4.0 HYDROGEOLOGIC INVESTIGATIONS

NUS/FIT conducted investigative tasks aimed at defining the geologic and hydrogeologic framework of the site in order to characterize contaminant migration mechanisms in soil and groundwater. Tasks were divided between Phase I and Phase II of the Remedial Investigation. During Phase I, NUS collected and evaluated the following data:

- Data collected by Ecology and Environment, Inc. (1980-1982)
- Analytical and hydrogeological data collected by W.R. Grace, Beatrice Foods and UniFirst Corporation in response to EPA administrative orders pursuant to RCRA Section 3013
- Data collected for the City of Woburn during exploratory testing to site Wells G & H
- Data collected by a variety of sources concerning groundwater and surface water south of Cedar/Salem Street, but within the hydrologic boundaries of the Aberjona aquifer (Ecology and Environment, Inc., 1982) (MWRC, 1967, 1973, 1975) (MDC, 1977, 1979)
- Data collected by a variety of sources concerning groundwater and surface water, north of State Route 128 (I-95), but within the hydrologic boundaries of the Aberjona aquifer (Roux Assoc., 1983a, 1983b, and 1984) (DEQE, 1977)
- Surface water quality data collected by DEQE within the study area (MDC, 1979)

Review of the existing data and preliminary data collected by NUS/FIT served to conceptualize the general hydrogeology of the Wells G & H aquifer area as well as indicate areas of contamination. These findings were further utilized in selecting initial locations for the drilling and installation of monitoring wells.

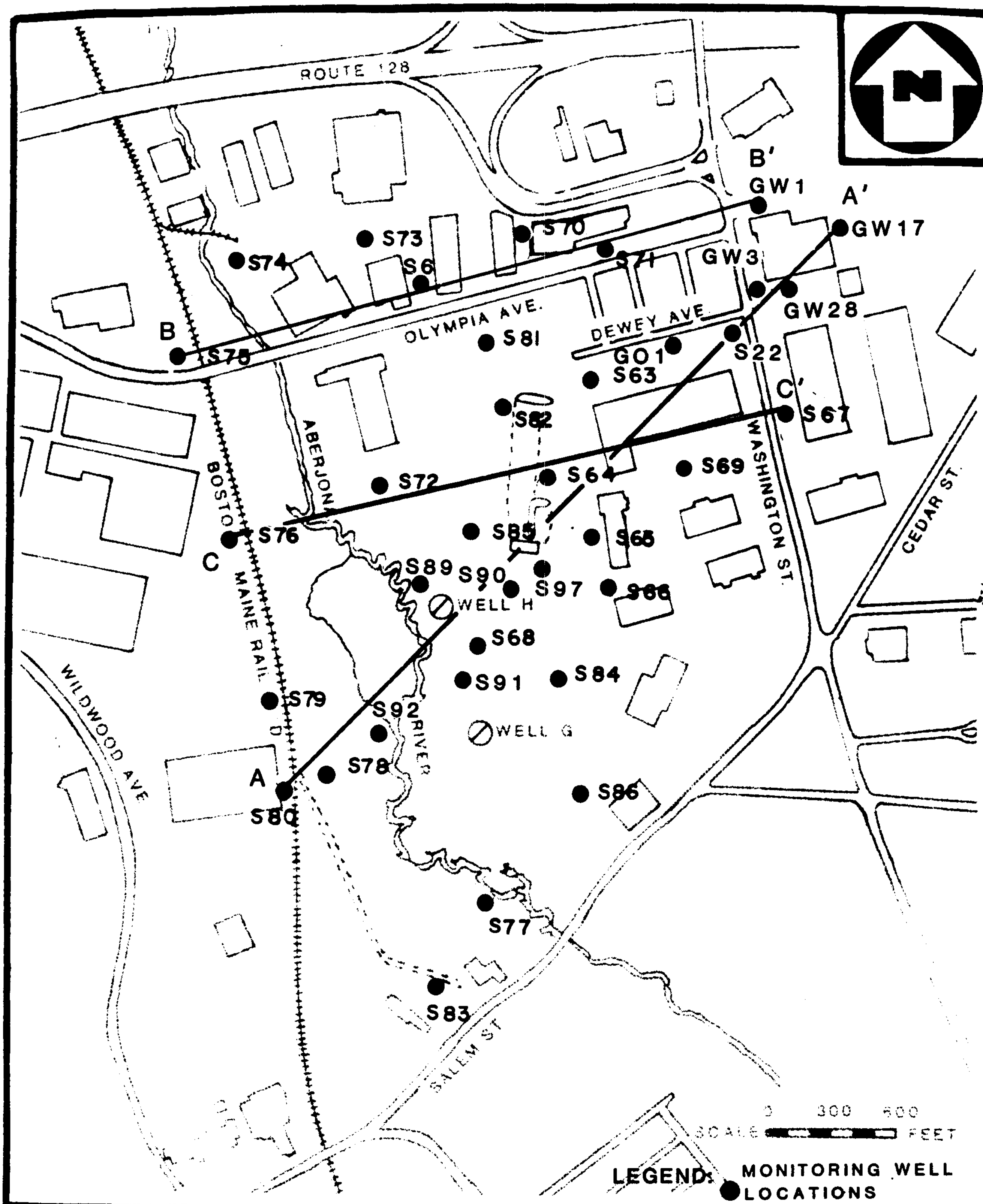
A greater understanding of site hydrogeology was developed using data collected during Phase II of the Remedial Investigation. Field investigation methods are described in Chapter 3. Further detail on method protocols is presented in Appendix D. Analysis of split spoon samples and of bedrock cores collected during monitoring well installations at 24 new locations enabled NUS/FIT to better characterize the type and extent of surficial deposits and bedrock formations that underlie the study area. Permeabilities of the various units encountered were calculated from data collected during 16 in-situ field permeability tests. Laboratory grain size analysis was conducted on 49 representative soil samples. The results of the in-situ field permeability tests and grain size analyses are presented in Appendix F.

Information gathered by other consulting firms was also included in the evaluation of the geology and hydrogeology of the area. Appendix B contains geologic data collected by consultants other than NUS/FIT.

The compiled data indicate that Wells G & H are located within a buried glacial valley. Figures 4-1 through 4-4 depict the generalized geology through geologic cross-sections.

The surficial geologic units of the study area are comprised primarily of glacial deposits consisting of a complex mixture of sand, silt, clay, and gravel. The majority of the sediments are the result of Late Wisconsin glaciation which receded through the Mystic River and Aberjona River Valleys approximately 14,000 years ago (Ecology and Environment, 1982b). Recent alluvial deposits associated with the Aberjona River overlie the glacial deposits at the lower elevations in the study area.

