REASSESSMENT OF HYDROGEOLOGIC DATA AND REFINEMENT OF A REGIONAL GROUND-WATER-FLOW MODEL FOR THE MILFORD-SOUHEGAN GLACIAL-DRIFT AQUIFER, MILFORD, NEW HAMPSHIRE

By Joseph R. Olimpio and Philip T. Harte

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot per day (ft/d)	0.3048	meter per day
gallon per minute (gal/min)	0.06308	liter per second

Sea Level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

REASSESSMENT OF GEOHYDROLOGIC DATA AND REFINEMENT OF A REGIONAL GROUND-WATER-FLOW MODEL FOR THE MILFORD-SOUHEGAN GLACIAL-DRIFT AQUIFER, MILFORD, NEW HAMPSHIRE

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ABSTRACT

Hydrogeologic data collected since 1990 were assessed and a ground-water-flow model was refined in this study of the Milford-Souhegan glacial-drift aquifer in Milford, New Hampshire. The hydrogeologic data collected were used to refine estimates of hydraulic conductivity and saturated thickness of the aquifer, which were previously calculated during 1988-90. In October 1990, water levels were measured at 124 wells and piezometers, and at 45 stream-seepage sites on the main stem of the Souhegan River, and on small tributary streams overlying the aquifer to improve an understanding of ground-water-flow patterns and stream-seepage gains and losses.

Refinement of the ground-water-flow model included a reduction in the number of active cells in layer 2 in the central part of the aquifer, a revision of simulated hydraulic conductivity in model layers 2 and 3 representing the aquifer, incorporation of a new block-centered finite-difference ground-water-flow model, and incorporation of a new solution algorithm and solver (a preconditioned conjugate-gradient algorithm).

Refinements to the model resulted in decreases in the difference between calculated and measured heads at 22 wells. The distribution of gains and losses of stream seepage calculated in simulation with the refined model is similar to that calculated in the previous model simulation. The contributing area to the Savage well, under average pumping conditions, decreased by 0.021 square miles from the area calculated in the previous model simulation. The small difference in the contributing recharge area indicates that the additional data did not enhance model simulation and that the conceptual framework for the previous model is accurate.

INTRODUCTION

The Milford-Souhegan glacial-drift aquifer (figs. 1 and 2) was an important municipal water supply to the town of Milford, New Hampshire, until the detection (in the early 1980's) of contaminated water in two public supply wells (the Savage and Keyes wells). These wells were removed from service in 1983. After the detection of contaminated water, State and Federal agencies began hydrogeologic studies to characterize the hydrogeology and extent of contamination of the glacial-drift aquifer.

The U.S. Geological Survey (USGS), in cooperation with the U.S. Environmental Protection Agency (USEPA), studied ground-water flow to the two former public supply wells during 1988-90 utilizing a ground-water-flow model (Harte and Mack, 1992). A second cooperative study with the USEPA began in July 1990. The USGS analyzed hydrogeologic data collected since 1990 and used the data to refine the regional ground-water-flow model for the Milford-Souhegan glacial-drift aquifer. Estimates of saturated thickness and horizontal hydraulic conductivity were adjusted in the refined model. A new solution algorithm and solver were incorporated into the model to solve mathematical equations of ground-water flow. These refinements are important in keeping the ground-water-flow model current and providing the USEPA, USGS, contractors, and water managers with an updated model for evaluating options in future remediation of contamination in the western part of the glacial-drift aquifer. This report is a

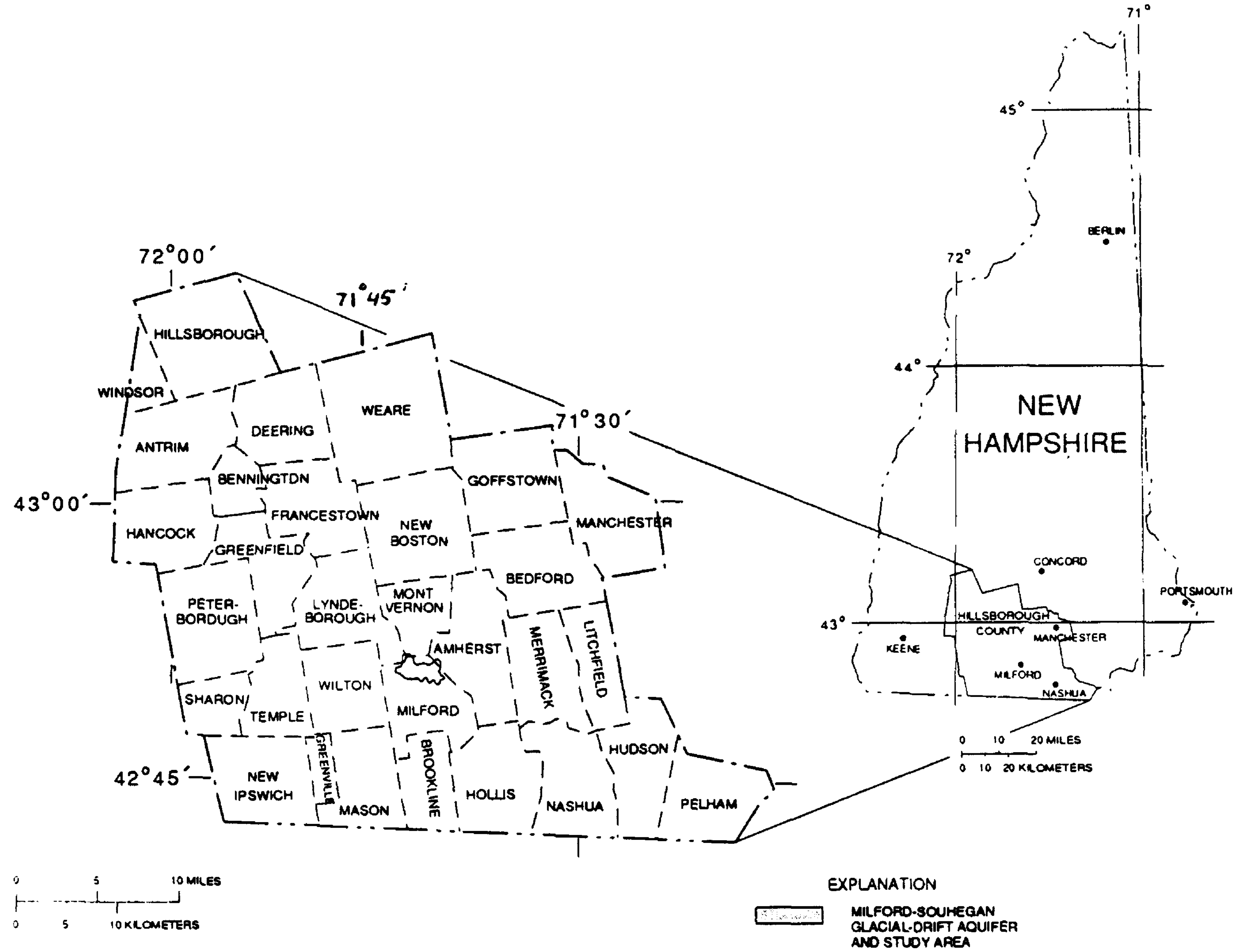


Figure 1. Location of study area, Milford, New Hampshire.

supplement to an earlier report by Harte and Mack (1992), which describes the hydrogeology of the aquifer and the simulated ground-water flow.

Purpose and Scope

This report presents a reassessment of hydrogeologic data collected during 1990-93 and describes refinements made to a regional ground-water-flow model of the Milford-Souhegan glacial-drift aquifer (Harte and Mack, 1992). Specific goals of the study were to (1) refine the previous estimates of saturated thickness and horizontal hydraulic conductivity of the aquifer utilizing hydrogeologic data collected since 1990, (2) determine gains and losses in tributary streams and the main stem of the Souhegan River, (3) compare measurements of water level and stream seepage made concurrently in October 1990 with measurements made in October 1988; (4) refine the ground-water-flow model by incorporating data collected since 1990, and (5) reassess the areal extent of the steady-state contributing area to the Savage well by use of the refined model.

Acknowledgments

Some information used in this study was provided by the New Hampshire Department of Environmental Services, Waste Management Division and Water Resources Division, and the Department of Fish and Game, Milford Fish Hatchery. Information also was provided by HMM Associates of Concord, Massachusetts. These agencies and firm are gratefully acknowledged. The authors also acknowledge officials and employees of the Town of Milford for their continued cooperation and assistance. Thanks also are extended to

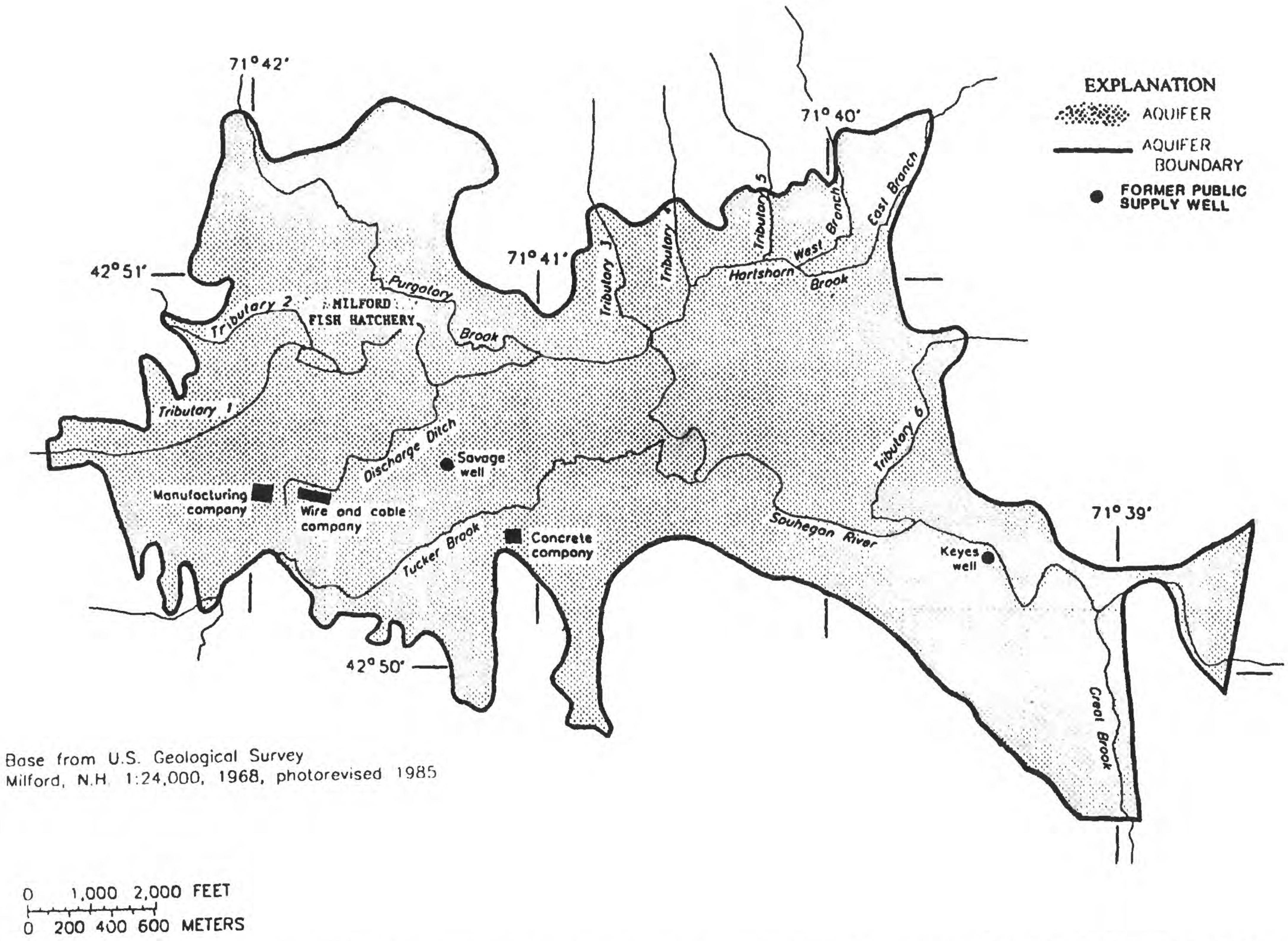


Figure 2. Areal extent of the Milford-Souhegan glacial-drift aquifer and locations of streams, major cultural features, and former public supply wells in Milford, New Hampshire.

private landowners and employees of two companies in the study area who courteously assisted with data collection and provided access to their properties.

HYDROGEOLOGIC-DATA REASSESSMENT

Hydrogeologic data collected during 1990-93 were compiled from various sources, including the New Hampshire Department of Environmental Services, landowners, and companies in the study area. This data included stratigraphic logs from new wells and borings that were used to estimate saturated thickness and horizontal hydraulic conductivity of the aquifer (HMM Associates, Inc., 1991). Values of saturated thickness and hydraulic conductivity, that were used in the previous model by Harte and Mack (1992), were adjusted in areas of the aquifer where hydraulic conductivity had been poorly defined and (or) depth to till or bedrock was uncertain. Piezometers installed since 1990 provided additional information on water levels in the aquifer. Water levels also were measured in several privately owned dug wells. Water levels were measured at 124 wells and piezometers in October 1990. Stream seepage was measured at 45 sites on the main stem of the Souhegan River and on small tributary streams in the study area.

Ground-Water-Flow Patterns and Stream Seepage

The general patterns of ground-water flow in the aquifer were similar for the October 1988 and October 1990 measurement periods. Differences in ground-water levels were generally less than 1 ft (Appendix 1) except at withdrawal wells where differences in pumping rates between the two measurement periods affected water levels.

