in monitor wells 2, 3, and 5. A layered approach may be needed to better predict this. For the purposes of this investigation the results of run three are acceptable. The results also show that recharge is not a factor in this system.

Figure 3 shows the predicted piezometric surface. The figure shows the influence of the difference in river stage in the back channel on the ground water flow pattern. The figure also shows the influence of the pumping wells and the flow pattern towards the main channel.

The major objective of the study is to predict the quantity of ground water flowing to the Ohio River from the Neville Chemical site. Tables 4 and 5 show the volumetric budget for Run 3. Table 4 shows the total flow to and from the constant head cells and Table 5 shows only those constant head cells which are adjacent to the Neville Chemical site. The budget indicates that approximately 1.9 million gallons per day (MGD) of ground water is contributed to the Ohio River from the area modelled and approximately 0.8 MGD

TABLE 3 - Comparison of Calculated and Measured Heads

		Calculated Heads				Actual - Predicted				
Monitoring Well	Measured Head	Run 1	Run 2	Run 3	Run 4	Delta 1	Delta 2	Delta 3	Delta 4	Avg
MW-2S	702.8	705.9	705.9	705.6	705.9	-3.1	-3.1	-2.8	-3.1	-3.0
MW-3S	710.6	709.0	709.0	708.9	709.0	1.6	1.6	1.7	1.6	1.6
MW-5S	708.3	701.6	701.6	701.4	702.1	6.7	6.7	6.9	6.2	6.6
MW-6S	693.8	695.2	695.2	694.5	694.9	-1.4	-1.4	-0.7	-1.1	-1.2
MW-7S	697.8	699.5	699.5	698.9	699.4	-1.7	-1.7	-1.1	-1.6	-1.5
MW-8S	693.5	695.2	695.2	694.5	694.8	-1.7	-1.7	-1.0	-1.3	-1.4
MW-9S	693.5	693.4	693.4	693.0	693.1	0.1	0.1	0.5	0.4	0.3
MW-10S	693.6	696.0	696.0	693.2	693.5	-2.4	-2.4	0.4	0.1	-1.1
MW-11S	700.6	702.9	702.8	702.3	702.7	-2.3	-2.2	-1.7	-2.1	-2.1
MW-12S	693.2	694.6	694.5	694.2	694.4	-1.4	-1.3	-1.0	-1.2	-1.2
Delta = Actual - Predicted					Avg	-0.56	-0.54	0.12	-0.21	

		Calculated Heads				Actual - Predicted				
Monitoring Well	Measured Head	Run 1	Run 2	Run 3	Run 4	Delta 1	Delta 2	Delta 3	Delta 4	Avg
MW-2D	705.5	705.9	705.9	705.6	705.9	-0.4	-0.4	-0.1	-0.4	-0.3
MW-3D	705.8	709.0	709.0	708.9	709.0	-3.2	-3.2	-3.1	-3.2	-3.2
MW-5D	699.2	701.6	701.6	701.4	702.1	-2.4	-2.4	-2.2	-2.9	-2.5
MW-6D	693.9	695.2	695.2	694.5	694.9	-1.3	-1.3	-0.6	-1.0	-1.0
MW-7D	696.6	699.5	699.5	698.9	699.4	-2.9	-2.9	-2.3	-2.8	-2.7
MW-8D	693.7	695.2	695.2	694.5	694.8	-1.5	-1.5	-0.8	-1.1	-1.2
MW-9D	693.5	693.4	693.4	693.0	693.1	0.1	0.1	0.5	0.4	0.3
MW-10D	693.5	696.0	696.0	693.2	693.5	-2.5	-2.5	0.3	0.0	-1.2
MW-11D	699.1	702.9	702.8	702.3	702.7	-3.8	-3.7	-3.2	-3.6	-3.6
MW-12D	693.6	694.6	694.5	694.2	694.4	-1.0	-0.9	-0.6	-0.8	-0.8
Delta = Actual - Predicted					Avg	-1.89	-1.87	-1.21	-1.54	