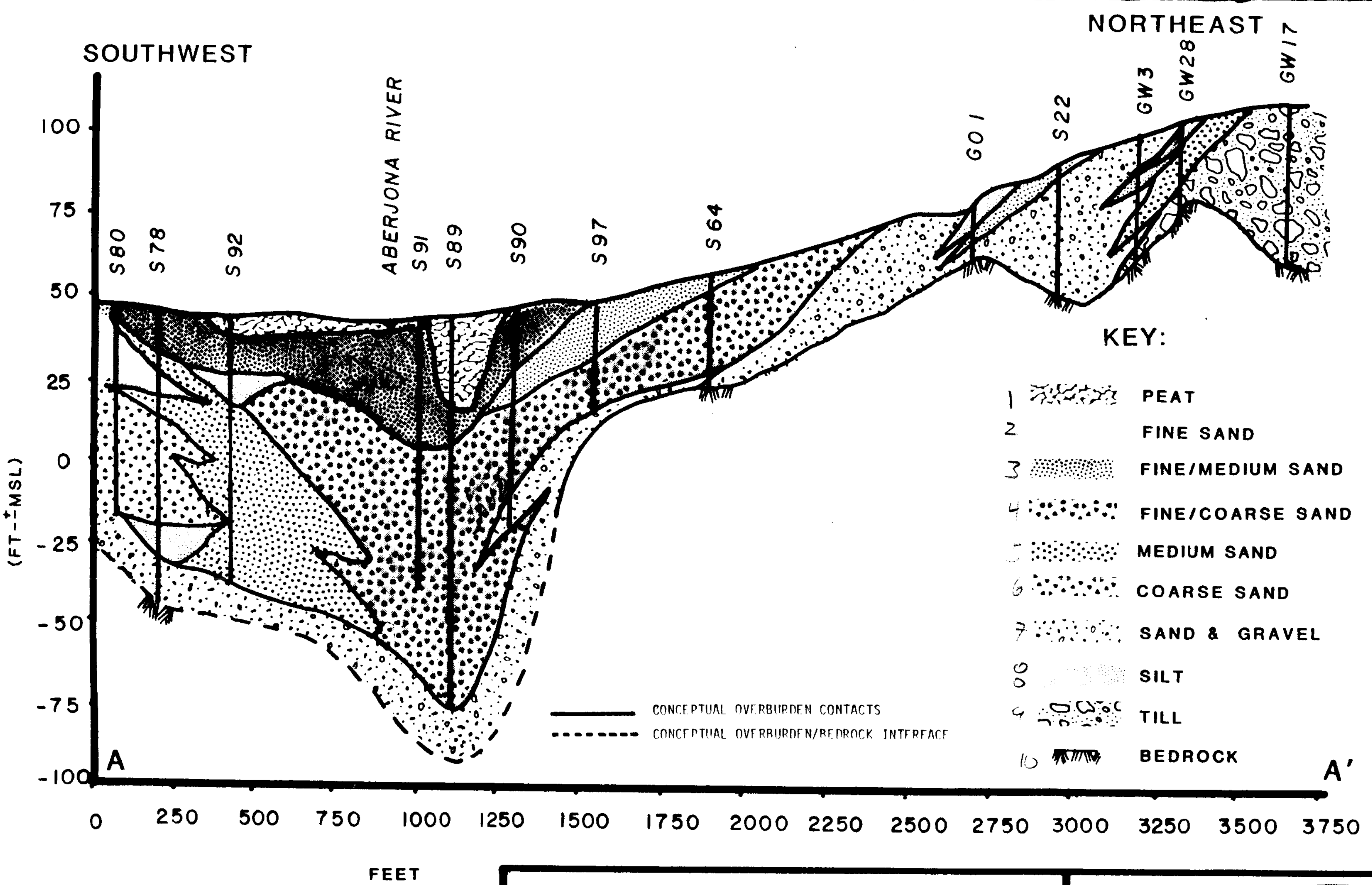
NUS/FIT identified two major glacial overburden units within the boundaries of the Wells G & H study area. These units were named for their probable modes of deposition and include a stratified drift unit and an ice contact unit. Characteristics of each unit are discussed in Section 4.1. The areal distribution of these units is depicted on Figure 4-5.



GEOLOGIC CROSS SECTION KEY
WELLS G AND H
WOBURN, MA

NUS CORPORATION
A Halliburton Company

FIGURE 4-1



CROSS SECTION A-A'