Stream-seepage data (fig. 3 and Appendix 2) indicate that stream-seepage gains and losses are variable throughout the aquifer. Gaining and losing stream-reach segments along the Souhegan River were more numerous during October 1990 than during 1988. Measurement differences result from the use of additional measurement sites, which increase the number of data points used to delineate gaining and losing reaches, and from the different hydrologic conditions that were present prior to the two measurement periods. The October 1990 measurements were made 4 days after a storm, whereas no precipitation had fallen 4 days before the October 1988 measurement. Streamflow duration was at the 60th percentile on October 22, 1990, at the Piscataquog River streamflow-gaging station near Goffstown (station number 01091500), which is 14 mi north of the study area. Streamflow duration was at the 85th percentile on October 18, 1988, at the same streamflow-gaging station. Streamflow duration is defined as the percentage of time during which specified daily discharges are equaled or exceeded within a given time period.

Differences in patterns of stream-seepage gains and losses for the two periods could be the result of bank-storage effects and increased ground-water runoff during the October 1990 measurement. In order to improve an understanding of stream seepage and ground-water interaction in the glacial-drift aquifer, additional stream-seepage data, in conjunction with additional ground-water-level data, are needed to determine causes for the measured differences.

Saturated Thickness

Stratigraphic logs from new wells and borings (locations are shown in fig. 4) and field observations of geologic materials were used to refine the saturated thickness maps of the Milford-Souhegan glacial-drift aquifer (fig. 5). The recent data indicate that saturated thicknesses are shallower adjacent to the Souhegan River in the central part of the aquifer and near the Milford Public Fish Hatchery in the northwestern part of the aquifer than the saturated thicknesses reported by Harte and Mack (1992). Data for selected wells and borings (1990-93) in the Milford-Souhegan glacial-drift aquifer are listed in Appendix 3.

Hydraulic Conductivity

Horizontal hydraulic conductivities estimated from stratigraphic logs of wells and borings generally are similar to the estimates of hydraulic conductivity made in the previous investigation (Harte and Mack, 1992). This similarity supports the original conceptual representation of horizontal hydraulic conductivity delineated by model layer and zone. Horizontal hydraulic conductivity was delineated into zones based on the layer and zone configuration used by Harte and Mack (1992, figs. 14-19). Similar values were grouped into zones of equal hydraulic conductivity. Zonal hydraulic conductivities for each layer were determined by averaging horizontal hydraulic conductivities computed from stratigraphic logs of test holes that penetrate the

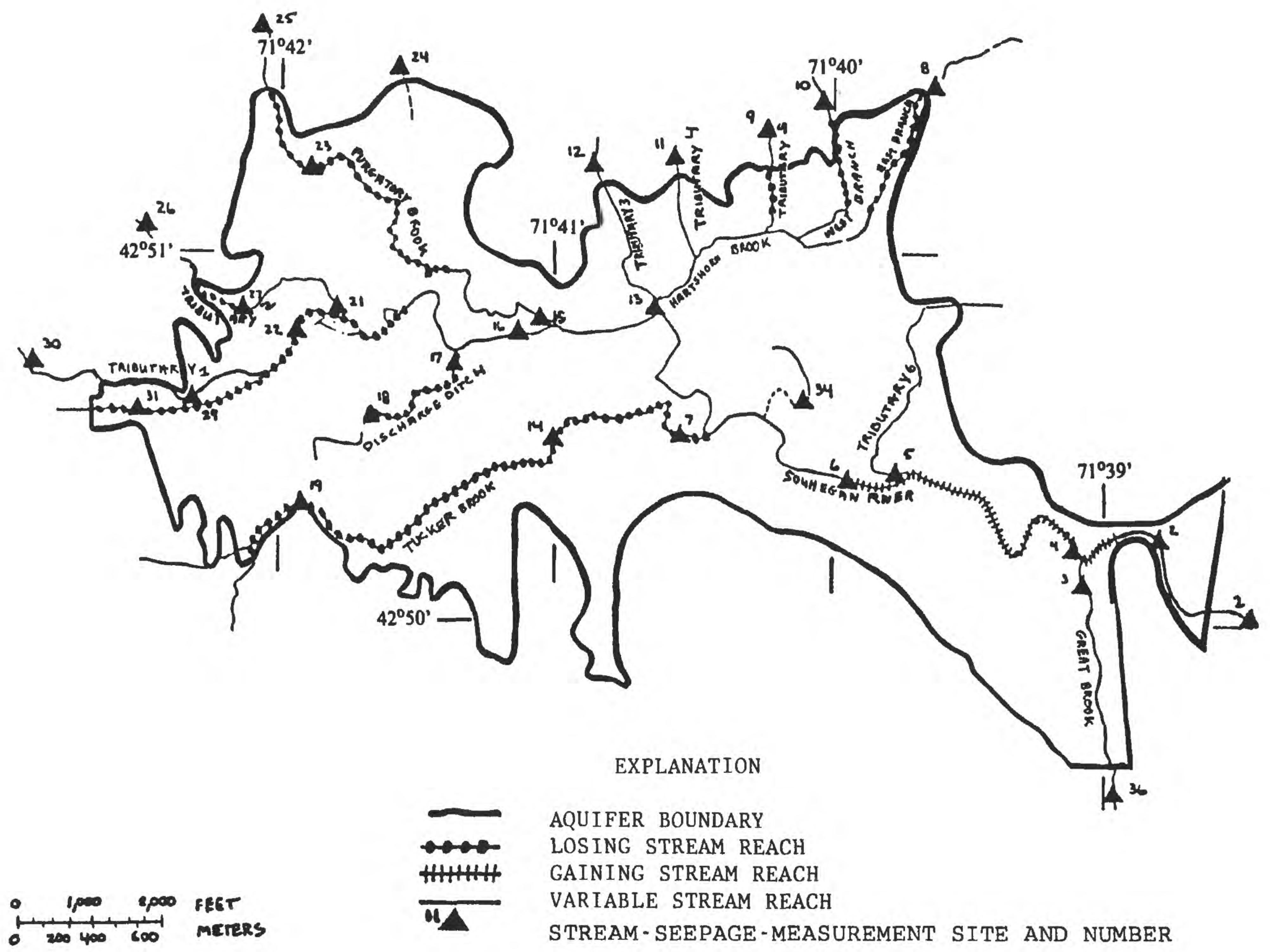


Figure 3a. Losing and gaining stream reaches in the Milford-Souhegan glacial-drift aquifer and location of stream-seepage-measurement sites, Milford, New Hampshire, 1988.

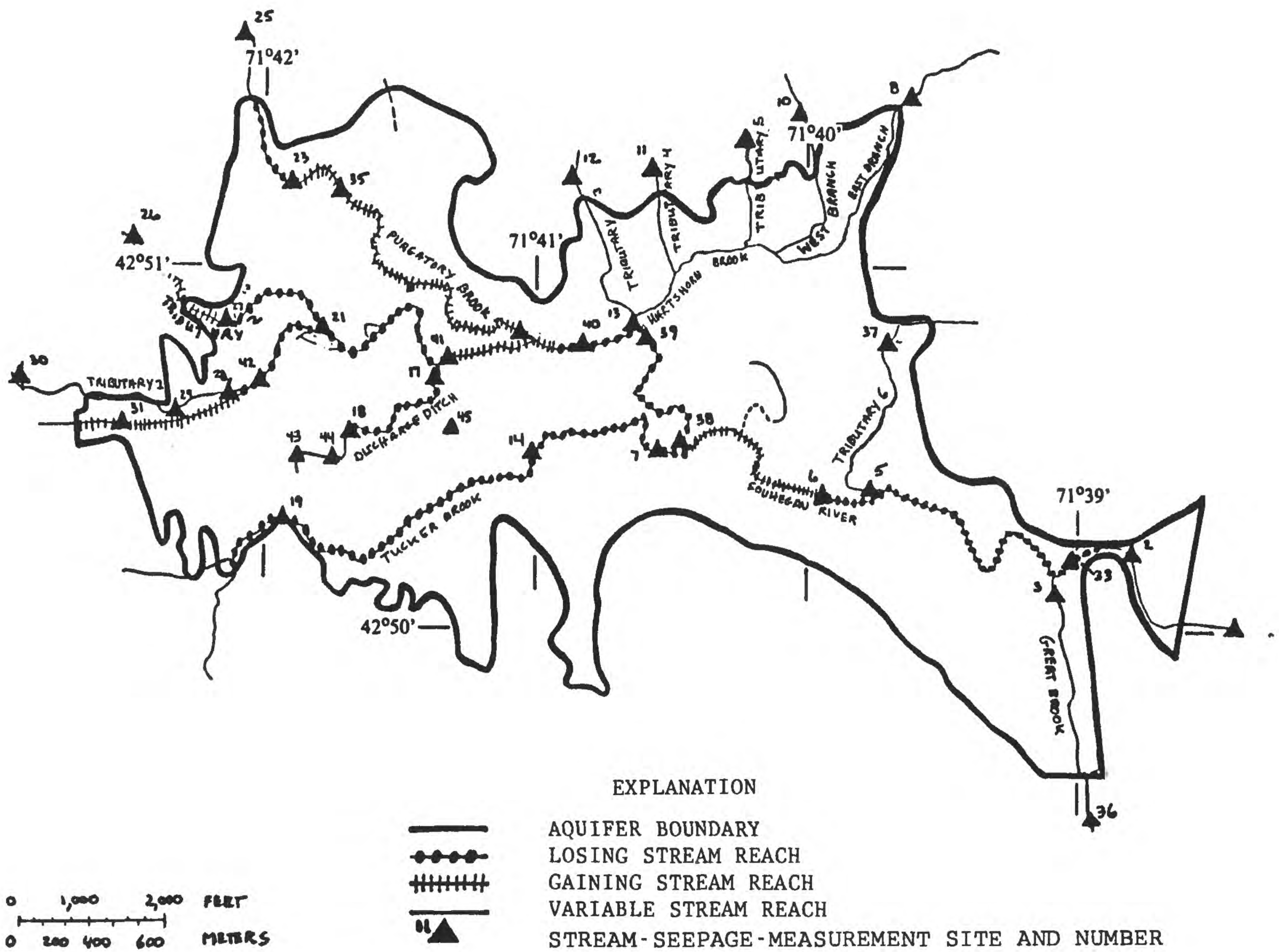
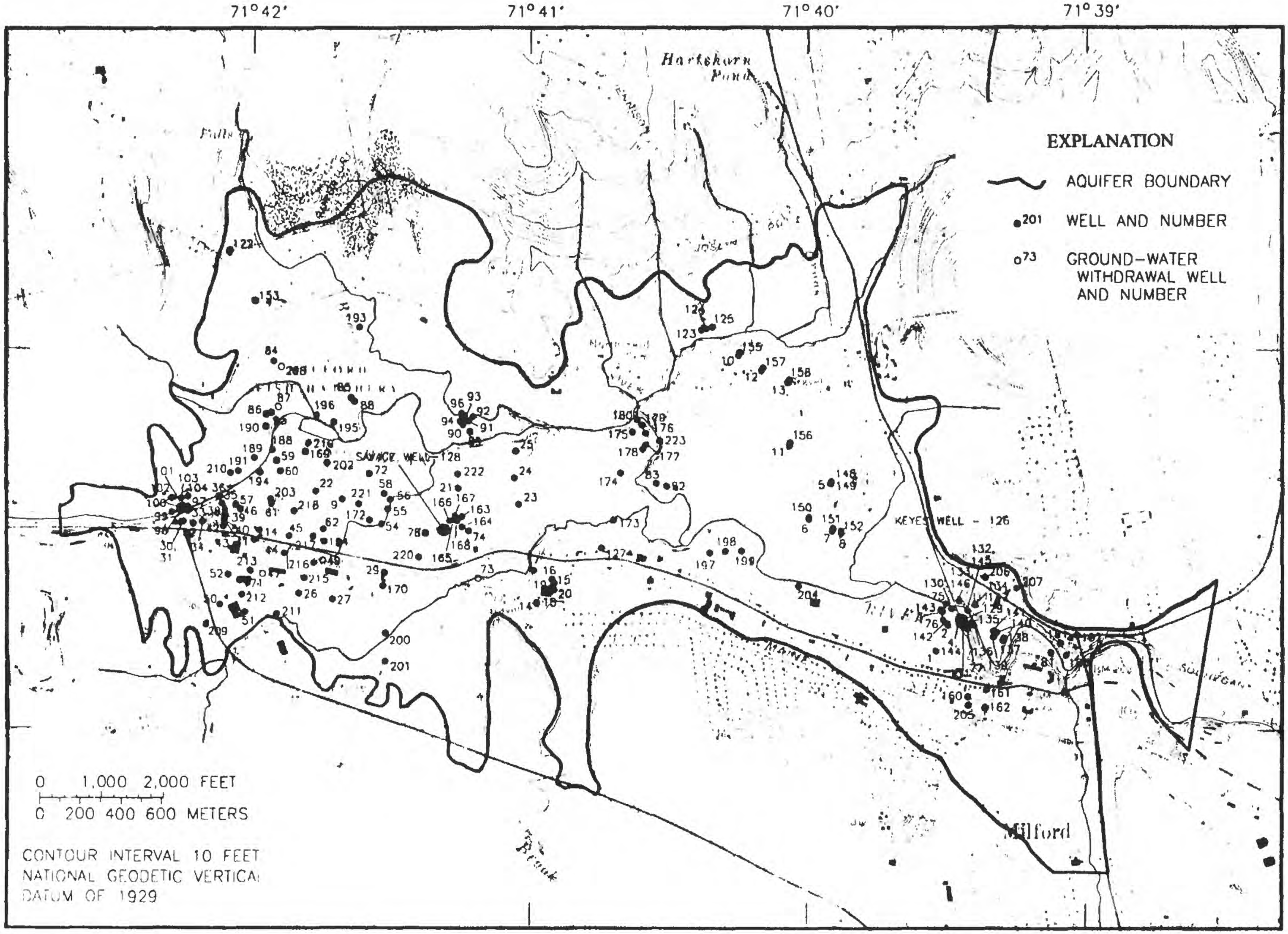


Figure 3b. Losing and gaining stream reaches in the Milford-Souhegan glacial-drift aquifer and location of stream-seepage-measurement sites, Milford, New Hampshire, 1990.