FIGURE 3

Neville Chemical Piezometric Surface (10-16-91)

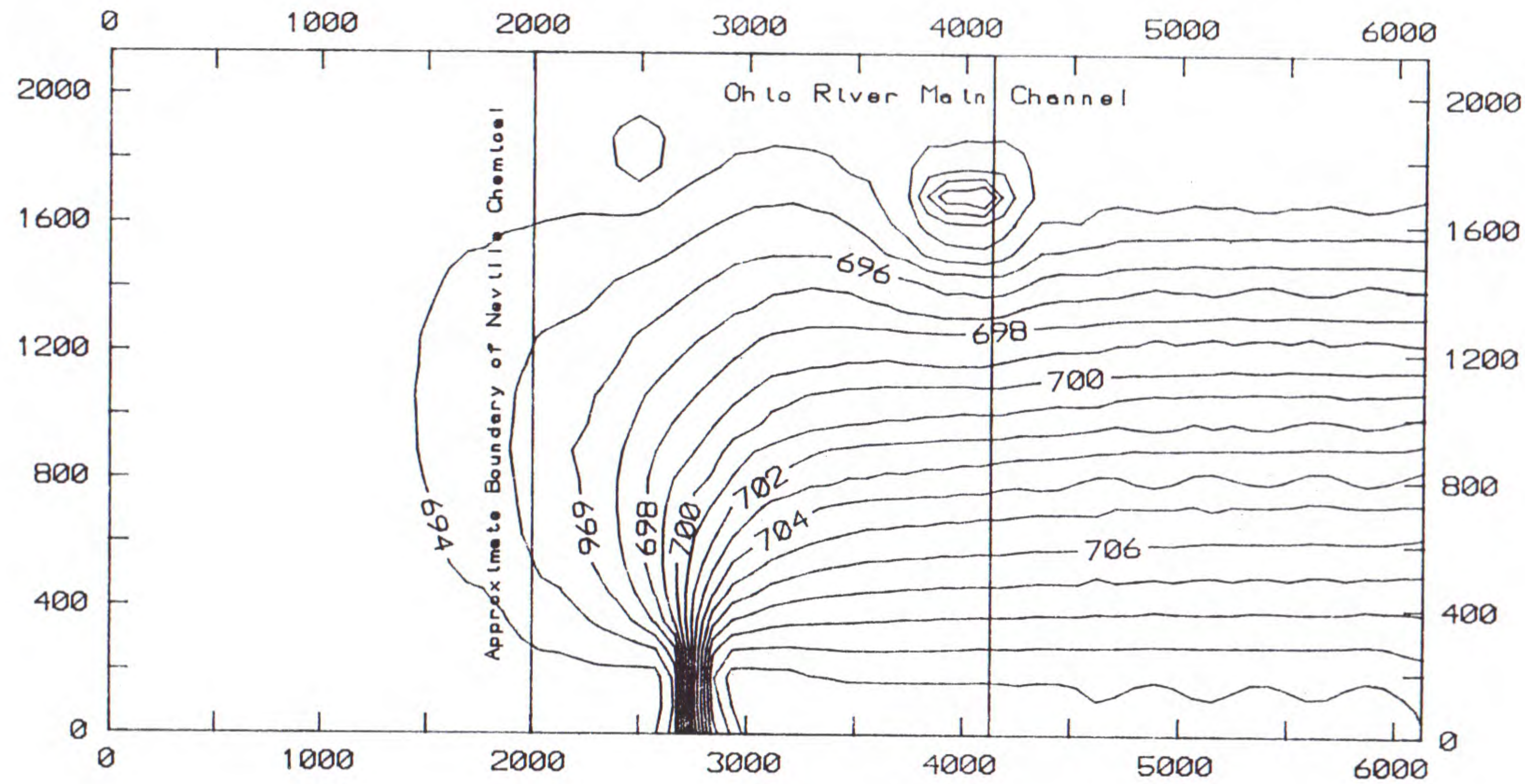


TABLE 4 - Flow Budget

October 16, 1991 River Stage

Flow Terms for Constant Head Cells		
Row	Column	Flow - cfs
1	1	-0.0077
1	2	-0.0120
1	3	-0.0220
1	4	-0.0366
1	5	-0.0108
1	6	-0.0020
1	7	0.0007
2	8	0.0207
2	9	0.0396
2	10	0.0164
2	11	-0.0022
2	12	-0.0381
2	13	-0.0554
2	14	-0.0593
2	15	-0.0486
3	16	-0.0668
3	17	0.0042
4	18	0.3921
4	19	0.3950
5	20	-0.2129
5	21	-0.4382
5	22	-0.4515
5	23	-0.4549
16	10	-0.2831
16	11	-0.3994
16	12	0.9097
17	1	-0.0082
17	2	-0.0141
17	3	-0.0311
17	4	-0.0775
17	5	-0.0625
17	6	-0.0425
17	7	-0.0513
17	8	-0.0592
17	9	-0.0561
17	13	0.2779
17	14	0.3235
18	15	0.1579
18	16	0.1791
18	17	0.1802
18	18	0.1782
18	19	0.1468
18	20	0.4789
18	21	0.4685
18	22	0.4630
18	23	0.4609

Flow Budget For the Modelled Site	
	Flow - mgd
Flow To Main Channel Flows < 0 & Row < 6	1.24
Flow From Main Channel Flows > 0 & Row < 6	0.56
Flow To Back Channel Flows < 0 & Row > 15	0.70
Flow From Back Channel Flows > 0 & Row > 15	2.73
Flow To Wells	1.35
Ohio Main Channel Elevation	693.3
Ohio Back Channel Elevation	711.2

Negative Flow Indicates Flow into Cell