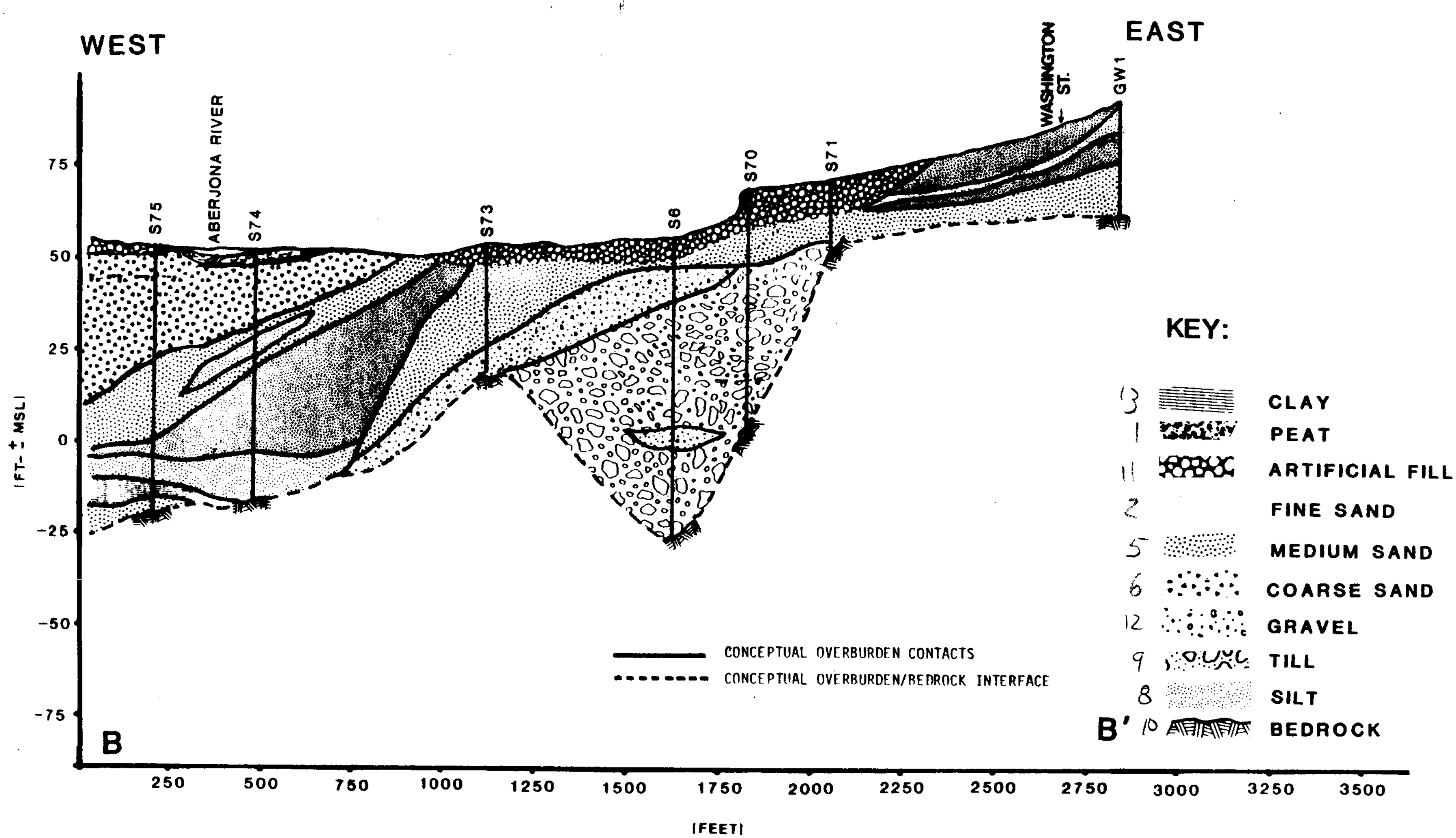
WELLS G&H

WOBURN, MA

NUS CORPORATION

A Halliburton Company

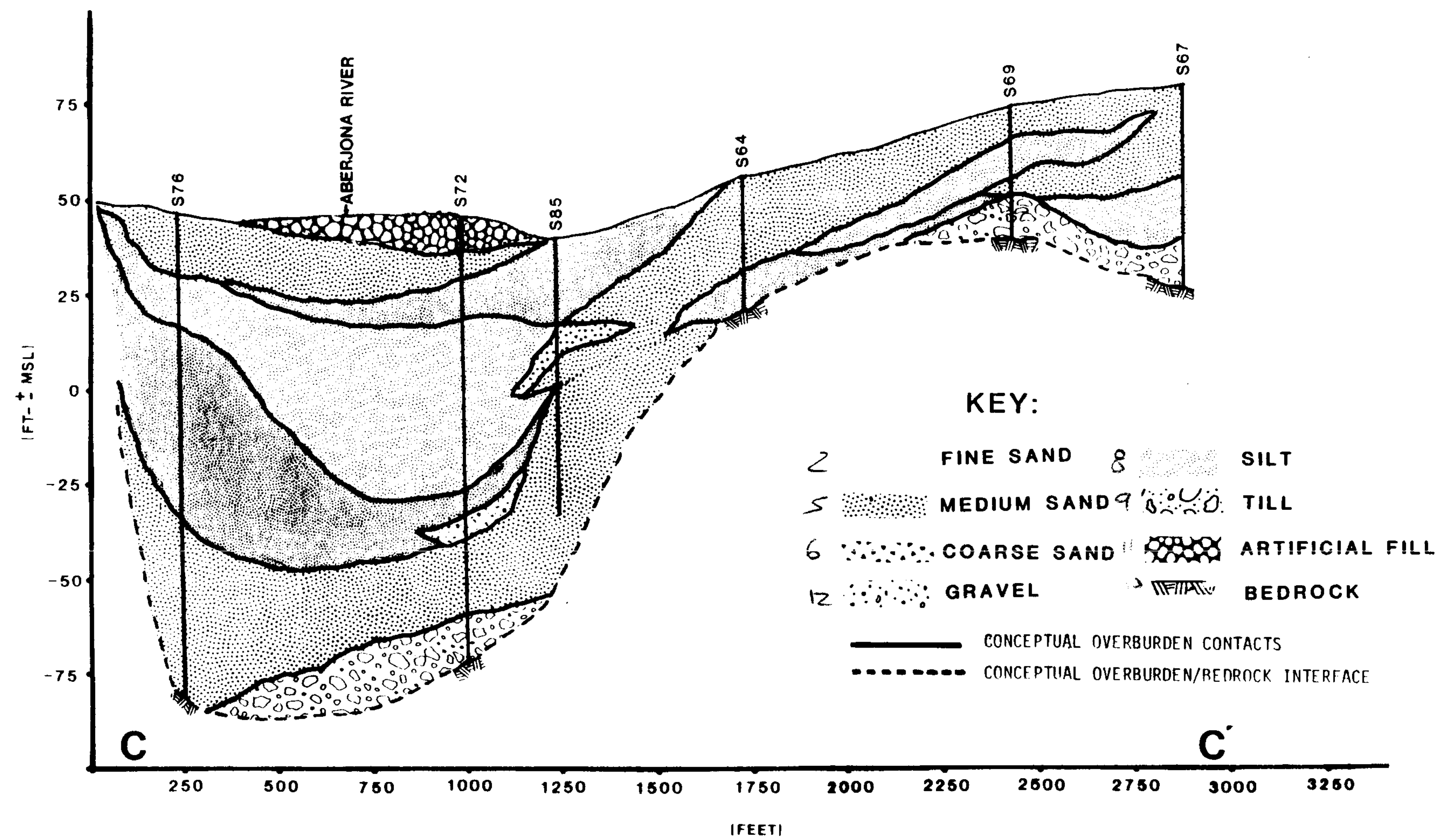
FIGURE 4-2



CROSS SECTION B-B'
WELLS G&H
WOBURN, MA

NUS CORPORATION
A Halliburton Company

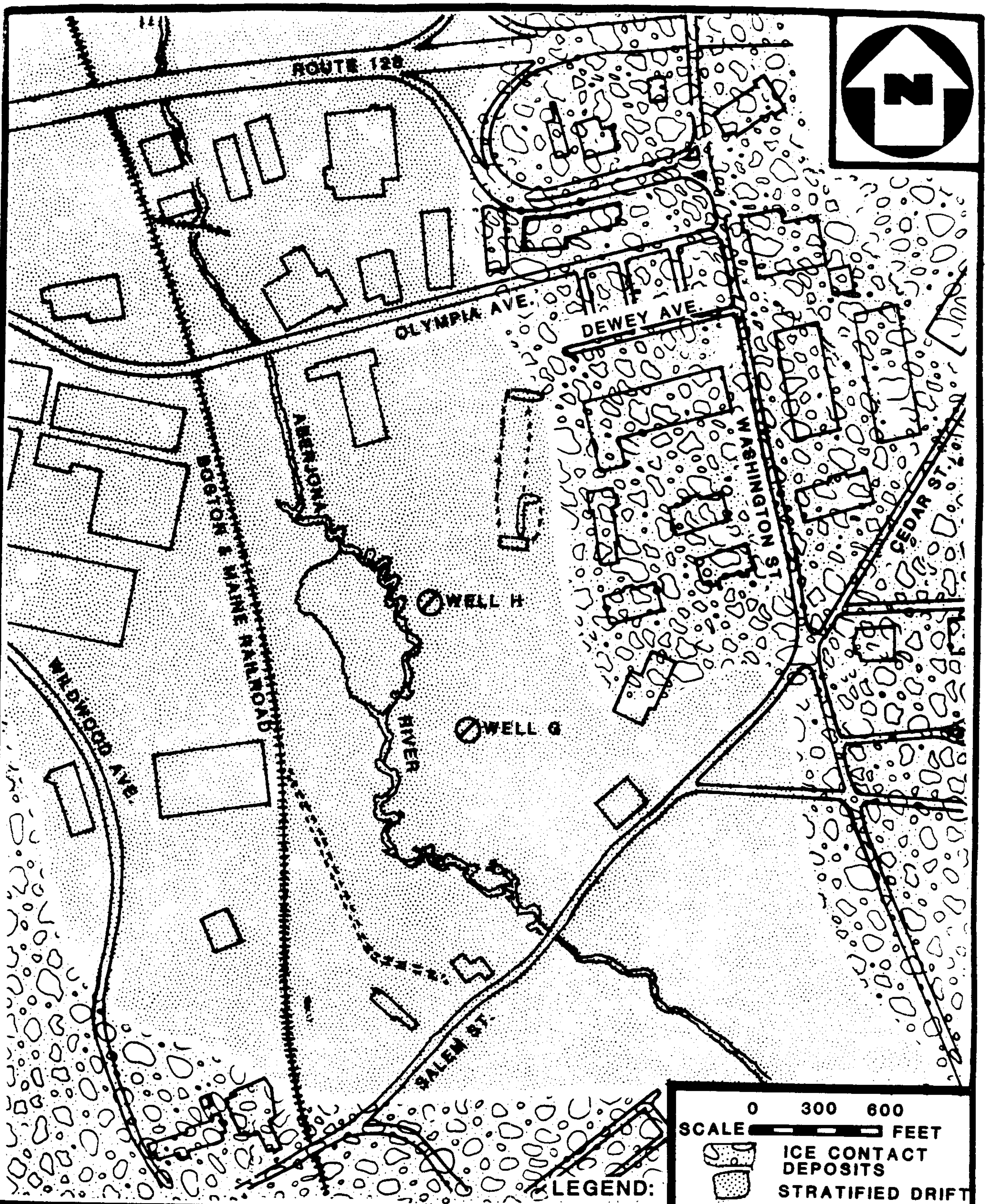
FIGURE 4-3



CROSS SECTION C–C'
WELLS G&H
WOBURN, MA

NUS CORPORATION
A Halliburton Company

FIGURE 4–4



GENERALIZED SURFICIAL DEPOSITS MAP
WELLS G AND H
WOBURN, MA

NUS CORPORATION
A Halliburton Company

FIGURE 4-5

The deposition of surficial deposits was controlled to some extent by the bedrock topography. The most prominent bedrock feature is a fault-controlled buried bedrock valley. This buried valley was probably widened and deepened during Pleistocene glaciation. The valley has gently sloping walls, but locally may be very steep (Ecology and Environment, 1982b).

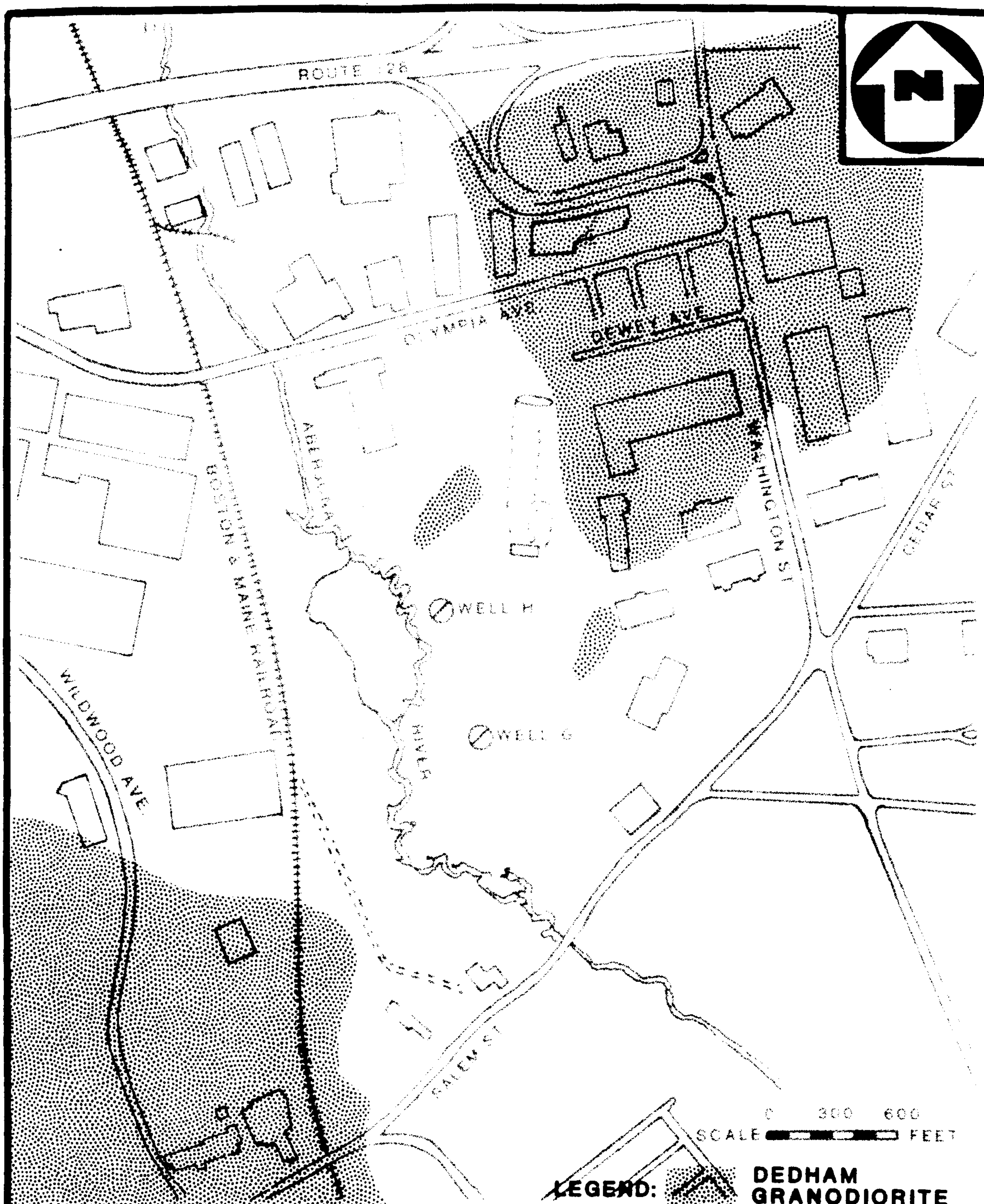
Two bedrock formations (Salem Gabbrodiorite, Dedham Granodiorite) were identified as underlying the study area; their characteristics and relationship to one another are discussed in Section 4.2. The areal distribution of bedrock types is depicted in Figure 4-6.

4.1 Surficial Geology

Characterization of the surficial geology of the Wells G & H site was an important aspect of the NUS/FIT Remedial Investigation. As noted in previous sections, solvents were allegedly disposed of directly into the ground with no artificial containment. For this reason, the composition of the surficial geologic materials at the site is a critical factor in assessing contaminant migration.

Information describing regional surficial geology was obtained through review of available published literature. Site-specific information was developed through review of previous investigators' findings and through surface and subsurface investigative work conducted by NUS/FIT during the course of the Remedial Investigation. The collective findings of these efforts are summarized below.

The surficial geologic units underlying the Wells G & H site consist of a complex mixture of glacial and fluvial deposits. The collective thickness of these units can exceed 135 feet as observed during the installation of monitoring well S77 (Plate 1). The stratigraphic relationship among the valley deposits beneath the study area is illustrated in a series of three interpretive geologic cross sections, which were prepared from information obtained during the drilling and installation of NUS/FIT monitoring wells (S63 through S86). This information was



GENERALIZED BEDROCK MAP
WELLS G AND H
WOBURN, MA

NUS CORPORATION
A Halliburton Company

FIGURE 4-6

supplemented with data collected by the previous FIT contractor as well as by data obtained through field investigations conducted by other firms. Figure 4-1 shows the locations of the cross sections that are presented as Figures 4-2 through 4-4.