Base from U.S. Geological Survey
Milford, N.H. 1:24,000, 1968, photorevised 1985

Figure 4a. Location of wells 1 through 223 in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire (modified from Harte and Mack, 1992).

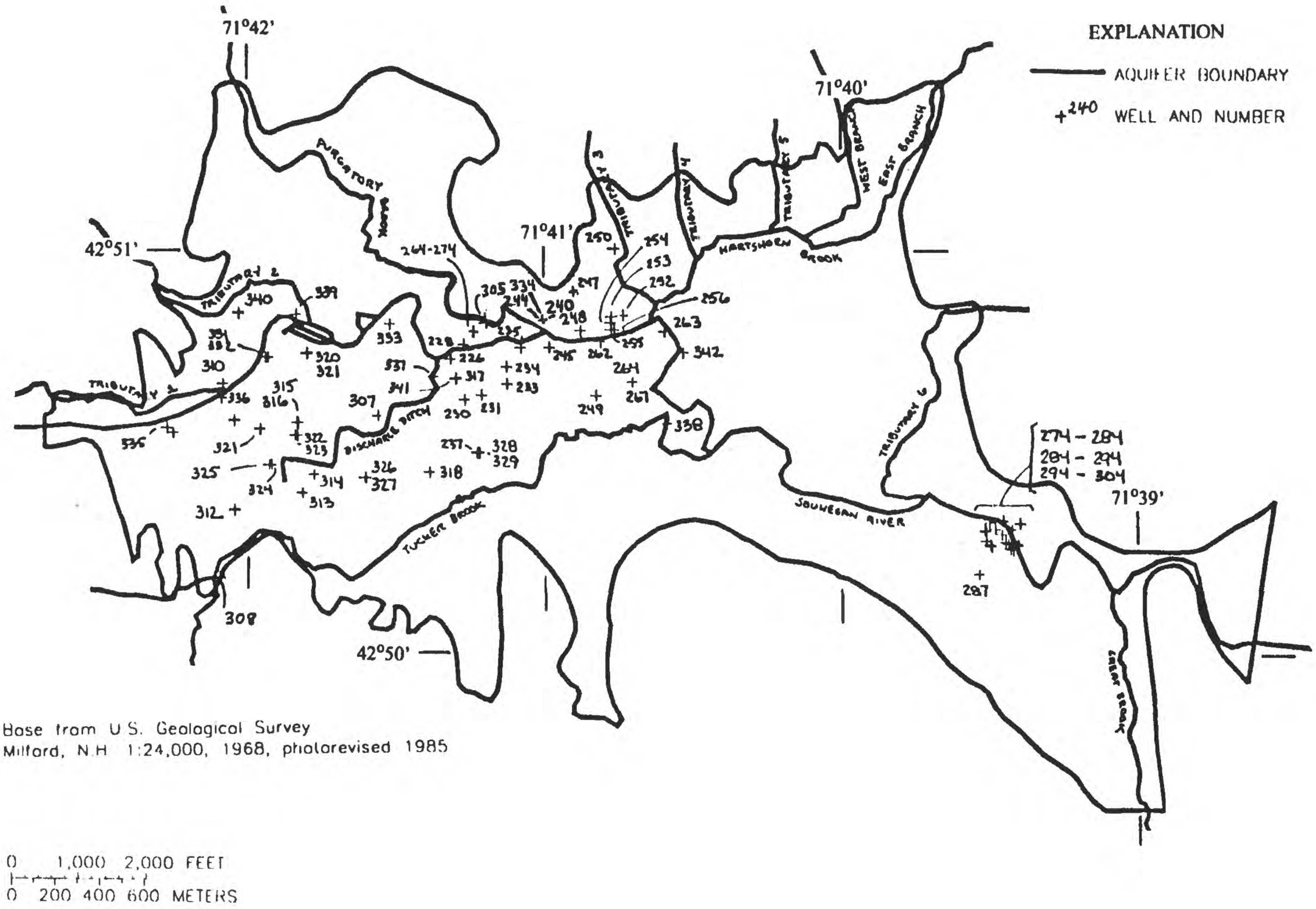


Figure 4b. Location of wells 224 through 341 in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire.

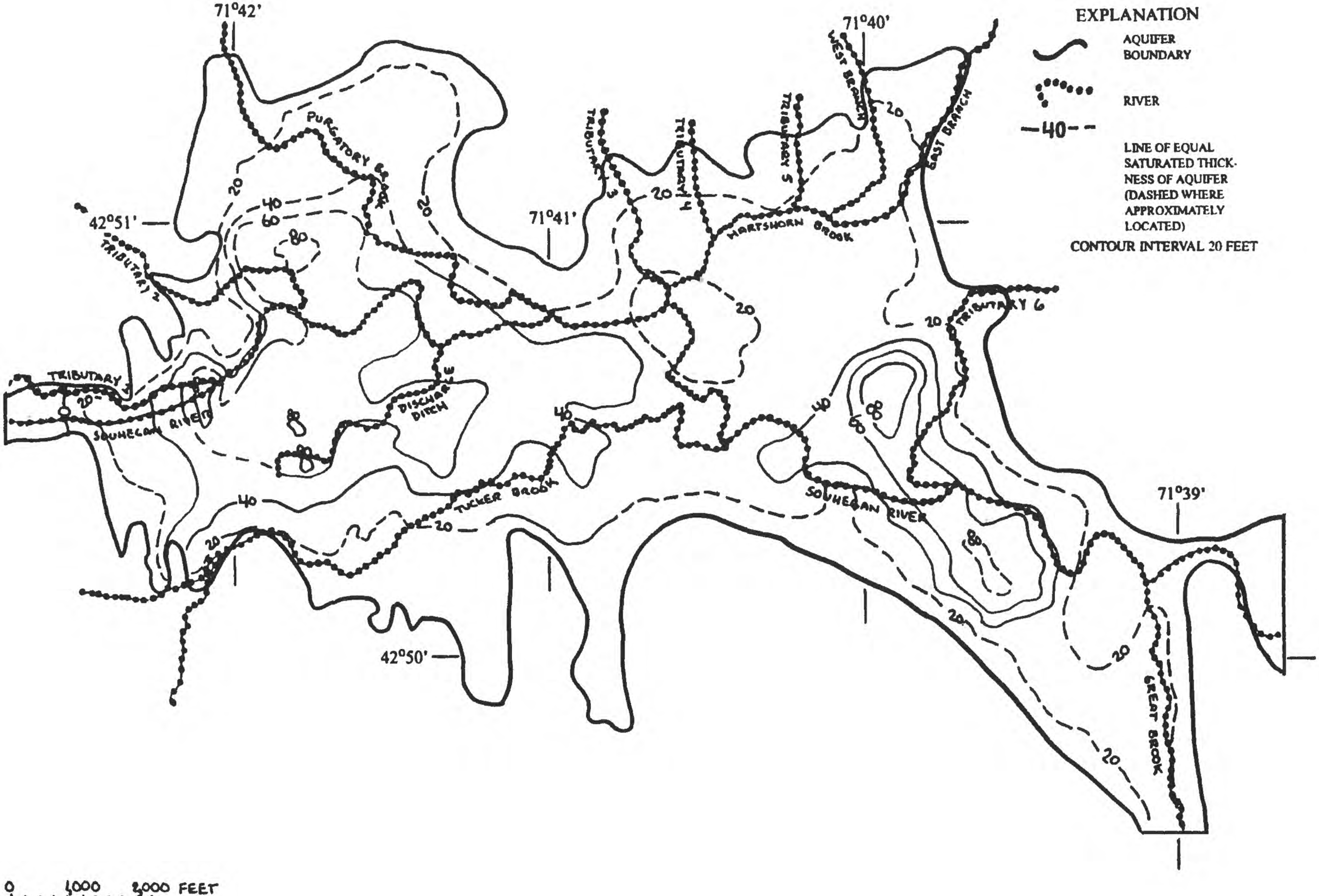


Figure 5. Saturated thickness of the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire, based on geohydrologic data collected since 1990.

layer, utilizing methods described by Harte and Mack (1992, p. 30-38). A comparison of estimated horizontal hydraulic conductivity values collected from previously installed wells and borings (pre 1990) with recently estimated values (1990-93) for the same layer and zone is shown in table 1. The average values reported in table 1 represent an integration of horizontal hydraulic conductivity estimates from all well logs penetrating a zone.

Estimated horizontal hydraulic conductivity and transmissivity at wells near an aquifer test conducted and analyzed by a private consultant (HMM Associates, Inc., 1989) are higher than estimates used in this investigation. The higher estimated horizontal hydraulic conductivities are representative of material found over a larger aquifer area than over an area near a well in which lithologic data were available (table 2). The variation in estimates of horizontal hydraulic conductivity from the aquifer test indicates a greater variability within model zones than the variability from lithologic logs.

Data were not available on vertical hydraulic conductivity; therefore, ratios of horizontal to vertical hydraulic conductivity ranging from 1:10 between layers 1 and 2, to 1:100 between layers 2, 3, 4, and 5 were assumed, as described by Harte and Mack (1992).

REFINEMENT OF THE GROUND-WATER-FLOW MODEL

A block-centered, finite-difference ground-water-flow model, known as Modflow (McDonald and Harbaugh, 1988) was used to simulate steady-state ground-water flow in three dimensions in the Milford-Souhegan glacial-drift aquifer. The model grid consists of 76 rows and 122 columns. Horizontal dimensions represented by grid cells range from 50 to 200 ft along rows and columns. The model is vertically discretized into a maximum of five layers, each about 20 ft thick. (For a complete description of the model construction, see Harte and Mack, 1992.) Refinements to the ground-water-flow model included changes in saturated thickness and distribution of horizontal hydraulic conductivity, and the incorporation of a new solution algorithm designed for MODFLOW (McDonald and others, 1991).

Saturated Thickness

The bottom altitude of model layers was increased adjacent to the Souhegan River in the central part of the aquifer, which reduced the area of active cells for model layer 2 (fig. 6). This change was made because field observations of till and bedrock indicated that the saturated thickness was shallower than the saturated thickness previously reported by Harte and Mack (1992).

Horizontal Hydraulic Conductivity

Horizontal hydraulic conductivities were modified for model layers 2 and 3. The revised zonation is shown in figures 7 and 8. In each zone, horizontal hydraulic conductivity is homogeneous and isotropic (Harte and Mack, 1992). Hydraulic conductivities assigned to layer 2 of the model are divided into five zones, as in the previous model. Assigned hydraulic-conductivity values were decreased slightly in zones 1, and 2 and increased in zones 3, 4, and 5. In layer 3, the number of horizontal hydraulic conductivity zones was increased from four in the previous model to five in the refined model. The hydraulic conductivity of this layer ranges from 1 ft/d in zone 1 to 260 ft/d in zone 5 (fig. 8).

Solution Algorithm and Solver

A solution algorithm that allows cells that go dry during the model simulation to resaturate (McDonald and others, 1991) was used in the revised model. The solution algorithm allowed for a precise solution of the finite-difference equations used for areas near withdrawal wells that had gone dry during simulation with the previous model (Harte and Mack, 1992). Previously, a cell that could not resaturate was removed from the active area of the model. Cells tended to go dry near withdrawal wells because of desaturation of the simulated aquifer near the withdrawal well. The new solution algorithm provides a more accurate solution than that used in the previous model because dry cells are resaturated and not removed from the model simulation.

A preconditioned, conjugate-gradient solution solver developed by Hill (1990) was utilized to solve the finite-difference equations for hydraulic head. This technique was preferred over other solvers because numerically difficult problems are solved more easily.

Table 1. Comparison of estimated horizontal hydraulic conductivities from previous well and boring data with recent estimates for the same layer and zone in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire

[Layers 2 and 3 are shown in figures 7 and 8; layers 1, 4, and 5 are shown in figures 15, 18, and 19 (Harte and Mack, 1992); ft/d, foot per day; previous data: pre 1990 (Harte and Mack, 1992); recent data: 1990-93, present investigation]

Layer	Zone	Horizontal hydraulic conductivity				Difference in zonal value between previous and recent data
		Previous data (pre 1990)		Recent data (1990-93)		
		Average[1] (ft/d)	Model value (ft/d)	Average[1] (ft/d)	Model value (ft/d)	
1	4	182.5	170	178.6	170	0
1	5	197.5	190	187.9	190	0
2	2	52.5	60	59.5	58	-2
2	3	103.0	110	110.8	95	-15
2	4	119.5	125	122.4	157	+32
2	5	207.5	210	204.1	229	+19
3	2	40.9	55	41.2	38	-17
3	3	140.4	135	142.6	55	-80
3	4	216.2	200	210.1	260	+60
4	5	151.8	150	122.7	150	0
5	1	52.3	50	50.0	50	0

[1]Average value estimated from wells in the zone.

Table 2. Estimated average hydraulic conductivity and transmissivity at wells near the site of an aquifer test in the western part of the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire

[No., number; ft, foot; ft/d, foot per day; ft^2/d, foot squared per day]

Well No. (fig.4)	Saturated thickness (ft)	Horizontal hydraulic conductivity			Transmissivity		
		Aquifer test (ft/d)	Lithologic log (ft/d)	Model value assigned[1] (ft/d)	Aquifer test (ft^2/d)	Lithologic log (ft^2/d)	Model value assigned (ft^2/d)
47	64	53	117	95	3,392	7,488	11,150
313	51	218	199	108	11,118	10,149	8,550
213	51	254	199	108	12,954	10,149	8,550
325	71	200	138	114	14,200	9,798	11,700
171	52	307	137	107	15,964	7,124	7,595
44	72	241	164	114	17,352	11,808	11,900
45	90	98	76	122	8,820	6,840	14,600
215	55	241	146	134	13,255	8,030	8,050
321	77	187	119	139	14,399	9,163	14,170

[1]Assigned value is an average over the well-depth interval.