Positive Flow Indicates Flow out of Cell

TABLE 5 - Flow Budget (Neville Chemical Site Only)

October 16, 1991 River Stage

Flow Terms for Constant Head Cells

Row	Column	Flow - cfs
1	5	-0.0108
1	6	-0.0020
1	7	0.0007
2	8	0.0207
2	9	0.0396
2	10	0.0164
2	11	-0.0022
2	12	-0.0381
2	13	-0.0554
2	14	-0.0593
2	15	-0.0486
3	16	-0.0668
3	17	0.0042
4	18	0.3921
4	19	0.3950
16	10	-0.2831
16	11	-0.3994
16	12	0.9097
17	5	-0.0625
17	6	-0.0425
17	7	-0.0513
17	8	-0.0592
17	9	-0.0561
17	13	0.2779
17	14	0.3235
18	15	0.1579
18	16	0.1791
18	17	0.1802
18	18	0.1782
18	19	0.1468

Flow Budget For the Modelled Site

	Flow - mgd
Flow To Main Channel Flows < 0 & Row < 6	0.18
Flow From Main Channel Flows > 0 & Row < 6	0.56
Flow To Back Channel Flows < 0 & Row > 15	0.62
Flow From Back Channel Flows > 0 & Row > 15	1.52
Flow To Wells	1.35
Ohio Main Channel Elevation	693.3
Ohio Back Channel Elevation	711.2

Negative Flow Indicates Flow into Cell
Positive Flow Indicates Flow out of Cell

flows to the Ohio River from cells adjacent to the Neville Chemical site. Approximately 0.1 MGD flows from the Neville Chemical site to the adjacent property to the west and approximately 0.2 MGD flows from the property to the east.