The overburden deposits encountered in the valley flat consist of stratified gravel, sand, silt and clay. Stratification was noted throughout the majority of the study area through collection of split spoon samples at every five feet during drilling/well installation. In general, the uppermost valley flat deposits are associated with the Aberjona River system and consist primarily of interbedded silty peat and sandy peat strata. These deposits are confined to the lower topographic elevations immediately surrounding the river channel and extending the width of the valley flat. The thickness of the peat deposit averages between four and six feet, however, a 30 foot thick peat and organic silt deposit was encountered during the installation of well S89 for the joint EPA/USGS aquifer test. The organic silt unit seems to be localized in the vicinity of Well H and was not encountered at any other location in the study area. Cross-section A-A' (Figure 4-2) shows the proximity of the peat and organic silt units to Well H.

Directly underlying the alluvial deposits are brown to gray, fine to coarse sands and gravel with traces of silt. The thickness of this stratum ranges from 5 to 50 feet in the immediate vicinity of Wells G & H. In general, grain size of the particles decreases with depth with fine to medium sands and silt extending approximately another 30 feet in thickness. A sand and gravel unit was encountered below the fine materials at approximately 70 to 80 feet in depth along the eastern flank of the valley. It is within these sand and gravel deposits that Wells G & H are screened.

At well locations S72, S73, S77, S78, S79, and S80, 20 to 50 feet of interbedded blue to gray very fine sands, silts and clays were encountered. This material is thickest in the deepest portions of the valley and decreases in thickness toward the valley walls. These materials appear to be confined to the central sections of the valley. The small particle size of this unit indicates deposition in a low energy regime such as that of a lake or pond. Directly underlying the fine grained, blue gray deposits are coarser sand and gravel with cobbles and boulders.

The surficial deposits found in the higher elevations of the site do not reflect the same high degree of sorting found in the deposits that fill the valley flat. Based on the in-situ density and lack of sorting, this material has been interpreted as an ablation till/ice contact unit which was deposited as the underlying glacial ice melted. Contained within the till body are lenses of sorted sands and gravels (Figure 4-3). These lenses represent sorting by melt waters. Ablation till is characterized by a high sand and gravel percentage with varying amounts of silt (Ritter, 1978). Ablation till was encountered during the installation of well S70. The till apparently fills a bedrock low which may have protected it from being reworked by the glacial melt waters (Figure 4-3).

NUS/FIT also identified a basal or lodgement type till in the study area during installation of wells S67 and S86. In the deposition of lodgement till, sediments are plastered against the underlying bedrock surface beneath the ice flow. Because of the extreme weight of the overlying ice and debris, and relatively high water content resulting from pressure melting, lodgement tills are generally very dense (Sugden et al, 1977, Goldthwait, 1948).

The tills encountered during the NUS/FIT Remedial Investigation do not form a continuous mantle, but instead appear to generally occupy bedrock depressions (Figure 4-3). Overlying the tills on the eastern flank are gravels, sands and some silts of varying thickness. These sediments are believed to have been deposited as glacial meltwaters washed over the highlands to the valley.

4.2 Bedrock Geology

The Wells G & H study area is situated within the Appalachian Mountain orogenic belt in an area mapped as the Brittlely Deformed Terrane by Zen et al. (1983) and consists of a diorite and gabbro complex with secondary metavolcanic rocks and intrusive granite and granodiorite. These units have been severely distorted by faults and associated fracturing which has dissected the area into small blocks and slices. Where faulting has occurred, the original character of the rock is locally altered to produce a finer grained, highly foliated rock which may be more susceptible to weathering. The weathering of the faulted materials is believed to have produced the bedrock troughs found in the study area (Plate 3). With the onset of glaciation, the bedrock troughs afforded preferrential pathways for the accumulating glacial mass. Differential plucking of the more weathered, less resistant rock likely resulted in the widening and deepening of the valley immediately surrounding the fault. It is through these mechanisms that the bedrock valley beneath the Aberjona River is believed to have been formed.

There are two major rock types underlying the Wells G & H aquifer area. They were identified by the previous EPA FIT contractor (Ecology & Environment, 1982a) as the Dedham Granodiorite and Salem Gabbrodiorite, respectively. Based on mineral assemblages and physical description, NUS/FIT concurs with these designations.

The Dedham Granodiorite is believed to be the older rock unit and dates to the Precambrian. It is characteristically a grayish-pink, coarse grained, moderately foliated, biotite-hornblende quartz feldspar granodiorite (Ecology and Environment, 1982a). Rock quality designation calculations indicate that this unit is slightly to moderately fractured (Table 4-1).

The Salem Gabbrodiorite is Precambrian to Ordovician in age. It is medium to coarse-grained, bluish gray in color and is composed of hornblende, quartz and feldspar. The rock is highly fractured (Table 4-1) and altered. Quartz veins are present throughout this unit (Ecology and Environment, 1982a).

The bedrock topography was interpreted within the context of the scoured glacial valley model. Bedrock surface elevations were developed using borehole logs from the newly installed NUS/FIT monitoring wells (S63-S86) in conjunction with data collected during previous investigations (Ecology and Environment, 1982a; GeoEnvironmental, 1983; WWC, 1984a and 1984b; ERT, 1984). Due to the number of data points available, NUS/FIT was able to develop a bedrock surface elevation map with ten foot contour intervals. Table 4-2 presents the elevations used to develop bedrock topography (Plate 3)

TABLE 4-1
BEDROCK CORING RESULTS

Well No.	Coring Run No.	Cored Depth (feet)	Length Cored (inches)	RQD (%)	Rock Quality Description
S63	1	26-31	60	83.83	Good
S63	2	31-36	60	100	Excellent
S64	1	36-41	60	15.83	Very Poor
S64	2	41-46	60	59.17	Fair
S64	3	46-51	60	77.50	Good
S64	4	51-56	60	97.50	Excellent
S65	1	39.2-44.2	60	63.33	Fair
S65	2	44.2-49.2	60	60.00	Fair
S65	3	49.2-54.2	60	85.00	Good
S65	4	54.2-59.2	60	63.33	Excellent
S66	1	14.7-19.7	60	78.18	Good
S66	2	19.7-24.7	60	91.67	Excellent
S66	3	24.7-29.7	60	75.00	Good
S66	4	29.7-34.7	60	98.33	Excellent
S67	1	55-60	60	36.67	Poor
S67	2	60-65	60	66.67	Fair
S67	3	65-70	60	58.33	Fair
S67	4	70-75	60	41.67	Poor
S68	1	107.5-112.5	60	65.00	Fair
S69	1	35-40	60	25.83	Poor
S69	2	40-45	60	51.67	Fair
S69	3	45-50	60	74.17	Fair
S69	4	50-55	60	45.83	Poor
S70	1	63-68	60	23.33	Very Poor
S70	2	68-73	60	76.67	Good
S70	3	73-78	60	50.00	Fair
S70	4	78-83	60	86.67	Good

The relationship of RQD values to descriptive rock quality is as follows:

- 90-100%: excellent
- 75-90%: good
- 50-75%: fair
- 20-50%: poor
- 0-25%: very poor