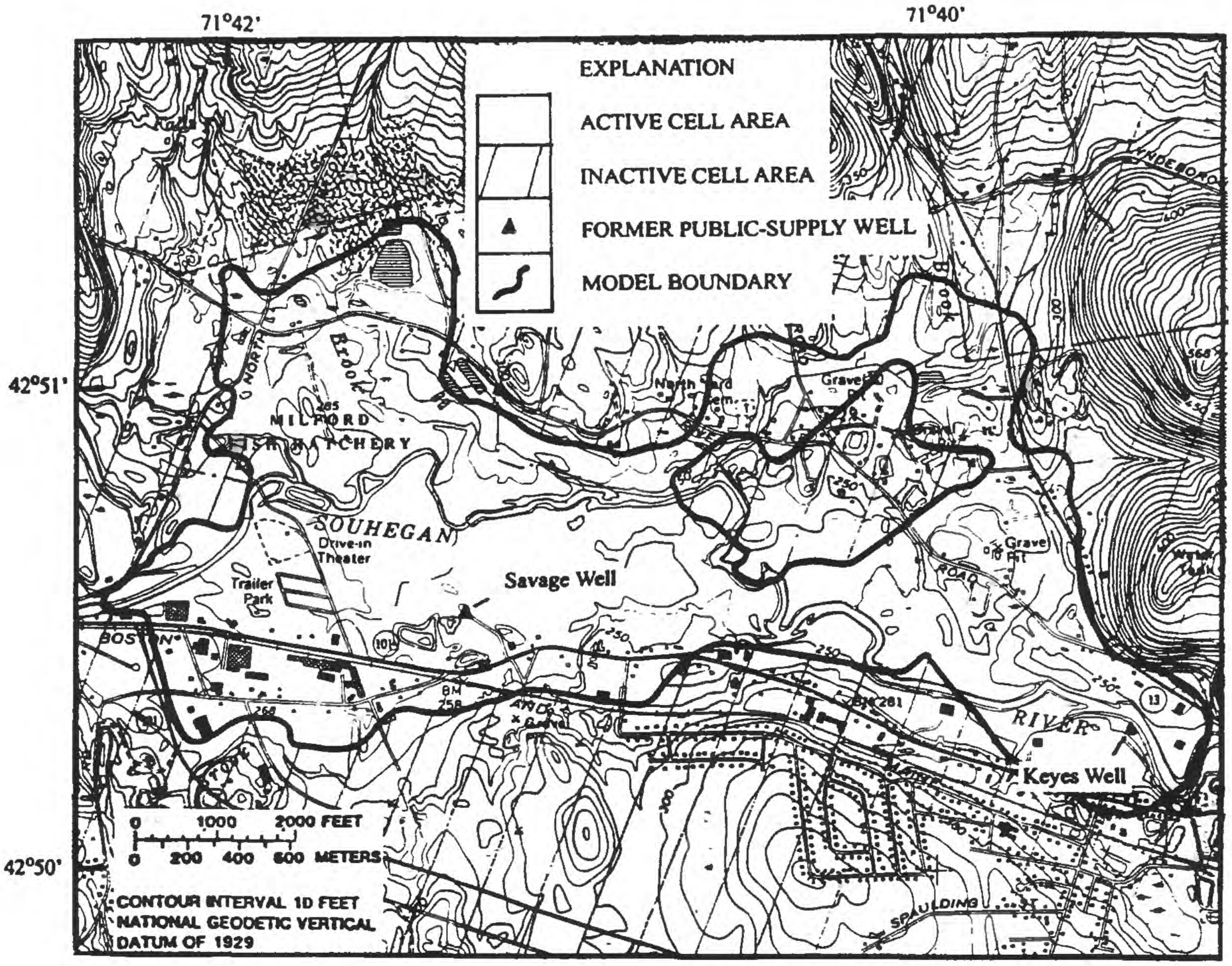


Figure 6. Active and inactive cell areas for model layer 2 of the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire.

EFFECTS OF REFINEMENTS ON RESULTS OF MODEL SIMULATION

The effects of model refinements were evaluated by comparing model-calculated heads with heads measured in October 1988. This is the same data set used to evaluate the previous model. Effects of model results on stream-seepage gains and losses and the contributing area to the Savage well also were evaluated.

Model-Calculated Heads

Refinement of the distribution of horizontal hydraulic conductivity resulted in observable differences in model-calculated heads. The refinements improved the match between model-calculated and measured heads (table 3), especially in the southwestern part of the aquifer where most modifications were made. The locations of measured heads are shown in figure 9.

Differences in heads calculated in simulation with the previous model (Harte and Mack, 1992) and then calculated by the refined model (fig. 10) are small except near withdrawal well 208 at the Milford Public Fish Hatchery. Because of large pumping rates at this well, the model is sensitive to small changes in hydraulic conductivity. A similar difference in hydraulic conductivity at withdrawal well 47 is the result of a change in well location from what was used in the previous model. At the remaining withdrawal wells, changes in model-input data resulted in small but improved head matches.

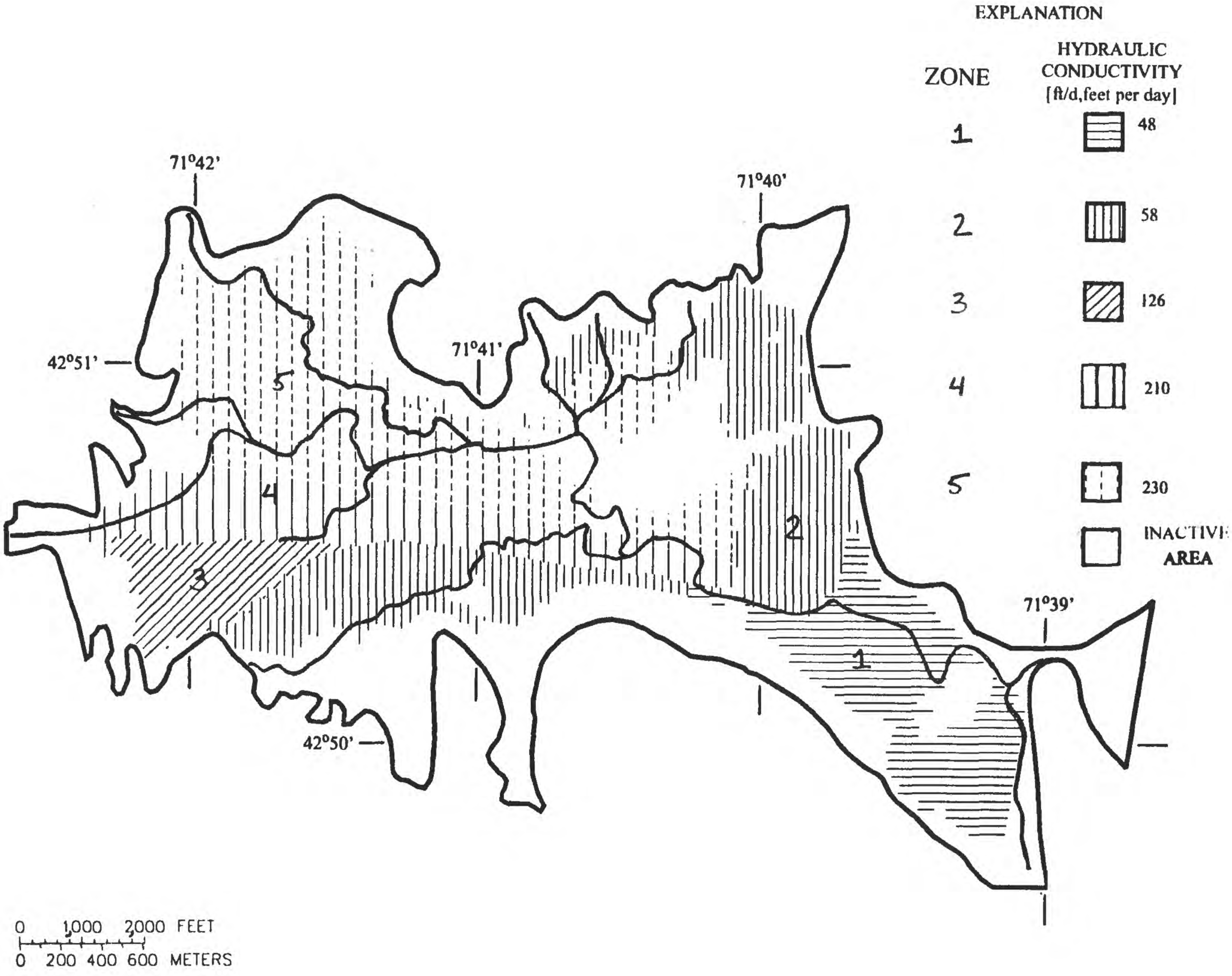


Figure 7. Modeled zones of hydraulic conductivity of the Milford-Souhegan glacial-drift aquifer for modeled layer 2, Milford New Hampshire.

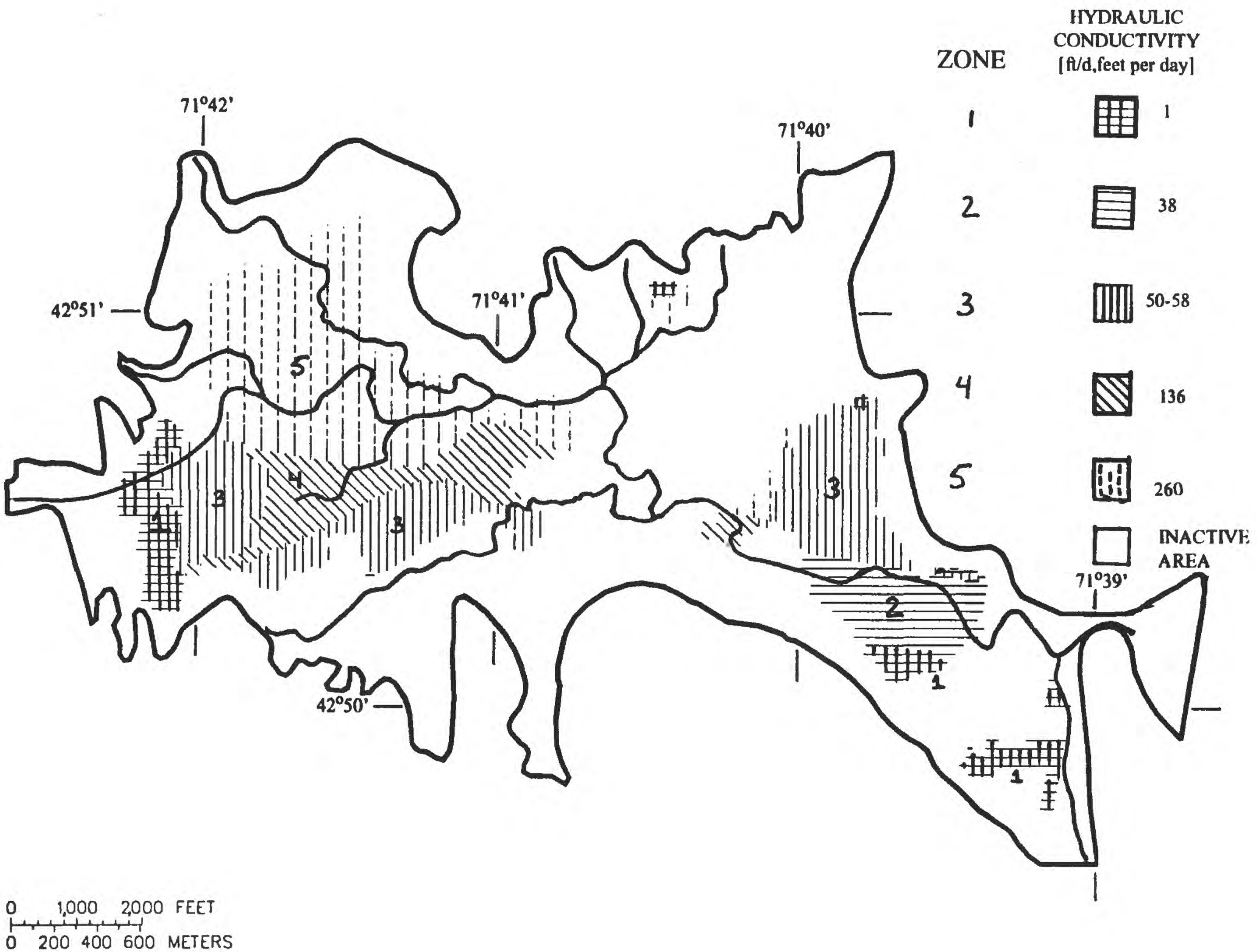


Figure 8. Modeled zones of hydraulic conductivity of the Milford-Souhegan glacial-drift aquifer for modeled layer 3, Milford, New Hampshire.