The volumetric budget indicates approximately 1 cfs (0.65 MGD) is discharged to the back channel of the Ohio River. This is important to note given the flow of the back channel(not to be less than 1200 cfs) and the location of a public water supply. The Robinson Township water supply is located 3 miles downstream, in the backchannel. At a stream flow of 1200 cfs and a discharge to the stream from ground water of 1 cfs, a benzene concentration in the ground water of approximately 6000 ug/L would raise the instream concentration above maximum contaminant levels allowable in drinking water. Benzene concentrations in the ground water at the Neville Chemical site are documented to be as high as 56,000 ug/L.

Two additional runs were then made. Table 6 shows the conditions used:

Table 6 - Model Conditions		
Steady State		
Assume Subsurface is isotropic and homogeneous		
Hydraulic Conductivity		= 0.002 ft/sec*
Ohio River is Constant Head Boundary		
Bedrock Elevation		= 660' msl
Pumping Wells (well Id (row,col), pump rate)*		
WW-2 (5,19)	0.89 cfs	
WW-3 (5,18)	0.84 cfs	
WW-7 (4,9)	0.36 cfs	
River Stage:@		
December 16, 1991		Main Channel 695.9
		Back Channel 710.7
January 22, 1992		Main Channel 694.2
		Back Channel 711.0

* - From " Ground Water Phase I Report, Neville Chemical Company, Pittsburgh, Pennsylvania", ERM, February 1990.
► - From Water Supply and Pollution Control, Fourth Edition, Viessman, W., & Hammer, M.J., Harper & Row NY, NY.
@ - From "Phase II Ground Water Assessment Program" Status Reports, Environmental Resources Management, Inc.

Tables 7 and 8 show the volumetric budget for the simulation of the December 16, 1991 conditions and Tables 9 and 10 are the budgets for the January 22, 1992 conditions. Table 11 shows the calculated heads resulting from the simulation compared to the measured heads. The differences between the measured heads and the calculated heads are similar to the run using the October 16, 1991 data. Figures 4 and 5 show the predicted piezometric surface for these two runs.

The results indicate the dependence of the quantity discharged from the ground water to the surface water on the difference between the river stage in the back channel and the main channel. As stated earlier the differences between the calculated heads and the measured may be due to the dynamic nature of the ground water because of fluctuations in river stage and the inability of the two dimensional model to predict the vertical gradient.

TABLE 7 - Flow Budget

December 16, 1991 River Stage

Flow Terms for Constant Head Cells

Row	Column	Flow - cfs
1	1	-0.0055
1	2	-0.0087
1	3	-0.0157
1	4	-0.0249
1	5	-0.0050
1	6	0.0008
1	7	0.0029
2	8	0.0285
2	9	0.0453
2	10	0.0223
2	11	0.0039
2	12	-0.0250
2	13	-0.0415
2	14	-0.0453
2	15	-0.0365
3	16	-0.0445
3	17	0.0194
4	18	0.4185
4	19	0.4110
5	20	-0.1329
5	21	-0.3671
5	22	-0.3813
5	23	-0.3849
16	10	-0.4252
16	11	-0.4180
16	12	0.8278
17	1	-0.0060
17	2	-0.0102
17	3	-0.0224
17	4	-0.0548
17	5	-0.0410
17	6	-0.0251
17	7	-0.0259
17	8	-0.0177
17	9	0.0225
17	13	0.2464
17	14	0.2833
18	15	0.1373
18	16	0.1551
18	17	0.1556
18	18	0.1535
18	19	0.1262
18	20	0.4101
18	21	0.3993
18	22	0.3935
18	23	0.3912

Flow Budget For the Modelled Site

	Flow - mgd
Flow To Main Channel Flows < 0 & Row < 6	0.98
Flow From Main Channel Flows > 0 & Row < 6	0.62
Flow To Back Channel Flows < 0 & Row > 15	0.68
Flow From Back Channel Flows > 0 & Row > 15	2.39
Flow To Wells	1.35
Ohio Main Channel Elevation	695.9
Ohio Back Channel Elevation	710.7