TABLE 4-1
BEDROCK CORING RESULTS PAGE TWO

Well No.	Coring Run No.	Cored Depth (feet)	Length Cored (inches)	RQD (%)	Rock Quality Description
S71	1	20-25	60	76.67	Good
S71	2	25-30	60	78.33	Good
S71	3	30-33.5	42	61.90	Fair
S71	4	33.5-38.5	60	43.33	Poor
S71	5	38.5-42.7	50	38.9	Poor
S72	1	117-120	36	0	Very Poor
S72	2	122-127	60	0	Very Poor
S72	3	127-132	60	61.67	Fair
S72	4	132-137	60	58.33	Fair
S73	1	36.5-41.5	60	37.50	Poor
S73	2	41.5-46.5	60	75.00	Fair
S73	3	46.5-51.5	60	28.33	Poor
S73	4	51.5-56.5	60	15.00	Very poor
S74	1	68.5-73.5	60	28.33	Poor
S74	2	73.5-78.5	60	62.50	Fair
S74	3	78.5-83.5	60	72.50	Fair
S74	4	83.5-88.5	60	64.17	Fair
S75	1	75-80	60	76.67	Good
S75	2	80-85	60	71.67	Fair
S75	3	85-90	60	19.17	Very Poor
S75	4	90-95	60	51.67	Fair
S76	1	130-135	60	50.83	Fair
S76	2	135-140	60	60.83	Fair
S76	3	140-145	60	40.00	Poor
S76	4	145-150	60	98.33	Excellent

The relationship of RQD values to descriptive rock quality is as follows:

- 90-100%: excellent
- 75-90%: good
- 50-75%: fair
- 20-50%: poor
- 0-25%: very poor

TABLE 4-1
BEDROCK CORING RESULTS PAGE THREE

Well No.	Coring Run No.	Cored Depth (feet)	Length Cored (inches)	RQD (%)	Rock Quality Description
S78	1	90.5-95.5	60	76.67	Good
S78	2	95.5-100.5	60	70.83	Fair
S78	3	100.5-105.5	60	13.33	Very Poor
S78	4	105.5-110.5	60	10	Very Poor
S79	1	107.5-112.5	60	87.50	Good
S79	2	112.5-117.5	60	96.67	Excellent
S79	3	117.5-122.5	60	97.50	Excellent
S79	4	122.5-127.5	60	0	Very Poor
S81	1	62.5-67.5	60	58.33	Fair
S81	2	67.5-72.5	60	74.17	Fair
S81	3	72.5-77.5	60	87.50	Good
S81	4	77.5-82.5	60	80.00	Good
S84	1	81.5-86.5	60	73.33	Fair
S84	2	86.5-91.5	60	63.33	Fair

The relationship of RQD values to descriptive rock quality is as follows:

- 90-100%: excellent
- 75-90%: good
- 50-75%: fair
- 20-50%: poor
- 0-25%: very poor

TABLE 4-2
BEDROCK ELEVATIONS
USED IN CONSTRUCTION OF BEDROCK TOPOGRAPHIC MAP

Well Number	Ground Surface Elevation	Depth To Bedrock	Bedrock Elevation
IUS1	87.6	11.5	76.1
IUS2	61.3	53.6	7.7
IUS3	66.9	55.2	11.7
S5	48.9	54.5	-5.6
S6	62.3	40.6	21.7
S11	42.9	75.0	-32.1
S21	79.6	22	57.6
S22	77.2	37	40.2
S60	122.4	24	98.4
S63D	69.5	22.0	47.5
S64D	57.8	35.0	22.8
S65D	76.9	39.2	37.7
S66D	69.6	11.5	58.1
S67D	83.3	54.0	29.3
S68D	45.5	105	-59.5
S69D	75.4	36	39.4
S70D	69.4	62	7.4
S71D	71.4	16.5	54.9
S72D	50.2	116	-65.8
S73D	52.0	35	17
S74D	48.2	67.5	-19.3
S75D	56.9	75	-18.1
S76D	53.0	130	-77
S77D	44.9	>135	-90.1
S78D	45.8	90.5	-44.7
S79D	47.4	107.5	-60.1
S80M	55.4	>70	-14.6
S81D	54.1	62	-7.9
S82	57.0	>45	<12
S83D	48.1	>87	-38.9
S84D	46.2	81.5	-35.3
S85M	46.1	>70	<23.9
S86D	43.3	>62	<18.7

TABLE 4-2
BEDROCK ELEVATIONS
USED IN CONSTRUCTION OF BEDROCK TOPOGRAPHIC MAP
PAGE TWO

Well Number	Ground Surface Elevation	Depth To Bedrock	Bedrock Elevation
GW1D	97.8	34.5	63.4
GW2D	97.4	29.0	68.4
GW3D	91.7	38.6	53.1
GW4D	93.6	24.5	69.1
GW5D	93.8	19.5	74.3
GW7D	96.8	28.5	68.3
GW11D	91.2	24	67.2
GW12D	93.4	25.5	67.9
S97D	51.0	33.5	17.5
BW8	45.4	61.5	-16.1
BW9	46.0	28.7	17.3
BW10	46.5	39.5	7
BW13	46.6	57.5	-10.9
S41	60.0	38.0	22

NOTE:

\> indicates bedrock lies at a depth greater than the penetrated thickness
<12 indicates the bedrock surface is at an elevation less than the elevation (eg. 12) listed, with respect to Mean Sea Level

The central axis of the buried valley grades from north to south with its position in the valley approximated by the current course of the Aberjona River. From this axis, the bedrock surface rises gradually to the east and west. The slope markedly increases at the trough edges lending the characteristic U-shape of the glacial valley. The steepest grades occur along the eastern flank of the valley where the bedrock surface rises abruptly to form the bedrock highlands that underlie the higher elevations in the area.

There is a correlation between bedrock lithology and bedrock surface elevations. In general, the rock type found underlying the deeper deposits, within the buried valley, is the Salem Gabbrodiorite (Figure 4-6). It is theorized by NUS/FIT that the Salem was more easily fractured, and therefore excavated through glacial plucking and scouring, than the more highly resistant Dedham Granodiorite which underlies the higher elevations. Such selectivity of glacial erosion has been described in a number of regional studies (Sugden and John, 1976). A characteristic of this type of erosion is a very steep slope to the trough edge. This feature was demonstrated during the installation of well S84. Bedrock outcrops with surface elevations of approximately 50 feet above MSL are located within 200 feet of the well boring, yet bedrock was not encountered until 45 feet below MSL in the well boring.

Other features inferred from the bedrock surface elevations are smaller, less pronounced troughs and swales that are tributary to the main bedrock trough. These features are evident in the bedrock formation which underlies the eastern half of the site. Zones of weakness in the bedrock were recorded during the installation of monitoring wells S8 and S22. Fault gouge and brecciated rock were recovered from boreholes (S8, S69, S21). No other zones exhibiting such intense deformation were encountered by NUS/FIT in the study area.

4.3 Hydrogeology

The previous section described the geologic framework of the Wells G & H aquifer area in terms of surficial and bedrock geology. This section presents information on the occurrence of groundwater within this framework. For purposes of organization, this section is subdivided into Subsection 4.3.1 Hydrologic Setting, Subsection 4.3.2 Hydrogeology of Surficial Units, and Subsection 4.3.3 Hydrogeology of Bedrock.

This information is derived from a variety of sources including published reports on regional conditions, reports of investigative activities prior to the NUS/FIT Remedial Investigation and information acquired during NUS/FIT field activities conducted for the Remedial Investigation.

4.3.1 Hydrogeologic Setting

The two primary sources of recharge to the aquifer from which Wells G & H withdrew groundwater have been identified as: infiltration of precipitation throughout the aquifer area, and surface and groundwater recharge from the bedrock highlands (Ecology and Environment, 1982a).