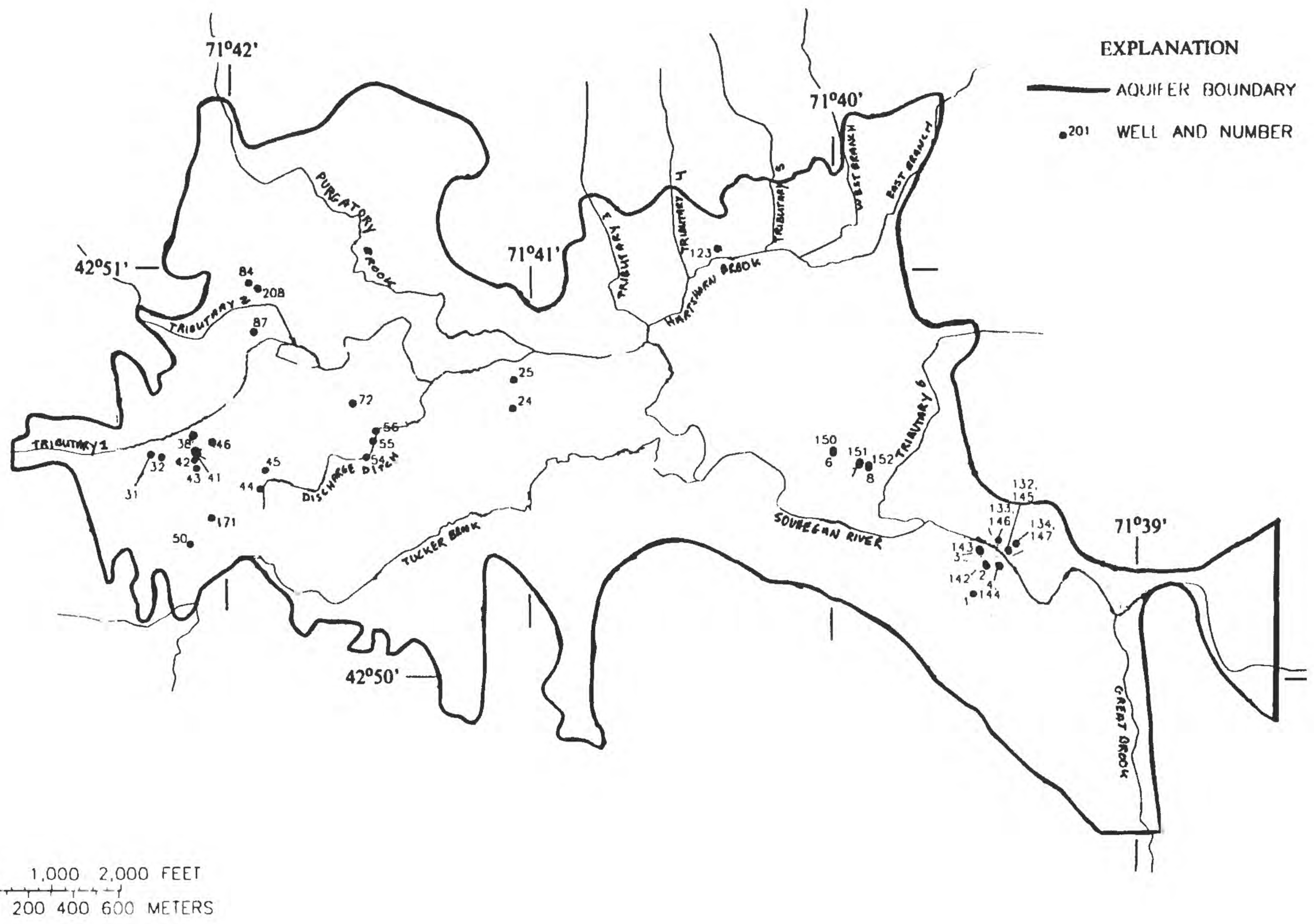


Figure 9. Location of wells where measured heads were compared to model-calculated heads in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire.

Table 3. Differences between measured and model-calculated heads in the previous and refined models for selected wells by layer in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire

[No., number; head values are in feet; -, negative difference]

Well No. (See fig. 4)	Model node		Measured head October 1988	Previous model		Refined model	
	Row	Column		Model-calculated head	Difference between model-calculated head and measured head	Model-calculated head	Difference between model-calculated head and measured head
				Model Layer 1			
31	56	8	264.95	262.47	-2.48	262.43	-2.52
32	56	8	264.47	262.47	-2.00	262.43	-2.04
37	48	10	260.39	260.36	-.03	260.51	.12
38	50	11	259.86	259.51	-.35	259.68	.18
41	53	11	259.84	259.48	-.36	259.64	.20
42	55	11	259.98	259.48	-.50	259.59	-.39
50	70	12	262.55	260.54	-2.01	259.97	-2.58
54	46	24	253.80	254.90	1.10	254.61	.81
55	41	24	253.54	254.42	.88	254.15	.61
56	38	24	252.99	254.12	1.13	253.83	.84
72	32	22	254.34	253.82	-.52	253.51	-.83
123	16	70	251.24	251.76	.52	251.59	.35
142	48	97	235.90	236.02	.12	236.01	.11
143	44	94	235.52	235.82	.30	235.81	.29
144	46	101	235.58	235.27	-.31	235.26	.32
145	42	102	235.69	234.87	-.82	234.86	.83
146	40	100	235.69	235.01	-.68	235.00	-.69
147	40	105	236.01	235.12	-.89	235.11	-.90
150	29	81	238.15	242.51	4.36	242.20	4.05
151	30	83	237.24	241.49	4.25	241.27	4.03
152	30	83	238.74	241.49	2.75	241.27	2.53

Table 3. Differences between measured and model-calculated heads in the previous and refined models for selected wells by layer in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire--Continued

Well No. (See fig. 4)	Model node		Measured head October 1988	Previous model		Refined model	
	Row	Column		Model-calculated head	Difference between model-calculated head and measured head	Model-calculated head	Difference between model-calculated head and measured head
Model Layer 2							
43	58	11	260.56	259.46	-1.10	259.47	-1.09
44	61	16	256.85	257.68	.83	257.47	-.62
45	55	16	256.22	257.45	1.23	257.23	1.01
171	68	13	259.99	258.44	-1.55	257.95	-2.04
Model Layer 3							
1	57	95	237.26	237.22	-0.04	237.17	-0.09
2	48	97	235.79	236.02	.23	236.01	.22
3	44	95	235.59	235.75	.16	235.75	.16
4	46	102	235.61	235.37	-.24	235.37	-.24
6	29	81	238.13	242.53	4.40	242.22	4.09
7	30	83	237.30	241.50	4.20	241.29	3.99
8	30	83	237.13	241.50	4.37	241.29	4.16
24	30	57	247.56	249.44	1.88	249.37	1.81
25	28	57	243.59	248.96	5.37	248.91	5.32
84	25	14	235.20	243.13	7.93	248.57	13.37
87	28	14	241.65	237.07	-4.58	[1]243.87	2.22
132	42	102	235.65	235.20	-.45	235.20	-.45
133	40	99	235.72	235.27	-.45	235.27	-.56
134	40	104	235.97	235.17	-.80	235.16	-.81
208	25	14	224.60	[1]236.71	--	[1]227.80	8.68
Model Layer 4							
46	49	12	259.16	258.57	-.59	258.36	-.80

[1]Simulated head was adjusted to represent head at a pumped well utilizing the method described by Trescott and other (1976, p. 9).

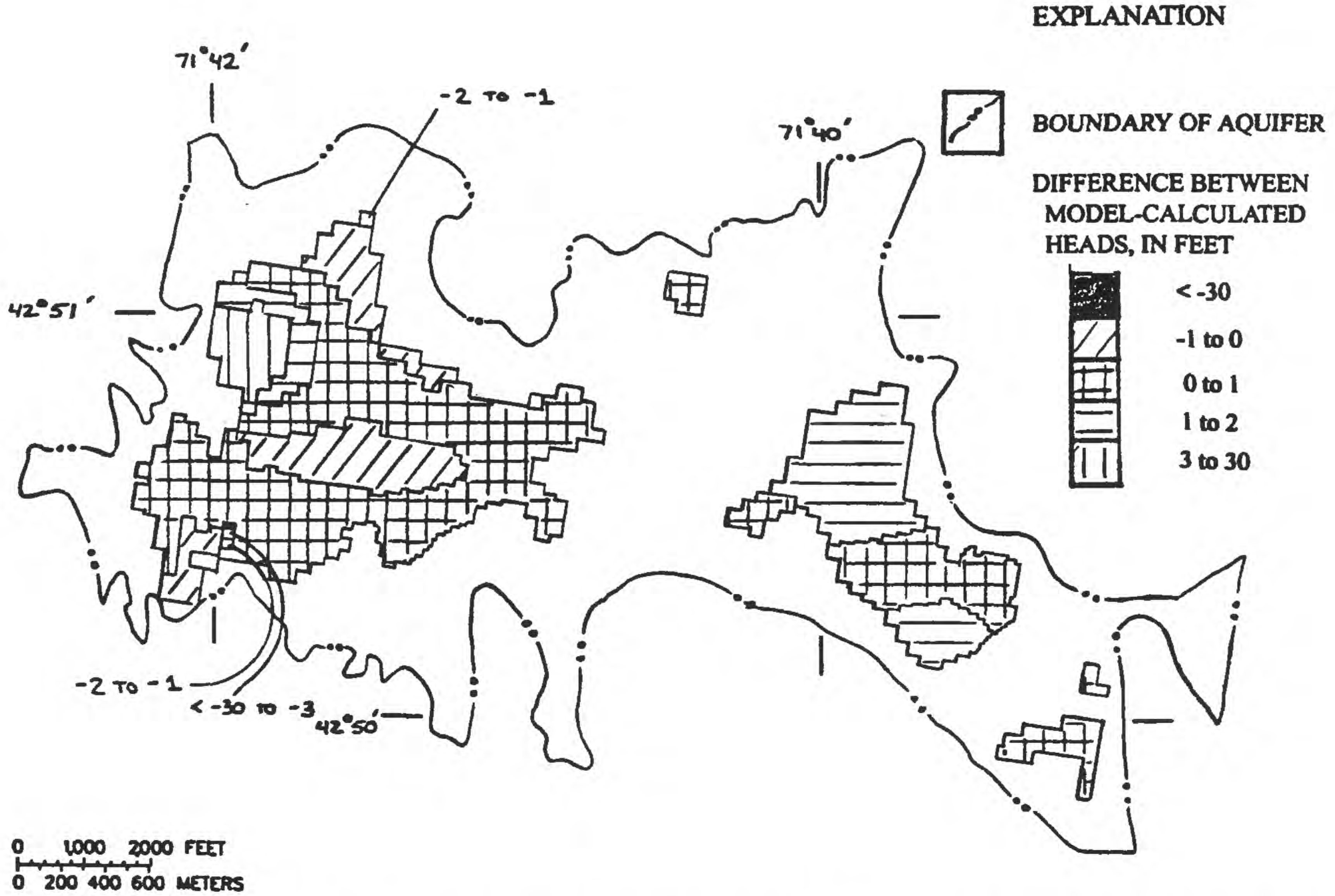


Figure 10. Differences between heads calculated in simulation with the previous model and the refined model, layer 3, of the Milford-Souhegan glacial drift aquifer, Milford, New Hampshire.

Model-Calculated Stream-Seepage Gains and Losses

Results of stream seepage calculated in the refined model compare favorably with those calculated in the previous model (table 4) for the drainage basins shown in figure 11. Stream seepage calculated in the previous and refined models were compared to the October 1988 field stream-seepage measurements. As in the previous model, stream seepages calculated in the refined model generally indicate patterns of losing and gaining stream reaches similar to those measured in 1988. Differences between calculated and measured stream seepages are less in drainage basins 2, 3, 5, 6 and 9 in the refined model than in the same drainage basins in the previous model (table 4 and fig. 11).

Contributing Area of the Savage Well

The 0.127-mi^2 contributing area of the Savage well covers an area between an industrial discharge ditch, Tucker Brook, a withdrawal well at an industrial facility, and the southern model boundary (fig. 12). The Savage well was pumped at a daily mean rate of 145.0 gal/min (0.323 ft^3/s) in the refined model—the same rate used in the previous model (Harte and Mack, 1992, fig. 31). The difference between areal extent of the contributing area calculated in the previous model and that calculated in the refined model is small; the contributing area calculated in the refined model decreased by 0.021 mi^2. The decrease in contributing area results from an increase in model-calculated stream seepage from the discharge ditch and Tucker Brook. The configuration of the contributing area calculated in both the previous and refined models indicates that the discharge ditch and Tucker Brook contribute water to the Savage well. Stream seepage calculated in the refined model for drainage basin 8 (fig. 11), in which the drainage ditch is located, was -0.39 ft^3/s. This seepage rate was greater than the -0.35 ft^3/s calculated in the previous model. (A negative number indicates flow from

