brook trout was found in 1992 (Pers. Comm., Kim Hughes, NBDOT, 1994).

## 4.4 Terrestrial Environment near Crane Mountain Site

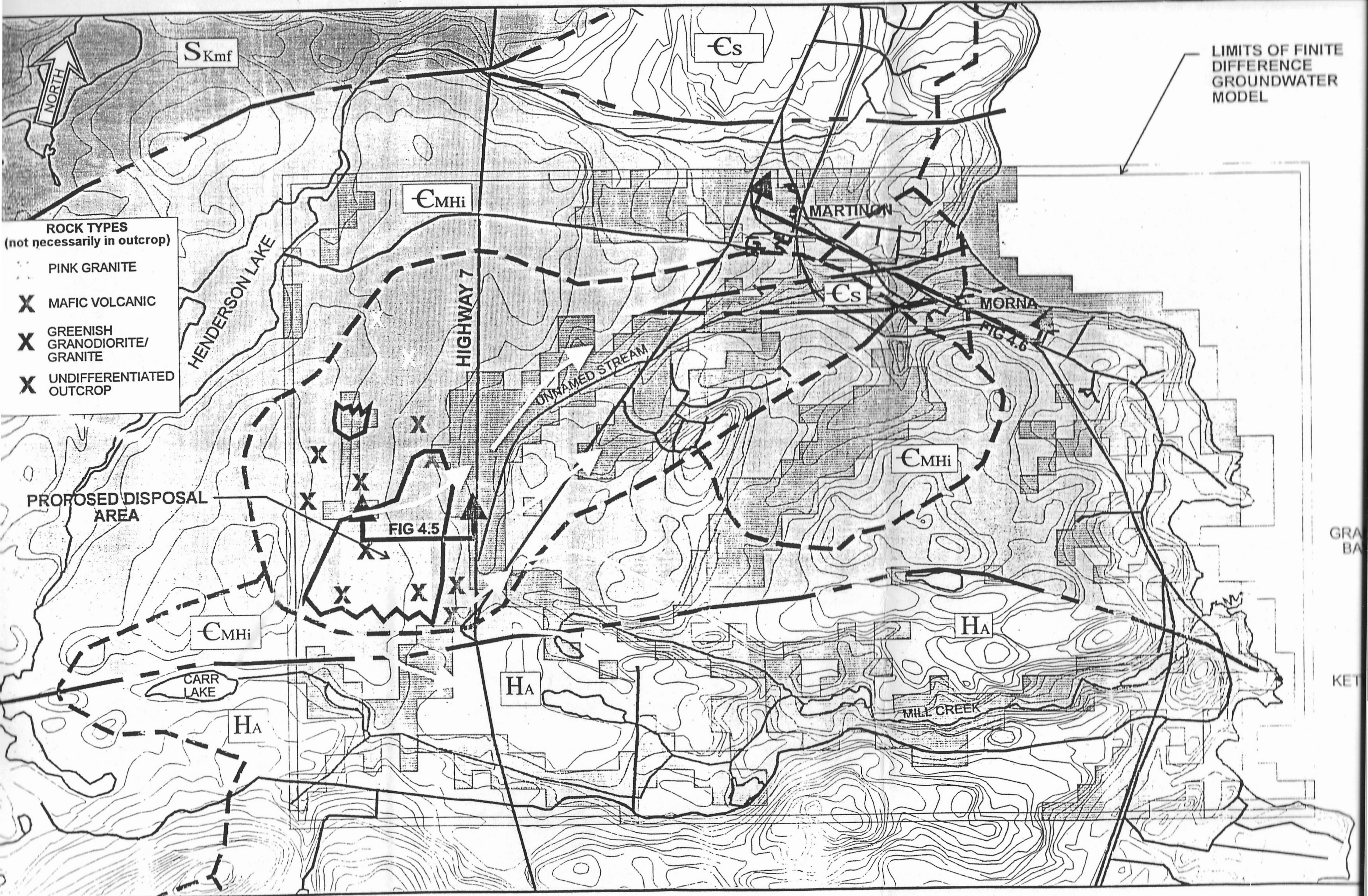
### 4.4.1 Geology and Soils

The surficial geology of southwestern New Brunswick has been mapped by Gadd (1973), and more recently, on a provincial scale, by Rampton *et al.* (1984). The investigated area has been mapped as a blanket of loamy lodgment till, minor ablation till, silt, sand, gravel, and rubble, with overburden thicknesses varying from 0.3 metres to in excess of three metres (Figure 4.4).