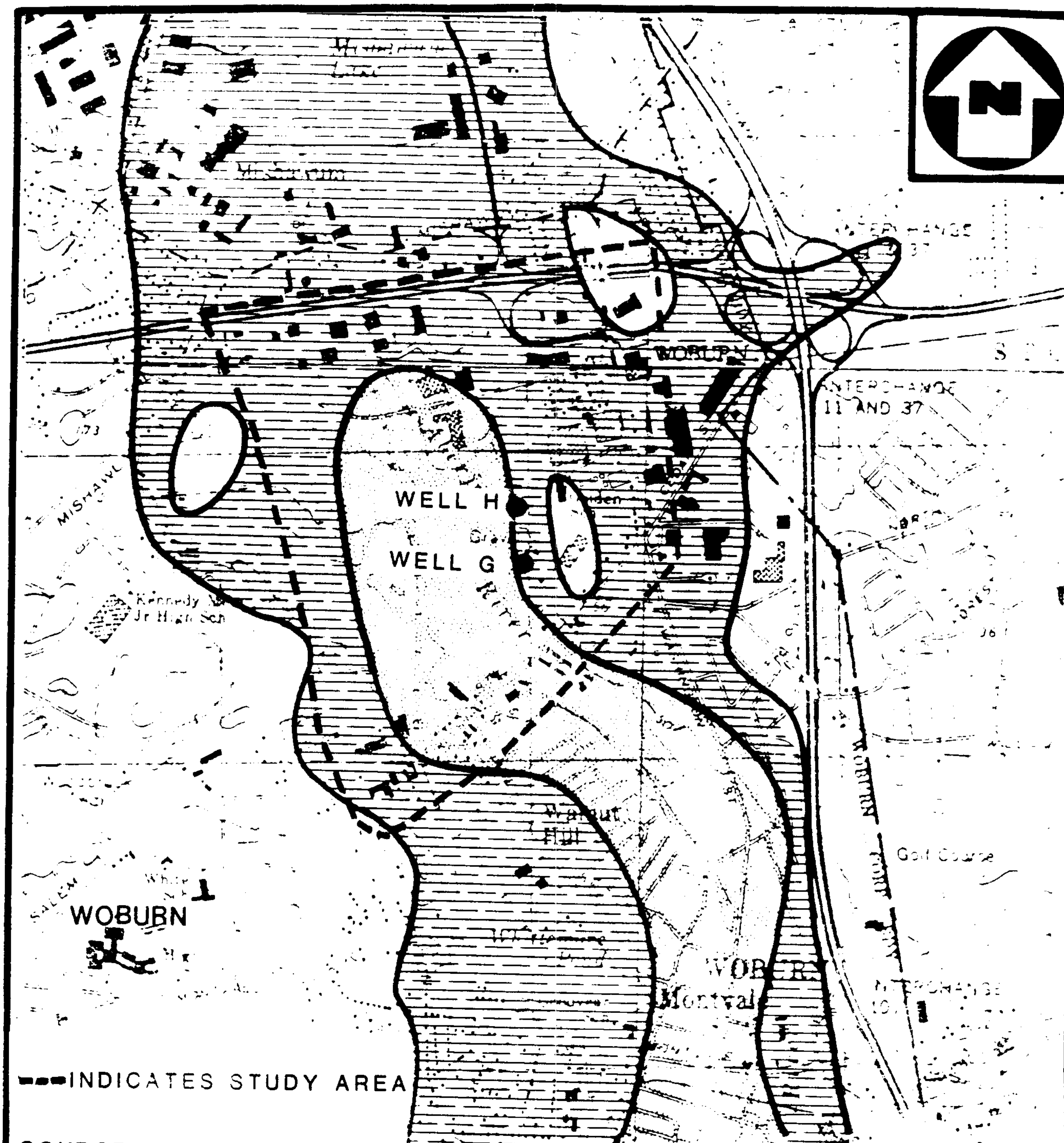
A third potential source of recharge to the Wells G and H aquifer area is the Aberjona River. This possibility will be discussed in light of data collected during the groundwater monitoring well installation phase of the Remedial Investigation in Subsection 4.3.2 Hydrogeology of Surficial Units. Further data on the Aberjona River/Wells G & H aquifer area relationship was collected during the EPA/USGS aquifer test conducted during December, 1985 (Section 3.10).

Approximately 20 inches of surface water runoff is generated annually in the Woburn area from an average annual precipitation of 44 inches (USGS, 1977). Some of the remaining 24 inches of precipitation percolates through the surficial deposits to become groundwater. Previous studies (Delaney and Gay, 1980) of the hydrology of the Mystic River Drainage Basin, and the Aberjona River Drainage Basin, which includes the Aberjona River system, indicate that the study area is in large part underlain by a highly productive aquifer. The Wells G & H aquifer area consists of the glacial deposits discussed in Section 4.1, Surficial Geology; it is located entirely within the Aberjona River Watershed. The Aberjona River, which drains the watershed, has its headwaters in Reading, Massachusetts, and flows to the south 8.7 miles before discharging to the Upper Mystic Lake (MDC, 1977). Approximately eleven percent of its length is within the study area.

The estimated transmissivity of the stratified drift deposits within the Wells G & H aquifer area is in excess of 4,000 ft^2/day. Transmissivity is a measure of the ability of a unit to conduct groundwater flow. The higher the transmissivity of the unit, the more readily groundwater can flow through the deposit. Wells G & H are located in what is mapped as the most transmissive unit in the Aberjona aquifer (Delaney and Gay, 1980). Figure 4-7 reproduces a portion of the transmissivity map developed by Delaney and Gay in 1980. The Wells G & H study area is outlined on this figure. The USGS reported estimated transmissivities of 29,700 square feet per day near Well G and 20,700 ft^2/day at Well H (USGS, 1986). The average horizontal hydraulic conductivity at Well G is 350 feet per day and 235 feet per day at Well H (USGS, 1986). Local historical water table measurements compiled by the USGS indicate annual water level variations of up to five feet in the study area (Maevsky, 1974; USGS, 1980). The highest levels occur between early November and late April with the lowest levels occurring in August, September, and early October. These variations are typical of New England and reflect seasonal changes in the rate of groundwater recharge.

4.3.2 Hydrogeology of Surficial Units

One of the overall objectives of the NUS/FIT monitoring well installation program was to provide site specific information on groundwater conditions, both in terms of groundwater occurrence and groundwater quality. As part of the Remedial Investigation, NUS/FIT installed 55 wells at 24 locations. To complement already existing wells in the area, thirty-eight of these wells are screened only in surficial (overburden) geologic materials. The remainder are screened in bedrock. Table 3-2 lists the total depth, ground elevation and elevations of the screened intervals of each NUS/FIT well. Table 4-3 lists the water level measurements taken on April 2, 3 and 4, 1985 that were used in conjunction with elevation



SOURCE: DELANEY AND GAY, 1980

LEGEND:

> 1400 FT^2/DAY (100 GAL/MIN)

> 4000 FT^2/DAY (300 GAL/MIN)

0 ½ SCALE MILE APPROXIMATE

TRANSMISSITY OF THE ABERJONA AQUIFER

WELLS G & H SITE

WOBURN, MASSACHUSETTS

NUS CORPORATION

A Halliburton Company

FIGURE 4-7

BASE MAP IS A PORTION OF THE U.S.G.S. LEXINGTON, BOSTON NORTH, READING & WILMINGTON QUADRANGLES (7.5' SERIES, 1971-1979)