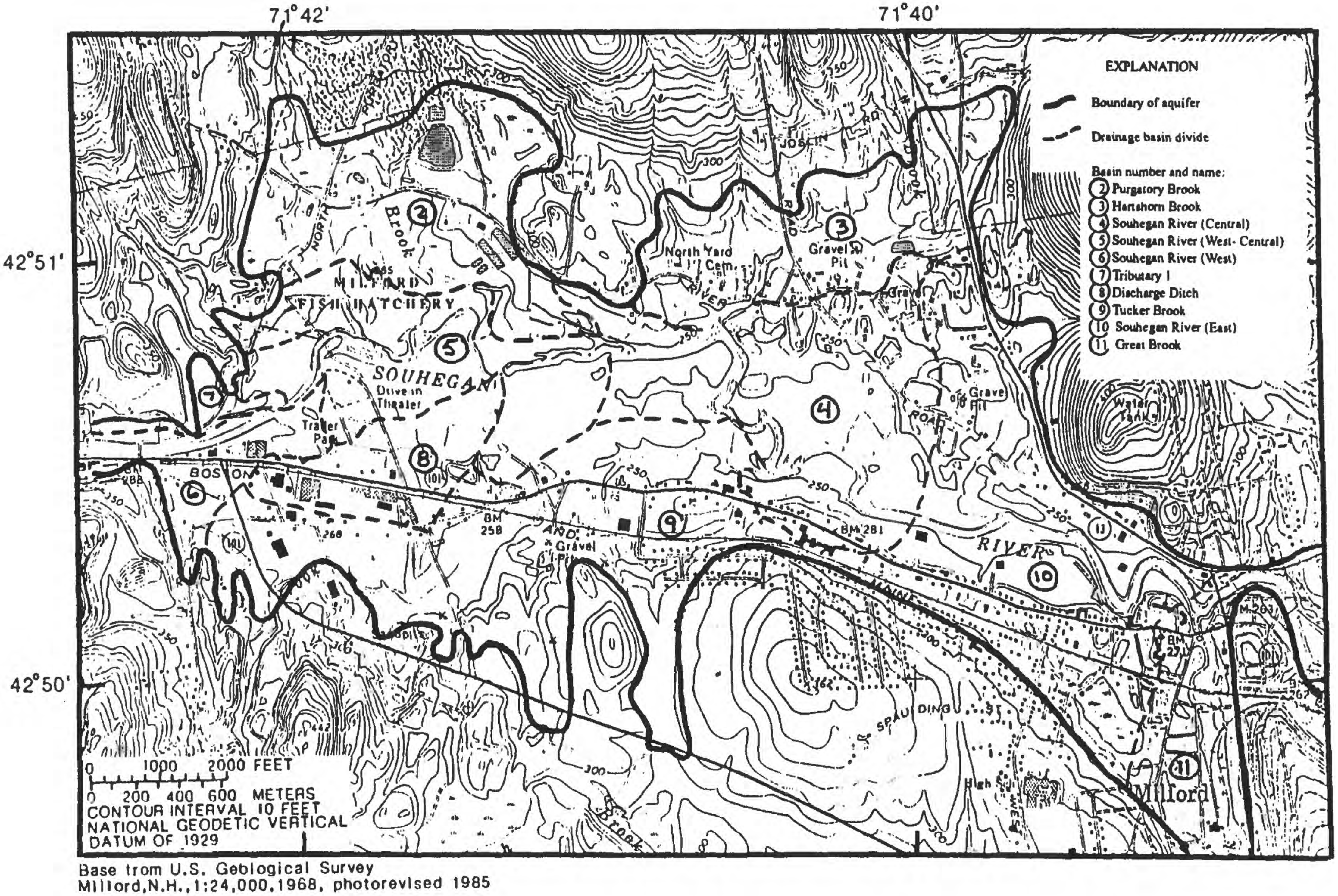


Figure 11. Drainage basins in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire (modified from Harte and Mack, 1992).

Table 4. Differences between measured and model-calculated stream-seepage gains and losses for drainage basins in the Milford-Souhegan aquifer, previous and refined model, Milford, New Hampshire

[All streamflow values are in cubic foot per second; fig., figure; --, no data. Negative values indicate stream-seepage loss to the aquifer; positive values denote stream-seepage gain. A negative value indicates either simulated-seepage losses are greater than measured-seepage losses or simulated-seepage gains are less than measured-seepage gains. A positive value indicates either simulated-seepage losses are less than measured-seepage losses or simulated-seepage gains are greater than measured-seepage gains.]

Drainage basin (fig. 11)	Measured stream-flow, October 1988	Model-calculated streamflow		Difference between measured and model-calculated streamflow	
		Previous model	Refined model	Previous model	Refined model
2	-0.18	-0.67	-0.90	-0.49	-0.72
3	.05	.13	.21	.08	.16
4	1.58	1.28	[1]1.25	-.30	-.33
5	-.27	-.50	.17	-.77	-.44
6	-.73	-.87	-.94	-.14	-.21
7	-.06	0	-.03	.06	.09
8	-.31	-.35	-.39	-.04	-.08
9	-.47	-.34	-.37	.13	.10
10	3.47	1.05	1.04	-2.42	-2.43
11	--	-.24	.24	--	--

1. Seepage estimated as 60 percent of sepage in basin 4, June 1988.

the stream to the aquifer.) Stream seepage calculated in the refined model for drainage basin 9 (table 4, fig. 11), in which Tucker Brook is located, was -0.37 ft^3/s. This stream seepage is greater than the -0.34 ft^3/s calculated in the previous model and indicates a small increase in model-calculated induced stream seepage to the aquifer from this basin.

SUMMARY

Hydrogeologic data collected since 1990 were used to refine previous estimates of saturated thickness and horizontal hydraulic conductivity of the Milford-Souhegan glacial-drift aquifer, underlying Milford, New Hampshire. Most new data (since 1990) correlated with previous data; however, differences in saturated thickness were found in the northwestern and central parts of the aquifer.

Stream seepage was measured in October 1990 at 45 sites on the main stem of the Souhegan River and on small tributary streams. These measurements indicated that ground-water-seepage patterns in October 1990 were different from those determined in October 1988; differences resulted from the incorporation of additional measurement sites on the Souhegan River and small tributary streams, which improved the delineation of gaining and losing reaches, and the different hydrologic conditions during the October 1990 measurements.

Several refinements were made to the model: (1) small changes were made in the saturated thickness of the aquifer in the northwestern and central parts of the model area to improve the accuracy of aquifer representation in these areas, (2) a solution algorithm was used that allowed cells that had gone dry during the model-solution process in the previous model to resaturate in the refined model, the new solution algorithm improved the accuracy of solutions of the finite-difference equations for cells at and near modeled withdrawal wells that went dry during the solution process, (3) a preconditioned conjugate-gradient solver was used to solve the numerically complex finite-difference equations for hydraulic head, (4) small changes to horizontal hydrau-

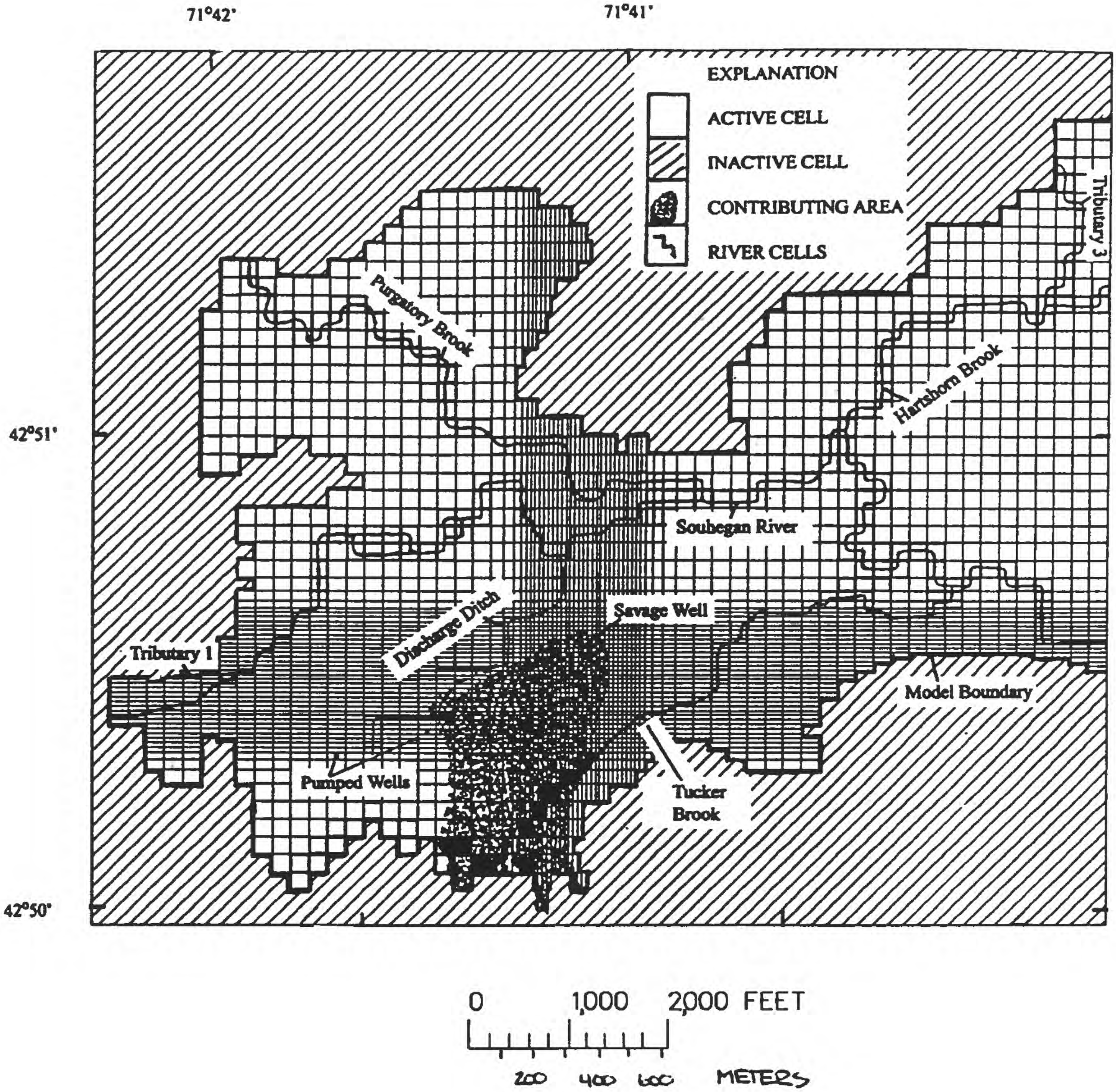


Figure 12. Contributing area to the Savage Well in the refined model of the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire.

lic conductivity in the model of the Milford-Souhegan aquifer resulted in small changes in the model-calcuated heads. These changes decreased the difference between model-calculated and measured heads at 22 wells. Estimates of hydraulic conductivity used in the refined model were greater than in the previous model for layers 2 and 3 of the five-layer model.

Stream seepage calculated in the refined model correlated with stream seepage calculated in the previous model. Calculated stream seepage gain and loss patterns in drainage basins 2-9 were similar in the previous and refined model. Stream seepage calculated in the refined model correlated more closely with measured stream seepages than the stream seepage calculated in the previous model in two drainage basins.

The contributing area to the Savage well calculated in the refined model decreased. Under average withdrawal conditions of October 1988, the contributing area decreased by 0.021 mi^2. The decrease in the contributing area is the result of an increase in model-calculated stream seepage from the discharge ditch and Tucker Brook.

Model-calculated stream seepage in drainage basin 8, in which the discharge ditch is located, increased from -0.35 ft^3/s in the previous model to -0.39 ft^3/s in the refined model. Model-calculated stream seepage in drainage basin 9, near Tucker Brook, increased from -0.34 ft^3/s in the previous model to -0.37 ft^3/s in the refined model.

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APPENDIX 1. Water levels measured at selected wells in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire, 1988 and 1990

Table 1. Water levels measured at selected wells in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire, 1988 and 1990

[fig., figure; ft, foot; --; no data]

Well No. (fig 4)	Altitude of water level, October 1988 (ft above sea level)	Altitude of water level, October 1990 (ft above sea level)	Change in altitude of water levels from October 1988 to October 1990 (ft)
1	237.26	237.44	0.18
2	235.79	236.28	.49
3	235.59	236.05	.46
4	235.61	236.01	.40
6	238.13	238.10	-.13
7	237.30	239.11	1.81
8	237.13	237.88	.75
16	248.81	--	--
17	248.83	--	--
21	250.16	251.07	.91
24	247.56	249.40	1.84
25	243.59	247.18	3.59
30	264.43	--	--
31	263.95	--	--
32	264.47	--	--
35	259.93	--	--
37	260.39	--	--
38	259.86	--	--
40	259.73	--	--
41	259.84	--	--
42	259.98	--	--
43	260.56	261.18	.62
44	256.85	257.82	.97
45	256.22	258.11	1.89
46	259.16	259.94	.78
47	--	258.96	--
48	264.11	--	--
50	262.55	--	--
54	253.80	--	--
55	253.55	--	--
56	252.99	--	--
72	254.34	--	--
84	235.20	242.48	7.28
85	--	249.55	--
86	--	247.37	--
87	241.65	245.58	--
88	--	262.54	--
89	--	246.06	--
90	--	247.35	--
91	--	245.90	--
92	--	247.33	--
93	--	245.79	--
94	--	247.72	--

Table 1. Water levels measured at selected wells in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire, 1988 and 1990--Continued

Well No. (fig 4)	Altitude of water level, October 1988 (ft above sea level)	Altitude of water level, October 1990 (ft above sea level)	Change in altitude of water levels from October 1988 to October 1990 (ft)
123	251.24	--	--
124	252.26	--	--
125	251.60	--	--
126	235.66	--	--
132	235.65	--	--
133	235.72	--	--
134	235.97	--	--
136	--	235.87	--
142	235.90	236.19	0.29
143	235.52	235.98	.46
144	235.58	236.12	.54
146	235.69	--	--
147	236.01	--	--
150	238.15	238.93	.78
151	237.34	238.24	.90
152	238.74	239.14	.40
164	--	257.10	--
165	--	256.62	--
171	259.99	260.74	.75
204	--	236.22	--
208	224.60	240.76	--
210	--	240.76	--
212	--	260.83	--
213	--	258.07	--
215	--	258.31	--
216	--	257.50	--
218	--	257.30	--
219	--	255.46	--
220	--	253.46	--
221	--	254.60	--
225	--	264.49	--
226	--	266.72	--
228	--	261.09	--
231	--	258.17	--
233	--	258.48	--
234	--	267.14	--
250	--	252.57	--
251	--	251.12	--
254	--	251.59	--
258	257.85	--	--
262	--	256.31	--
264	--	254.98	--

Table 1. Water levels measured at selected wells in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire, 1988 and 1990--Continued