Negative Flow Indicates Flow into Cell
Positive Flow Indicates Flow out of Cell

TABLE 8 - Flow Budget - Neville Site Only

December 16, 1991 River Stage

Flow Terms for Constant Head Cells		
Row	Column	Flow - cfs
1	5	-0.0050
1	6	0.0008
1	7	0.0029
2	8	0.0285
2	9	0.0453
2	10	0.0223
2	11	0.0039
2	12	-0.0250
2	13	-0.0415
2	14	-0.0453
2	15	-0.0365
3	16	-0.0445
3	17	0.0194
4	18	0.4185
4	19	0.4110
16	10	-0.4252
16	11	-0.4180
16	12	0.8278
17	5	-0.0410
17	6	-0.0251
17	7	-0.0259
17	8	-0.0177
17	9	0.0225
17	13	0.2464
17	14	0.2833
18	15	0.1373
18	16	0.1551
18	17	0.1556
18	18	0.1535
18	19	0.1262
18	16	0.1551
18	17	0.1556
18	18	0.1535
18	19	0.1262

Flow Budget For the Modelled Site	
	Flow - mgd
Flow To Main Channel Flows < 0 & Row < 6	0.13
Flow From Main Channel Flows > 0 & Row < 6	0.62
Flow To Back Channel Flows < 0 & Row > 15	0.62
Flow From Back Channel Flows > 0 & Row > 15	1.74
Flow To Wells	1.35
Ohio Main Channel Elevation	695.9
Ohio Back Channel Elevation	710.7

Negative Flow Indicates Flow into Cell
Positive Flow Indicates Flow out of Cell

TABLE 9 - Flow Budget

Jan 22, 1992 River Stage

Flow Terms for Constant Head Cells		
Row	Column	Flow - cfs
1	1	-0.0069
1	2	-0.0108
1	3	-0.0197
1	4	-0.0322
1	5	-0.0084
1	6	-0.0009
1	7	0.0016
2	8	0.0239
2	9	0.0420
2	10	0.0189
2	11	0.0004
2	12	-0.0323
2	13	-0.0490
2	14	-0.0527
2	15	-0.0428
3	16	-0.0559
3	17	0.0118
4	18	0.4055
4	19	0.4033
5	20	-0.1713
5	21	-0.4007
5	22	-0.4143
5	23	-0.4178
16	10	-0.2596
16	11	-0.3668
16	12	0.8368
17	1	-0.0074
17	2	-0.0128
17	3	-0.0282
17	4	-0.0706
17	5	-0.0571
17	6	-0.0389
17	7	-0.0469
17	8	-0.0542
17	9	-0.0514
17	13	0.2559
17	14	0.2982
18	15	0.1457
18	16	0.1653
18	17	0.1664
18	18	0.1645
18	19	0.1355
18	20	0.4418
18	21	0.4315
18	22	0.4260
18	23	0.4238

Flow Budget For the Modelled Site	Flow - mgd
Flow To Main Channel Flows < 0 & Row < 6	1.11
Flow From Main Channel Flows > 0 & Row < 6	0.59
Flow To Back Channel Flows < 0 & Row > 15	0.64
Flow From Back Channel Flows > 0 & Row > 15	2.51
Flow To Wells	1.35
Ohio Main Channel Elevation	694.2
Ohio Back Channel Elevation	711.0

Negative Flow Indicates Flow into Cell
Positive Flow Indicates Flow out of Cell

TABLE 10 - Flow Budget - Neville Site Only

Jan 22, 1992 River Stage

Flow Terms for Constant Head Cells		
Row	Column	Flow - cfs
1	5	-0.0084
1	6	-0.0009
1	7	0.0016
2	8	0.0239
2	9	0.0420
2	10	0.0189
2	11	0.0004
2	12	-0.0323
2	13	-0.0490
2	14	-0.0527
2	15	-0.0428
3	16	-0.0559
3	17	0.0118
4	18	0.4055
4	19	0.4033
16	10	-0.2596
16	11	-0.3668
16	12	0.8368
17	5	-0.0571
17	6	-0.0389
17	7	-0.0469
17	8	-0.0542
17	9	-0.0514
17	13	0.2559
17	14	0.2982
18	15	0.1457
18	16	0.1653
18	17	0.1664
18	18	0.1645
18	19	0.1355