TABLE 4-3
WATER TABLE ELEVATIONS USED
IN CONSTRUCTION OF
WATER TABLE MAP
(MEASUREMENTS IN FEET FROM APRIL 2,3,4, 1985)

Well Number	Elevation of Ground Surface	Depth To Groundwater From Ground Surface	Elevation of Groundwater
IUS 1	88.4	12.2	76.2
IUS 2B	61.3	4.4	56.9
IUS 3C	66.9	7.7	59.2
S5	48.9	2.5	46.4
S6	62.3	7.4	54.9
S7	95.1	3.7	91.4
S11	42.9	11	41.8
S21	77.2	18.7	58.5
S63S	70.0	12.3	57.7
S64M	57.7	2.8	54.9
S65M	77.0	20.4	56.6
S67M	83.3	14.4	68.9
S68S	45.2	1.3	43.9
S70M	70.0	13.2	56.8
S71S	71.4	11.3	60.1
S72M	50.9	5.5	45.4
S73S	52.6	4.4	48.2
S74M	48.0	1.2	46.8

TABLE 4-3
WATER TABLE ELEVATIONS USED
IN CONSTRUCTION OF
WATER TABLE MAP
(MEASUREMENTS IN FEET FROM APRIL 2,3,4, 1985)
PAGE TWO

Well Number	Elevation of Ground Surface	Depth To Groundwater From Ground Surface	Elevation of Groundwater
S75M	56.7	8.5	46.2
S76M	52.4	6.6	45.8
S77M	44.7	2.0	42.7
S78S	45.4	2.0	43.4
S79M	48.0	4.2	43.8
S80M	48.7	4.9	43.8
S81M	55.4	4.2	51.3
S82	57.0	4.8	52.2
S83	48.1	6.3	41.8
S84M	46.0	2.2	43.8
S85M	46.0	1.6	44.4
S86S	44.7	1.3	43.4
GW1S	97.8	9.3	88.5
GW2M	98.5	8.1	90.4
GW3S	92.3	23.9	68.4
GW4S	95.7	12.0	83.7
GW5S	93.1	11.1	82.0
GW7	96.0	10.0	86.0

measurements of surface water bodies and consideration of surface and bedrock topography to prepare a water table (potentiometric surface) map of the site (Plate 4). The locations of the data points and their respective water level elevations are provided on the plate. The water table within the study area mimics the bedrock surface in a subdued manner. It exhibits an overall troughlike shape with its axis trending north to south. The main axis of the water table trough has a gradual hydraulic gradient of approximately five feet/mile as calculated from water level measurements recorded at monitoring well S5 in the north and S11 in the south of the study area. As shown on Plate 4, the steepest hydraulic gradients occur in the northeast section of the site. The calculated hydraulic gradient between wells GW1 and S63 is 151 ft/mile. Groundwater flows in a westerly to southwesterly direction beneath the northeast area of the site eventually discharging to the lower elevations of the bedrock valley.

There is a water table divide partially identified by wells GW6, GS7 and GW8. Groundwater near and east of these wells flows south and southeast.

The hydraulic gradient under static (non-pumping) conditions is controlled by many factors including gravity and the permeability of the deposits through which the groundwater flows. The variation in hydraulic gradients across the sandy till/ice contact deposits in the northeastern area of the site reflects in part the inhomogeneity of the deposits that comprise this unit. The overburden underlying the Dewey Street area appears to support a steeper hydraulic gradient with respect to the remainder of the highlands, which is indicative of material with lower hydraulic conductivity (such as a more dense till) underlying this area.

The groundwater flow in the area north of Olympia Avenue has a strong westerly component. The direction of groundwater flow under this area is westward, but becomes increasingly southwesterly as it continues downslope.

Permeabilities of the surficial geologic materials encountered in the area were estimated through sixteen in-situ permeability tests and from laboratory grain size analyses of overburden samples. The range of permeabilities garnered from this testing are consistent with permeabilities determined for similar unconsolidated deposits (Freeze and Cherry, 1979). Appendix F presents the methods, raw data, and results of the in-situ testing, as well as the remainder of the permeabilities estimated solely through grain size analysis.

Wells G & H are screened in the most permeable surficial deposit (stratified drift) in the study area (Delaney and Gay, 1980). They are capable of yielding 800 and 700 gallons per minute, respectively (Delaney and Gay, 1980b). The John J. Riley, Tannery Production Well No. 2 (S46), estimated to be capable of yielding 750 gallons per minute, draws water from the same stratified drift aquifer (Delaney and Gay, 1980b). The combined effect of simultaneous operation of Wells G & H and the Riley Production Well No. 2 (S46) has not been determined. Data collected during the EPA/USGS aquifer test is expected to establish the effect of combined withdrawal on the aquifer and will be presented in the USGS final aquifer test report.

Due to variations in depositional environment, the till and ice-contact deposits overlying the bedrock highlands vary areally and vertically in the inability to transport groundwater. As noted in Section 4.1, the till contains lenses of relatively well-sorted sand and gravel which may form preferred flow paths. These lenses may be able to transmit large volumes of groundwater to the Wells G & H aquifer area depending on the degree of interconnection between the relatively more permeable members of the unit.

The fine deposits in the valley (S80, S79, S77) are considerably less permeable than the coarse-grained glaciofluvial unit in which Wells G & H are screened and may tend to act as an aquitard. Water flowing to Wells G & H would more readily flow beneath this unit (aquitard) through the coarse sand and gravel that overlies the bedrock surface.

Overlying the glacial deposits within the valley flat are the alluvial and swamp deposits associated with the Aberjona River and surrounding wetlands (Section 4.1). Silty peat and sandy peat deposits are typically low in permeability with a reduced ability to transmit water. However, the variability of composition of the peat due to such factors as the reworking of the alluvial deposits by the meandering of the (Aberjona) river, the frequency and extent of flooding, as well as variation in vegetation may yield variable permeabilities in such units (Motts and Obrien, 1981).

4.3.3 Hydrogeology of Bedrock

As noted in Section 4.2, the bedrock underlying the Wells G & H aquifer area consists of crystalline igneous rocks. Rock of this type has virtually no ability to transmit water except through fractures. This ability to transmit water is largely dependent upon the extent of fracturing, including the size, orientation, and degree of interconnection of the fractures.

Wells intercepting systems of interconnected fractures are found throughout the Aberjona River Valley (Delaney and Gay, 1980). There is currently one bedrock well in use within the study area. It is located at New England Plastics Company approximately 750 feet due east of Well G and is indicated as well S41 on Plate 1. The well is 358 feet deep and has a reported yield of at 45 gallons per minute (Delaney and Gay, 1980).

An abandoned bedrock well located in the proximity of well S21, in West Cummings Park, was formerly used by the Johnson Bros., Inc. This well was 364 feet deep and was reported to yield 110 gallons per minute (Delaney and Gay, 1980).

This information suggests that the bedrock beneath the site is sufficiently fractured to support modest to moderate groundwater yields. This interpretation is further supported by bedrock coring collected by NUS/FIT during the installation of eighteen bedrock monitoring wells. The rock quality designations (RQDs) calculated for each core indicate that a high degree of fracturing in shallow bedrock is pervasive throughout the study area (Table 4-1). The fracturing detected in the upper bedrock suggests that recharge to the bedrock aquifer is derived at least in part from the overlying glacial deposits.