Well No. (fig 4)	Altitude of water level, October 1988 (ft above sea level)	Altitude of water level, October 1990 (ft above sea level)	Change in altitude of water levels from October 1988 to October 1990 (ft)
267	--	250.19	--
268	--	249.01	--
271	--	247.43	--
273	--	250.26	--
274	--	248.59	--
275	--	248.08	--
276	--	247.21	--
279	--	245.40	--
281	--	243.64	--
282	--	244.39	--
283	--	244.56	--
284	--	256.63	--
287	--	255.65	--
293	--	243.40	--
294	--	243.45	--
295	--	242.34	--
307	--	272.27	--
308	--	254.48	--
309	--	272.33	--
310	--	260.30	--
311	--	259.60	--
312	--	260.65	--
313	--	258.17	--
314	--	258.28	--
315	--	257.52	--
316	--	257.42	--
317	--	257.45	--
318	--	256.04	--
319	--	255.88	--
320	--	253.76	--
321	--	258.57	--
322	--	257.98	--
323	--	257.78	--
324	--	258.04	--
326	--	256.09	--
327	--	255.97	--
328	--	255.10	--
336	--	261.42	--
341	--	248.50	--

APPENDIX 2. Stream seepage at measurement sites in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire, 1988 and 1990

Table 1. Stream seepage at measurement sites in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire, 1988 and 1990

(Locations of measurement sites shown in figure 3; ft^3/s, cubic foot per second; --, no data)

Measurement site No.	Stream	Tributary to	Stream seepage, in ft^3/s, on given measurement date				
			6/14/88	10/14/88	10/18/90	10/21/90	10/22/90
1	Souhegan River	--	59.1	24.1	134.0	--	111.2
2	Souhegan River	--	--	0	.2	--	.2
3	Great Brook	Souhegan River	6.2	2.3	6.7	--	--
4	Souhegan River	--	0	--	0	--	--
5	Tributary 6	Souhegan River	0	0	--	--	--
6	Souhegan River	--	47.0	18.7	--	--	124.3
7	Tucker Brook	Souhegan River	0	0	--	0	--
8	East Branch	Hartshorn Brook	.2	0	--	--	.3
9	Tributary 5	Hartshorn Brook	0	0	--	--	0
10	West Branch	Hartshorn Brook	.4	.6	--	--	1.4
11	Tributary 4	Hartshorn Brook	0	0	--	--	0
12	Tributary 3	Hartshorn Brook	0	0	--	--	0
13	Hartshorn Brook	Souhegan River	.5	.7	--	--	2.4
14	Tucker Brook	Souhegan River	0	0	--	--	0
15	Purgatory Brook	Souhegan River	5.2	5.8	--	--	11.7
16	Souhegan River	--	37.3	14.9	--	--	--
17	Discharge Ditch	Souhegan River	.4	.5	--	.4	--

Table 1. Stream seepage at measurement sites in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire, 1988 and 1990--Continued

Measurement site No.	Stream	Tributary to	Stream seepage, in ft^3/s, on given measurement date				
			6/14/88	10/14/88	10/18/90	10/21/90	10/22/90
18	Discharge Ditch	Souhegan River	.5	.8	--	.4	--
19	Tucker Brook	Souhegan River	.6	.5	--	1.2	--
21	Tributary 2	Souhegan River	--	0	--	--	0
22	Souhegan River	--	35.3	14.1	--	--	--
23	Purgatory Brook	Souhegan River	2.3	1.2	--	6.2	--
24	Unnamed Drainage	Souhegan River	0	0	--	--	--
25	Purgatory Brook	Souhegan River	--	1.4	--	--	6.4
26	Tributary 2	Souhegan River	--	.1	--	--	.1
27	Tributary 2	Souhegan River	0	0	--	--	.2
28	Tributary 1	Souhegan River	--	--	--	--	.1
29	Tributary 1	Souhegan River	0	0	--	--	.3
30	Tributary 1	Souhegan River	.1	0	--	--	.2
31	Souhegan River	--	39.1	14.1	55.4	--	46.7
32	Souhegan River	--	32.6	--	--	--	--
33	Souhegan River	--	--	--	--	--	[1]24.7
34	Unnamed Drainage	Souhegan River	0	0	--	--	0
35	Purgatory Brook	Souhegan River	--	--	[1]8.6	[1]8.5	[1]8.7
37	Tributary 6	Souhegan River	--	--	--	--	[1]3.2

Table 1. Stream seepage at measurement sites in the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire, 1988 and 1990--Continued

Measurement site No.	Stream	Tributary to	Stream seepage, in ft^3/s, on given measurement date				
			6/14/88	10/14/88	10/18/90	10/21/90	10/22/90
38	Souhegan River	--	--	--	--	--	74.8
39	Souhegan River	--	--	--	--	--	122.7
40	Souhegan River	--	--	--	--	--	122.4
41	Souhegan River	--	--	--	--	103	--
42	Souhegan River	--	--	--	--	--	113.2
43	Discharge Ditch	Souhegan River	--	--	[1].3	[1].1	[1].2
44	Discharge Ditch	Souhegan River	--	--	[1].6	--	--
45	Unnamed Drainage	Souhegan River	--	--	[1]1.9	--	--

[1] Gage-height measurements only.

APPENDIX 3. Data for selected wells and borings in the Milford-Souhegan aquifer, Milford, New Hampshire,1990

Table 1. Data for selected wells and borings in the Milford-Souhegan aquifer, Milford, New Hampshire, 1990

(No., number; fig., figure; ft, foot; --, no data)

Map No. (fig. 4)	Local identifier	Altitude of land-surface (feet above sea level)	Base of stratified drift (feet below land surface)	Depth to bedrock (ft)	Depth drilled (ft)	Depth of screen		Saturated thickness (ft)
						Top (ft)	Bottom (ft)	
1	Keyes 1	248.7	78.0	85.0	85.0	53.0	55.0	72.9
2	Keyes 2D	246.6	--	--	57.0	54.5	56.5	--
3	Keyes 3D	244.8	--	--	55.0	48.7	50.7	--
4	Keyes 4D	243.3	--	--	53.0	49.9	51.9	--
5	LW-01D	264.8	85.0	114.0	124.3	100.0	110.0	91.2
6	LW-02D	243.1	62.0	62.0	73.5	45.0	55.0	56.6
7	LW-03D	247.3	80.0	80.0	90.2	44.5	54.5	69.7
8	LW-04D	243.4	80.0	80.0	90.0	40.0	50.0	73.4
9	MOW-33	260.0	--	--	52.0	--	--	--
10	GW-02D	255.4	34.0	34.0	44.0	19.0	19.0	--
11	GW-03D	252.4	23.0	23.0	38.0	28.0	38.0	--
12	GW-04D	255.6	19.0	19.0	31.5	21.5	31.5	--
13	GW-05D	261.0	33.0	33.0	48.0	23.0	33.0	22.0
14	RFW-1	256.0	28.0	28.0	28.0	8.0	28.0	26.3
15	RFW-2	254.2	35.0	35.0	35.0	10.0	35.0	30.9
16	RFW-3	254.5	43.0	43.0	43.0	13.0	43.0	38.1
17	RFW-4	252.1	16.0	16.0	16.0	6.0	16.0	13.6
18	PA-1	258.3	--	--	11.5	--	8.7	--
19	PA-2	255.5	--	--	11.0	--	8.7	--
20	PA-3	259.1	--	--	11.5	--	7.8	--
21	MI-7	255.4	--	--	--	--	--	--
22	MI-8	261.9	--	--	--	--	--	--
23	MI-10	252.1	59.0	59.0	59.0	44.0	47.0	54.3
24	MI-11	252.9	63.0	63.0	63.0	40.0	56.0	57.1
25	MI-12	251.6	50.0	50.0	50.3	43.0	49.0	43.7
26	MI-15	266.5	--	--	--	--	--	--
27	MI-16	269.1	--	--	--	--	--	--
29	MOW-36	260.0	--	--	14.6	--	--	--
30	MI-19	275.6	25.0	62.0	82.5	65.0	80.0	51.2
31	MI-20	275.6	--	--	82.5	10.0	40.0	--

Table 1. Data for selected wells and borings in the Milford-Souhegan aquifer, Milford, New Hampshire, 1990--Continued

Map No. (fig. 4)	Local identifier	Altitude of land-surface (feet above sea level)	Base of stratified drift (feet below land surface)	Depth to bedrock (ft)	Depth drilled (ft)	Depth of screen Top (ft)	Depth of screen Bottom (ft)	Saturated thickness (ft)
32	MI-20A	274.7	--	--	14.8	--	--	--
33	MI-21	273.0	30.0	--	53.0	15.0	40.0	--
34	MI-21A	270.0	--	--	--	--	--	--
35	MI-22	270.0	75.0	94.0	112.5	99.0	114.0	84.2
36	MI-22A	270.1	--	--	11.7	--	--	--
37	MI-23	270.0	75.0	94.0	112.5	10.0	75.0	84.9
38	MI-24	270.6	77.0	96.0	101.5	10.0	85.0	85.8
39	MI-24A	271.7	--	--	14.0	--	--	--
40	MI-25	270.6	57.0	104.0	110.0	101.8	111.0	93.7
41	MI-26	270.6	57.0	104.0	110.0	8.0	88.0	93.7
42	MI-27	270.7	57.0	86.0	92.0	13.0	78.0	75.5
43	MI-28	270.3	38.0	56.0	56.0	35.0	55.0	46.2
44	MI-30	265.4	70.0	--	75.0	27.0	72.0	--
44	MI-30	265.4	70.0	--	75.0	27.0	72.0	--
45	MI-31	266.0	--	--	60.0	36.0	54.0	--
46	MI-32	270.2	--	--	95.0	30.0	75.0	--
47	MI-33	268.2	--	--	--	--	--	--
49	MI-35	265.9	--	--	--	--	--	--
50	MI-36	270.0	--	--	--	--	--	--
51	MI-37	270.6	--	--	--	--	--	--
52	MI-38	270.0	--	--	--	--	--	--
54	MI-41	258.6	--	--	20.0	--	--	--
55	MI-42	257.4	--	--	20.0	--	--	--
56	MI-43	257.2	--	--	20.0	--	--	--
57	MOW-63	270.0	65.0	65.0	69.0	53.0	62.0	53.6
58	MI-44	259.8	--	--	20.0	--	--	--
59	MI-45	264.9	--	--	--	--	--	--
60	MI-46	267.3	--	--	--	--	--	--
61	MI-47	270.0	--	--	--	--	--	--
62	MI-48	260.3	--	--	--	--	--	--

Table 1. Data for selected wells and borings in the Milford-Souhegan aquifer, Milford, New Hampshire, 1990--Continued

Map No. (fig. 4)	Local identifier	Altitude of land-surface (feet above sea level)	Base of stratified drift (feet below land surface)	Depth to bedrock (ft)	Depth drilled (ft)	Depth of screen Top (ft)	Depth of screen Bottom (ft)	Saturated thickness (ft)
64	--	265.3	--	--	--	--	--	--
65	--	260.0	--	--	--	--	--	--
66	--	270.0	--	--	--	--	--	--
67	--	250.0	--	--	--	--	--	--
68	--	267.9	--	--	--	--	--	--
69	--	266.3	--	--	--	--	--	--
70	--	264.1	--	--	--	--	--	--
71	--	264.0	--	--	--	--	--	--
72	MI-62	260.0	58.0	60.7	60.7	17.0	58.0	55.0
73	MI-64	259.9	--	--	--	--	--	--
74	MOW-35	260.0	59.0	59.0	60.0	--	--	56.0
75	MOA-1	239.5	74.0	74.0	74.0	--	--	64.2
76	MOA-2	244.6	--	--	13.0	--	--	--
77	MOA-3	241.1	52.0	52.0	52.0	--	--	46.3
78	MOA-4	249.5	43.0	54.0	54.0	33.0	38.0	46.5
84	FH-1	268.0	--	--	66.0	51.0	66.0	--
85	FH-2	262.4	--	--	--	--	--	--
86	FH-3	260.0	--	--	--	33.0	43.0	--
87	FH-4	262.2	--	--	--	--	--	--
88	FH85-1	261.0	--	--	26.0	--	--	--
89	FH85-2	250.0	--	--	41.0	34.0	39.0	--
90	FH85-3	252.8	--	--	31.0	24.0	29.0	--
91	FH85-4	251.6	--	--	31.0	24.0	29.0	--
92	FH85-5	252.3	--	--	31.0	24.0	29.0	--
93	FH85-6	252.0	--	--	26.0	22.0	25.0	--
94	FH85-7	253.5	--	--	31.0	21.0	26.0	--
95	FH85-8A	260.0	--	--	26.0	20.0	26.0	--
96	FH 1974	254.5	--	--	--	--	--	--
97	B1	269.9	31.0	--	43.0	--	--	--
98	B3	269.3	34.0	--	34.0	--	--	--

Table 1. Data for selected wells and borings in the Milford-Souhegan aquifer, Milford, New Hampshire, 1990--Continued