Flow Budget For the Modelled Site	
	Flow - mgd
Flow To Main Channel Flows < 0 & Row < 6	0.16
Flow From Main Channel Flows > 0 & Row < 6	0.59
Flow To Back Channel Flows < 0 & Row > 15	0.57
Flow From Back Channel Flows > 0 & Row > 15	1.40
Flow To Wells	1.35
Ohio Main Channel Elevation	694.2
Ohio Back Channel Elevation	711.0

Negative Flow Indicates Flow into Cell
Positive Flow Indicates Flow out of Cell

TABLE 11 - Comparison of Calculated and Measured Heads

	December 16, 1991			January 22, 1992		
Monitoring Well	Measured	Calculated	Delta	Measured	Calculated	Delta
MW-2S	702.3	705.9	-3.6	701.7	705.8	-4.1
MW-3S	711.8	708.7	3.1	711.5	708.8	2.7
MW-5S	707.9	701.9	6.0	707.7	701.9	5.8
MW-6S	696.2	696.6	-0.4	695.2	695.8	-0.6
MW-7S	698.4	696.9	1.5	698.4	699.7	-1.3
MW-8S	696.1	696.1	0.0	694.8	695.1	-0.3
MW-9S	695.9	695.6	0.3	694.9	694.5	0.4
MW-10S	696.1	696.6	-0.5	694.9	694.5	0.4
MW-11S	700.6	703.1	-2.5	700.1	702.8	-2.7
MW-12S	695.9	696.5	-0.6	694.7	695.5	-0.8
Monitoring Well	Measured	Calculated	Delta	Measured	Calculated	Delta
MW-2D	704.3	705.9	-1.6	703.9	705.8	-1.9
MW-3D	705.1	709.0	-3.9	704.5	708.8	-4.3
MW-5D	700.2	701.6	-1.4	699.3	701.9	-2.6
MW-6D	696.3	695.2	1.1	695.3	695.8	-0.5
MW-7D	698.2	699.5	-1.3	697.4	699.7	-2.3
MW-8D	696.2	695.2	1.0	695.0	695.1	-0.1
MW-9D	695.9	693.4	2.5	694.9	694.5	0.4
MW-10D	696.1	696.0	0.1	695.0	694.5	0.5
MW-11D	699.7	702.9	-3.2	698.9	702.8	-3.9
MW-12D	696.0	694.6	1.4	694.9	695.5	-0.6
	Delta = Actual - Predicted					

FIGURE 4

Neville Chemical Piezometric Surface (12-16-91)