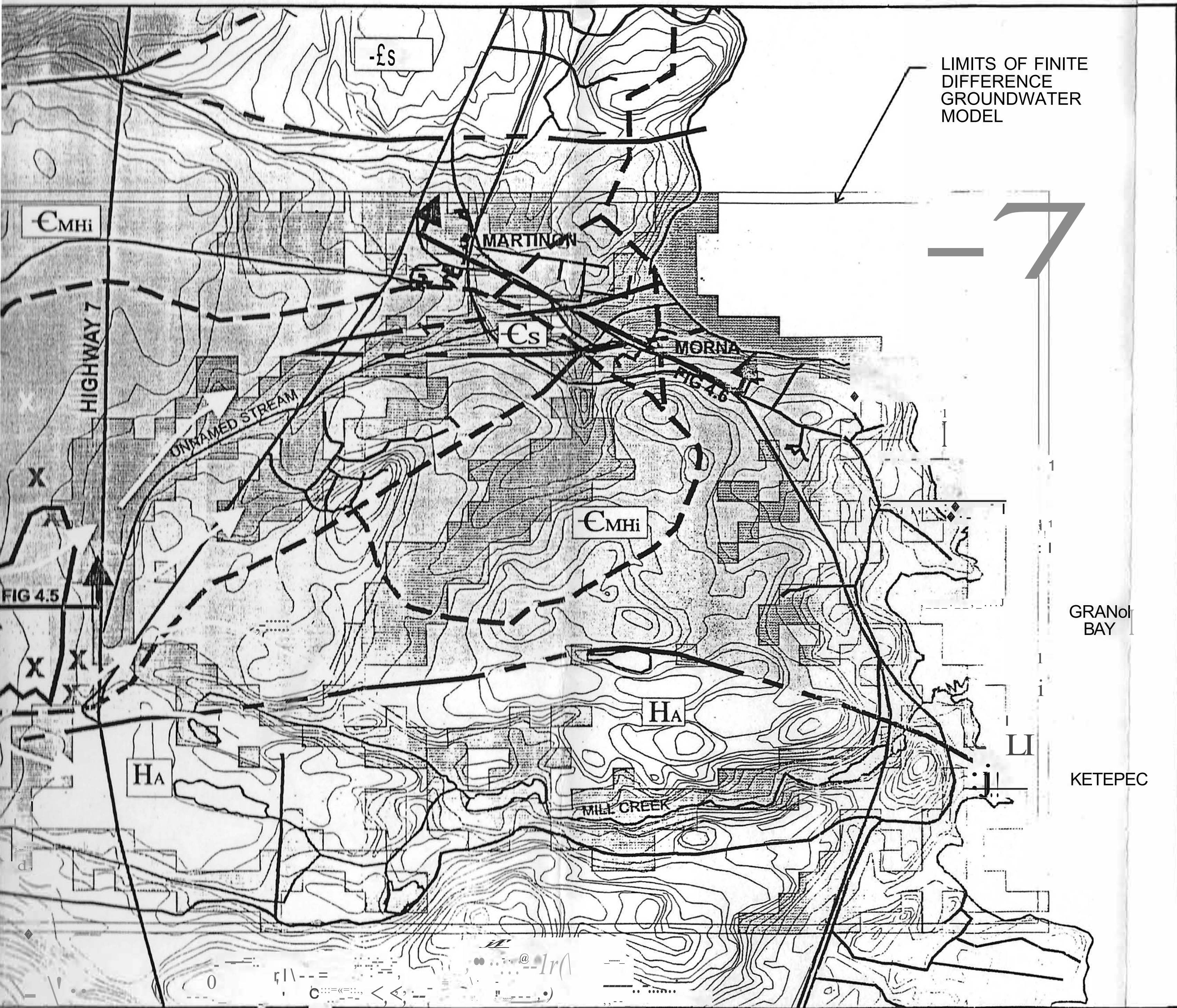
The borehole and test pit data broadly confirm the regional surficial geology picture. A thin root mat and layer of surface organics, locally thicker within the swampy area, overlay a cobble lag with some boulders. These cobbles mark the surface of the glacial till unit which in turn overlies bedrock. At higher elevations on the site, sands and gravels with some silt rest directly on bedrock.

A typical interpreted subsurface cross-section, showing the distribution of various soils on this site, is presented in Figure 4.5, reproduced directly from the Detailed Site Investigation Report (GEMTEC Limited, 1993e). The location of the cross-section is shown on a key map in the top right-hand corner of this figure and also on the hydrogeological plan (Figure 4.4).

From the cross-section it is evident that the principal soil unit is the deposit of silty lodgement glacial till which rests directly on bedrock. The till thickness ranged from 1.2 metres at borehole BH15 to 13.9 metres at BH23. The upper part of the unit (0.6 to 2.4 metres



NORTH
SKmf
€s
LIMITS OF FINITE DIFFERENCE GROUNDWATER MODEL
€MHi
MARTINON
ROCK TYPES
(not necessarily in outcrop)
PINK GRANITE
MAFIC VOLCANIC
GREENISH GRANODIORITE/ GRANITE
UNDIFFERENTIATED OUTCROP
HENDERSON LAKE
HIGHWAY 7
€s
MORNA
FIG 4.6
UNNAMED STREAM
€MHi
PROPOSED DISPOSAL AREA
FIG 4.5
€MHi
HA
CARR LAKE
HA
HA
HA
MILL CREEK