Map No. (fig. 4)	Local identifier	Altitude of land-surface (feet above sea level)	Base of stratified drift (feet below land surface)	Depth to bedrock (ft)	Depth drilled (ft)	Depth of screen		Saturated thickness (ft)
						Top (ft)	Bottom (ft)	
99	B4	270.0	39.0	--	54.5	--	--	--
100	B6	269.0	26.2	26.2	26.2	--	--	24.8
101	B8	269.7	--	--	26.0	--	--	--
102	B9	275.3	36.0	--	40.3	--	--	--
103	B11	275.0	37.0	--	38.0	--	--	--
104	B12	275.4	42.0	--	48.4	--	--	--
122	WW-125	269.0	--	--	--	--	--	--
123	GW-01S	256.1	--	--	20.0	6.0	16.0	--
124	GW-01D	256.5	40.0	56.0	76.4	60.0	70.0	51.2
125	GW-01M	256.7	40.0	--	41.0	30.0	40.0	--
126	Keyes	240.1	--	--	60.0	50.0	60.0	--
127	Haywood	256.3	--	--	--	--	--	--
128	Savage	261.0	--	--	52.0	42.0	52.0	--
129	Keyes-1	241.7	50.0	50.0	50.0	41.0	50.0	41.5
130	Keyes-2	240.5	65.0	65.0	65.0	52.0	60.0	55.9
131	Keyes-3	240.3	52.0	52.0	52.0	42.0	50.0	45.4
132	Potter-1D	251.8	67.0	80.0	80.0	55.0	57.0	63.3
133	Potter-2D	253.8	--	--	60.0	56.0	58.0	--
134.0	Potter-3D	253.7	--	--	60.0	56.0	58.0	--
135	Ford-34	241.4	50.0	50.0	50.0	40.0	50.0	40.0
136	Ford-Obs	247.1	46.0	46.0	46.0	--	--	33.0
137	Ford-33	240.0	40.0	40.0	40.0	--	--	27.0
138	Ford-32	240.0	42.0	42.0	42.0	32.0	42.0	29.0
139	Ford-1	239.8	47.0	50.0	50.0	35.0	50.0	37.3
140	Ford-5	241.7	35.0	35.0	35.0	--	--	23.2
141	Ford-4	245.3	47.0	47.0	47.0	--	--	34.7
142	Keyes-2S	246.1	--	--	57.0	18.0	20.0	--
143	Keyes-3S	246.0	--	--	55.0	16.6	18.6	--
144	Keyes-4S	244.3	--	--	53.0	14.4	16.4	--
145	Potter-1S	252.0	67.0	80.0	80.0	16.0	18.0	63.1

Table 1. Data for selected wells and borings in the Milford-Souhegan aquifer, Milford, New Hampshire, 1990--Continued

Map No. (fig. 4)	Local identifier	Altitude of land-surface (feet above sea level)	Base of stratified drift (feet below land surface)	Depth to bedrock (ft)	Depth drilled (ft)	Depth of screen Top (ft)	Depth of screen Bottom (ft)	Saturated thickness (ft)
146	Potter-2S	253.7	--	--	60.0	18.0	20.0	--
147	Potter-3S	253.7	--	--	60.0	17.0	19.0	--
148	LW-01M	265.1	--	--	60.0	42.6	52.6	--
149	LW-01S	265.2	--	--	40.0	25.6	35.6	--
150	LW-02S	243.4	--	--	17.0	4.0	14.0	--
151	LW-03S	250.0	--	--	25.0	9.0	19.0	--
152	LW-04S	244.8	--	--	20.0	5.0	15.0	--
153	MOW-38	262.7	--	--	16.0	--	--	--
154	MOW-32	261.8	--	--	54.5	--	--	--
155	GW-02S	255.2	--	--	17.0	6.0	16.0	--
156	GW-03S	252.4	--	--	20.0	8.4	18.4	--
157	GW-04S	255.6	--	--	15.4	5.4	15.4	--
158	GW-05S	264.2	--	--	19.0	7.0	17.0	--
160	Hamp-B1	266.3	--	--	21.5	10.0	20.0	--
162	Hamp-B3	258.9	--	--	30.0	20.0	30.0	--
163	MI-2	258.9	--	--	49.0	37.0	47.0	--
164	MI-3	260.0	--	--	49.0	44.0	49.0	--
165	MI-4	259.6	--	--	49.0	39.0	49.0	--
166	MI-5	260.0	--	--	49.0	39.0	49.0	--
167	MI-6	259.2	--	--	--	--	--	--
168	MI-6A	259.5	--	--	--	--	--	--
169	MI-9	262.2	--	--	--	--	--	--
170	MI-14	260.0	--	--	--	--	--	--
171	MI-29	269.9	49.0	51.5	51.5	31.5	51.5	40.7
172	MI-40	259.8	--	--	17.0	--	--	--
173	H12-71	250.0	28.0	36.0	36.0	--	--	31.1
174	H11-71	241.6	35.0	39.0	39.0	25.0	35.0	33.7
175	H9-71	250.8	25.0	28.5	28.5	20.0	25.0	21.6
176	H8-71	250.0	25.0	32.0	32.0	20.0	25.0	24.7
177	H6-71	249.5	11.0	16.0	16.0	--	--	--
178	H7-71	246.9	12.0	15.0	15.0	--	--	--

Table 1. Data for selected wells and borings in the Milford-Souhegan aquifer, Milford, New Hampshire, 1990–Continued

Map No. (fig. 4)	Local identifier	Altitude of land-surface (feet above sea level)	Base of stratified drift (feet below land surface)	Depth to bedrock (ft)	Depth drilled (ft)	Depth of screen Top (ft)	Depth of screen Bottom (ft)	Saturated thickness (ft)
179	H10-71	250.9	28.0	34.0	34.0	18.0	28.0	26.0
180	H5-71	250.5	28.0	31.0	31.0	23.0	28.0	22.3
183	B-61	239.9	23.0	23.0	23.0	--	--	--
188	MOA-25	262.0	60.0	72.0	72.0	50.0	60.0	61.9
189	MOA-35	265.2	12.0	12.0	12.0	--	--	--
190	MOA-37	260.0	13.0	13.0	13.0	--	--	--
191	MOA-38	270.0	14.0	14.0	14.0	--	--	--
193	MOW-15	260.0	--	--	55.0	--	--	--
194	MOW-58	268.7	76.0	76.0	76.0	54.0	63.0	65.7
195	MOW-64	260.0	76.0	76.0	76.0	41.0	49.0	70.4
196	MOW-65	260.0	73.0	73.0	73.0	54.0	62.0	67.5
197	MOW-66	252.8	37.0	37.0	37.0	27.0	33.0	34.3
198	MOW-67	249.8	45.0	45.0	45.0	37.0	43.0	42.2
199	MOW-68	245.0	53.0	53.0	53.0	36.0	42.0	49.0
200	MOW-25	259.7	4.0	4.0	4.0	--	--	--
201	MOW-26	260.0	14.0	14.0	14.0	--	--	--
202	MOW-19	260.8	--	--	52.0	--	--	--
203	MI-63	270.0	--	--	67.0	24.0	64.0	--
204	MI-13	249.6	33.0	--	33.0	12.0	18.0	--
205	HAMP GW 4	270.5	--	--	--	--	--	--
207	RB-38	259.7	--	--	13.0	--	--	--
208	FH-5	267.9	--	--	65.0	50.0	65.0	--
209	HMM 1C	275.5	62.0	62.0	71.0	51.0	61.0	51.1
210	HMM 2B	270.0	79.0	115.0	164.0	71.0	81.0	112.1
212	HMM 4B	270.1	45.0	45.0	98.0	46.0	56.0	39.3
213	HMM 5B	269.3	62.0	62.0	69.0	49.0	59.0	51.0
214	HMM 6B	270.0	71.0	71.0	80.0	56.0	65.0	61.1
215	HMM 7B	266.4	55.5	58.5	69.0	45.0	56.0	53.4
216	HMM 8B	265.0	67.0	90.0	94.0	57.0	67.0	83.4
217	HMM 9C	262.2	91.0	91.0	105.0	79.0	90.0	80.6
218	HMM 10C	266.5	91.6	91.6	101.0	81.0	91.0	86.3

Table 1. Data for selected wells and borings in the Milford-Souhegan aquifer, Milford, New Hampshire, 1990--Continued

Map No. (fig. 4)	Local identifier	Altitude of land-surface (feet above sea level)	Base of stratified drift (feet below land surface)	Depth to bedrock (ft)	Depth drilled (ft)	Depth of screen		Saturated thickness (ft)
						Top (ft)	Bottom (ft)	
219	HMM 11R	261.0	59.0	65.0	115.0	52.0	64.0	59.4
220	HMM 12A	262.4	64.0	66.0	78.0	25.0	35.0	56.4
221	HMM 13B	260.0	59.0	64.0	76.0	48.0	58.0	61.4
222	HMM 14R	253.7	60.0	60.0	110.0	50.0	60.0	57.1
223	HMM 15A	250.8	27.5	27.5	39.0	11.0	27.0	13.2
225	MW-26	268.49	0.0	--	--	3.0	13.0	0.0
226	MW-25	270.67	0.0	--	--	4.0	12.0	0.0
228	MW-3	268.84	21.5	--	--	11.5	21.5	13.7
231	MW-18A	267.55	82.0	--	--	44.5	54.5	72.6
233	MW-16A	267.33	60.0	--	--	16.9	26.9	51.2
234	MW-28	276.01	0.0	--	--	5.0	15.0	0.0
235	MW-27	273.76	0.0	--	--	5.0	15.0	0.0
237	MW-23A	265.38	86.0	--	--	20.0	30.0	0.0
250	SP-8	257.44	0.0	--	--	0.0	0.0	0.0
251	SP-7	258.16	0.0	--	--	0.0	0.0	0.0
252	SP-6	0.0	.0.0	--	--	0.0	0.0	0.0
254	SP-5	255.28	0.0	--	--	0.0	0.0	0.0
255	MW-24A	256.01	40.5	--	--	19.5	29.5	--
258	MW-17A	264.18	99.3	--	--	19.8	29.8	93.0
262	MW-29	260.40	--	--	--	2.5	12.5	--
264	MW-20A	260.48	47.5	--	--	15.0	25.0	42.0
267	SP-4	257.13	--	--	--	--	--	--
268	SP-3	255.30	--	--	--	--	--	--
271	P-15	251.68	--	--	--	--	--	--
273	HP-1	252.26	--	--	--	--	--	--
274	HP-2	251.04	--	--	--	--	--	--
275	HP-3	250.38	--	--	--	--	--	--
276	P-10	251.76	--	--	--	--	--	--
278	MW-21A	259.08	63.8	--	--	3.8	13.8	--
279	SP-2	249.94	--	--	--	--	--	--
280	P-16	258.30	--	--	--	--	--	--

Table 1. Data for selected wells and borings in the Milford-Souhegan aquifer, Milford, New Hampshire, 1990--Continued

Map No. (fig. 4)	Local identifier	Altitude of land-surface (feet above sea level)	Base of stratified drift (feet below land surface)	Depth to bedrock (ft)	Depth drilled (ft)	Depth of screen Top (ft)	Depth of screen Bottom (ft)	Saturated thickness (ft)
281	MW-34	256.31	20.5	--	--	9.5	19.5	7.8
282	P-17A	250.64	--	--	--	--	--	--
283	P-17B	252.64	--	--	--	--	--	--
284	Ferguson	278.28	--	--	--	--	--	--
287	Gorman	270.45	--	--	--	--	--	--
293	MW-22A	250.10	47.0	--	--	13.8	23.8	40.3
294	MW-22B	250.10	47.0	--	--	33.5	43.5	40.4
295	P-13	248.34	--	--	--	--	--	--
296	MW-32A	247.61	--	--	--	7.0	17.0	--
297	MW-32B	248.32	43.5	--	--	31.8	41.8	--
307	HM-1A	279.37	--	--	--	5.0	17.0	--
308	HMM-13A	257.78	58.0	--	--	--	--	54.8
309	MW-1B	279.70	62.0	--	--	35.4	45.4	--
310	MW-2A	266.65	--	--	--	29.0	39.0	--
311	MW-2R	266.20	78.0	--	--	--	--	71.4
312	MW-4A	266.60	45.0	--	--	19.7	29.7	--
313	MW-5A	267.72	61.4	--	--	28.0	38.0	--
314	MW-7A	262.26	58.6	--	--	3.2	13.2	51.9
315	MW-8A	261.95	67.0	--	--	4.5	16.5	54.6
316	MW-10A	262.00	91.6	--	--	19.0	29.0	62.6
317	MW-10B	261.97	91.6	--	--	44.0	54.0	87.0
318	MW-11A	260.99	64.0	--	--	20.5	30.5	59.1
319	MW-11B	260.96	--	--	--	52.3	62.3	--
320	MW-12B	264.36	66.0	--	--	56.0	66.0	--
321	MW-16B	267.43	60.0	--	--	39.6	49.6	51.1
322	MW-17B	264.36	99.3	--	--	52.4	62.4	92.9
323	MW-17C	264.45	99.3	--	--	52.4	62.4	92.9
324	MW-18B	267.56	82.0	--	--	44.5	54.5	72.5
326	MW-19A	261.37	--	--	--	23.5	33.5	--
327	MW-19B	260.71	35.0	--	--	39.0	49.0	30.3

Table 1. Data for selected wells and borings in the Milford-Souhegan aquifer, Milford, New Hampshire, 1990--Continued

Map No. (fig. 4)	Local identifier	Altitude of land-surface (feet above sea level)	Base of stratified drift (feet below land surface)	Depth to bedrock (ft)	Depth drilled (ft)	Depth of screen Top (ft)	Depth of screen Bottom (ft)	Saturated thickness (ft)
328	MW-20B	260.37	47.5	--	--	35.0	45.0	42.2
329	MW-21B	259.19	--	--	--	20.0	30.0	--
330	MW-21C	259.34	63.8	--	--	44.1	54.1	--
331	MW-23B	265.32	63.8	--	--	48.0	58.0	--
332	MW-23C	265.26	86.0	--	--	48.0	58.0	--
333	MW-24B	255.66	40.5	--	--	31.1	41.1	--
334	MW-34	256.31	20.5	--	--	--	--	--
335	P-1	276.60	--	--	--	--	--	--
336	P-2	268.62	--	--	--	--	--	--
339	SP-9	259.41	--	--	--	--	--	--
340	SP-10	262.42	--	--	--	--	--	--
341	MW-14B	252.95	60.0	--	--	50.0	60.0	55.5
342	MW-15B	257.05	27.5	--	--	29.4	36.4	--