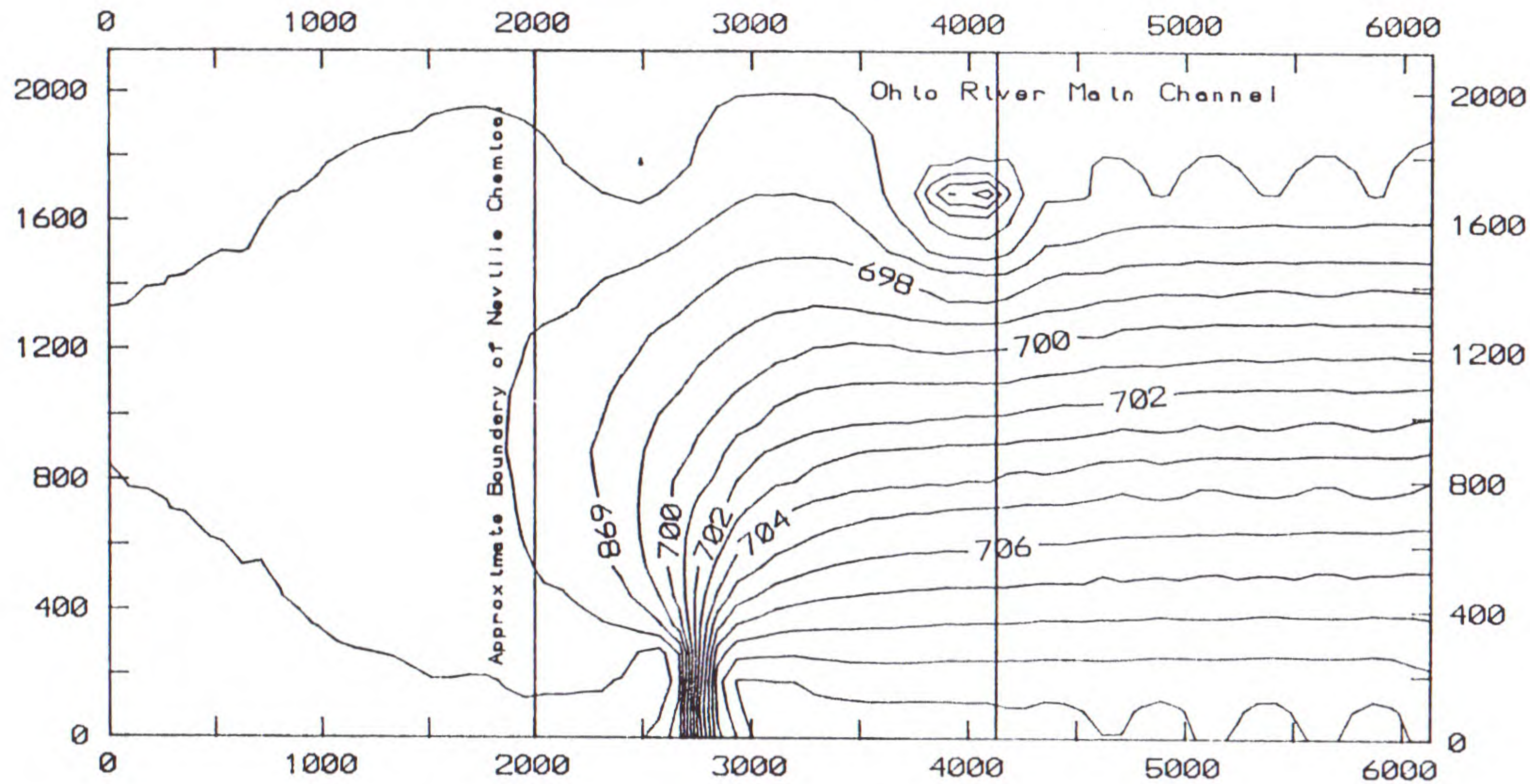
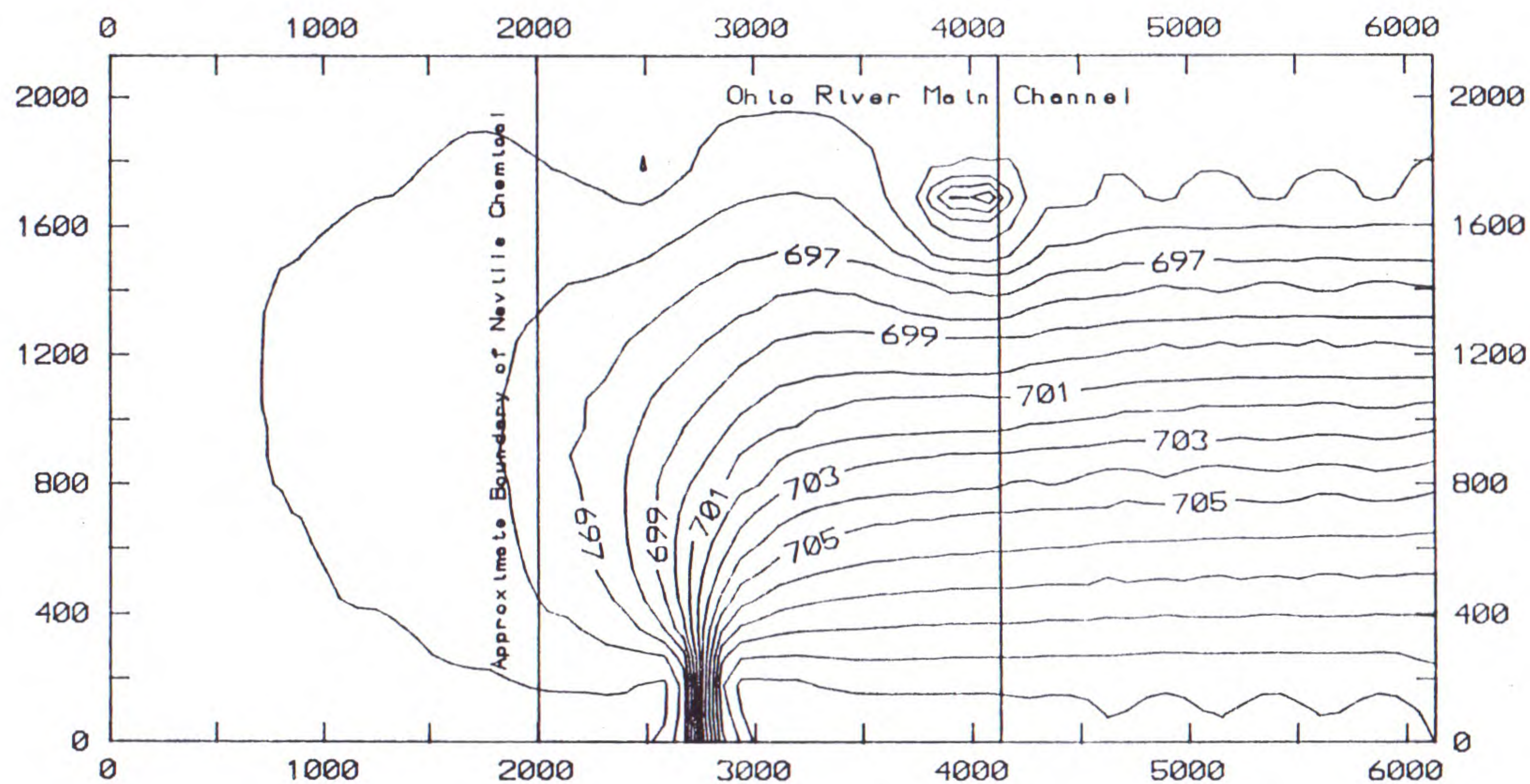


FIGURE 5

Neville Chemical Piezometric Surface (1-22-92)



Conclusions

Based on the results of the application of MODFLOW the following conclusions can be made:

1) The USGS ground water flow model MODFLOW, is an appropriate model for the estimation of ground water flow from ground water to surface water.

2) Ground water elevations estimated by MODFLOW are similar to actual conditions.

3) Approximately 0.8 MGD is contributed to the Ohio River from the aquifer underlying the Neville Chemical site.

4) Infiltration of contaminated ground water to surface water could cause violations of criteria developed for the protection of human health.

Recommendations

The following are recommendations for future activities in the Commission's ground water assessment program:

- Continue to apply MODFLOW to areas of concern to simulate ground water flow contribution.

- Investigate contaminant transport models for estimation of pollutant contribution.

- Application of MODFLOW on a large scale should be attempted to show ground water contribution to the river on a larger scale. A review of ORSANCO files should be conducted to identify a reach of the river with a large number of sites with the potential for contamination. It is recommended the reach modelled be at least 20 miles in length.