***LEGEND:***

CROSS SECTION LINE

SOLID GEOLOGY

GEOLOGICAL CONTACT

SKmf — Silurian, KINGSTON DYKE COMPLEX Felsic and Mafic Dykes

Cambrian, MILKISH HEAD PLUTON Grey to pink granitoids

1-£s1 — Cambrian conglomerate and sandstone

Helildan, GREEN HEAD GROUP (ASHBURN LAKE FORMATION) marble, orthoquartzite, sandstone, marble quartzite, conglomerate

*S 0 2 1*

SOIL COVER EXCEEDS Sm IN THICKNESS

**GROUNDWATER:**

DRAINAGE DIVIDE

GROUNDWATER FLOW DIRECTION: see figures 4.7 and 4.8

DISCHARGE AREAS

GEMTEC,Ma
GROUNDENGINEEAING & MATEFUALS TECHNOLOGY

PROJECT
ENVIRONMENTAL IMPACT ASSESSMENT FOR THE FUNDY REGION

DRAWING
HYDROGEOLOGICAL PLAN CRANE MOUNTAIN

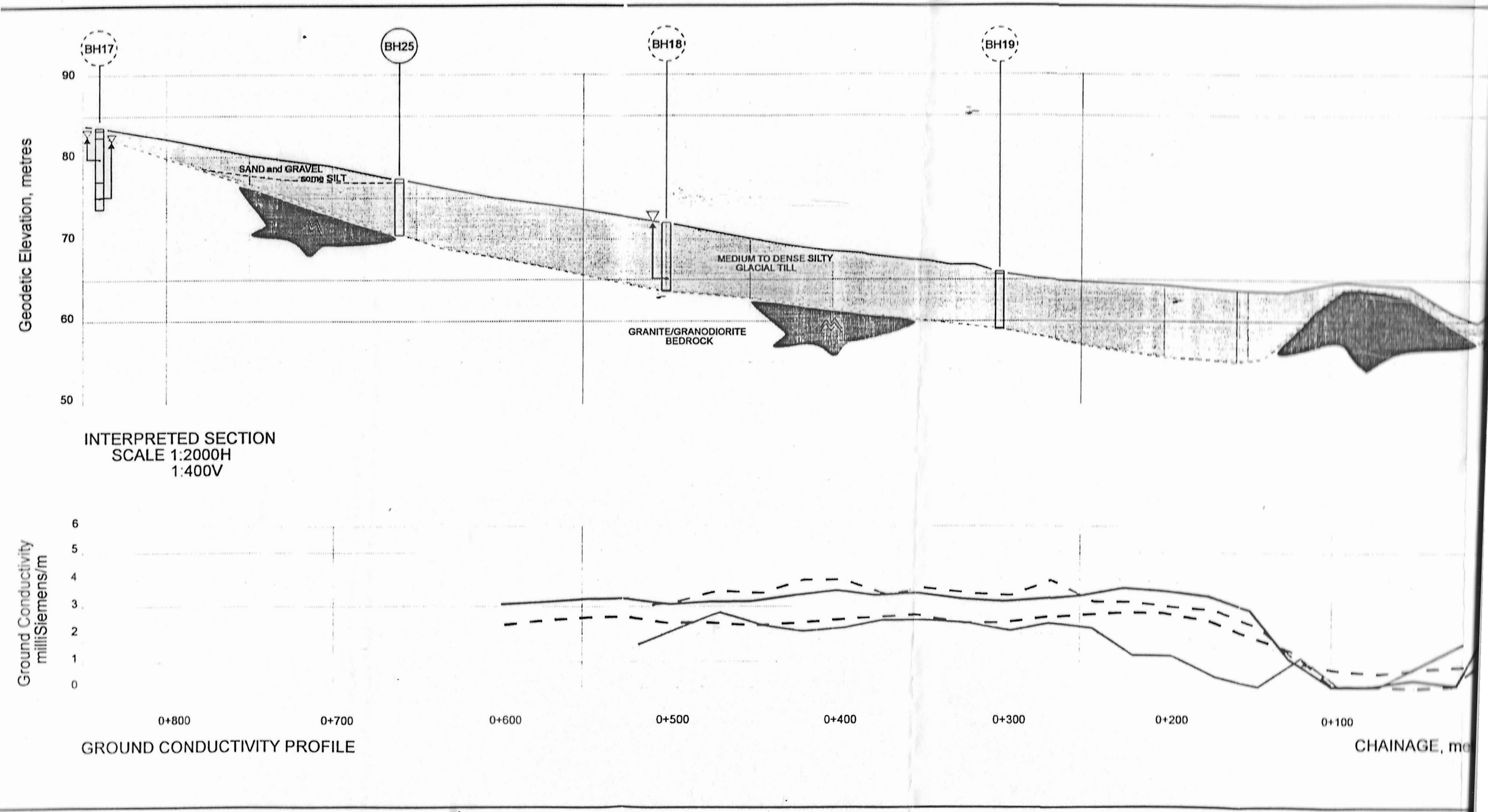
| SCALE | |
|---|---|
| 1:20000 | 250 500 750 1000 |
| PROJ. NO. 20221.21 | DWG. NO. FIGURE 4.4 |
| DATE OCTOBER, 1994 | DRN. BY CGII |

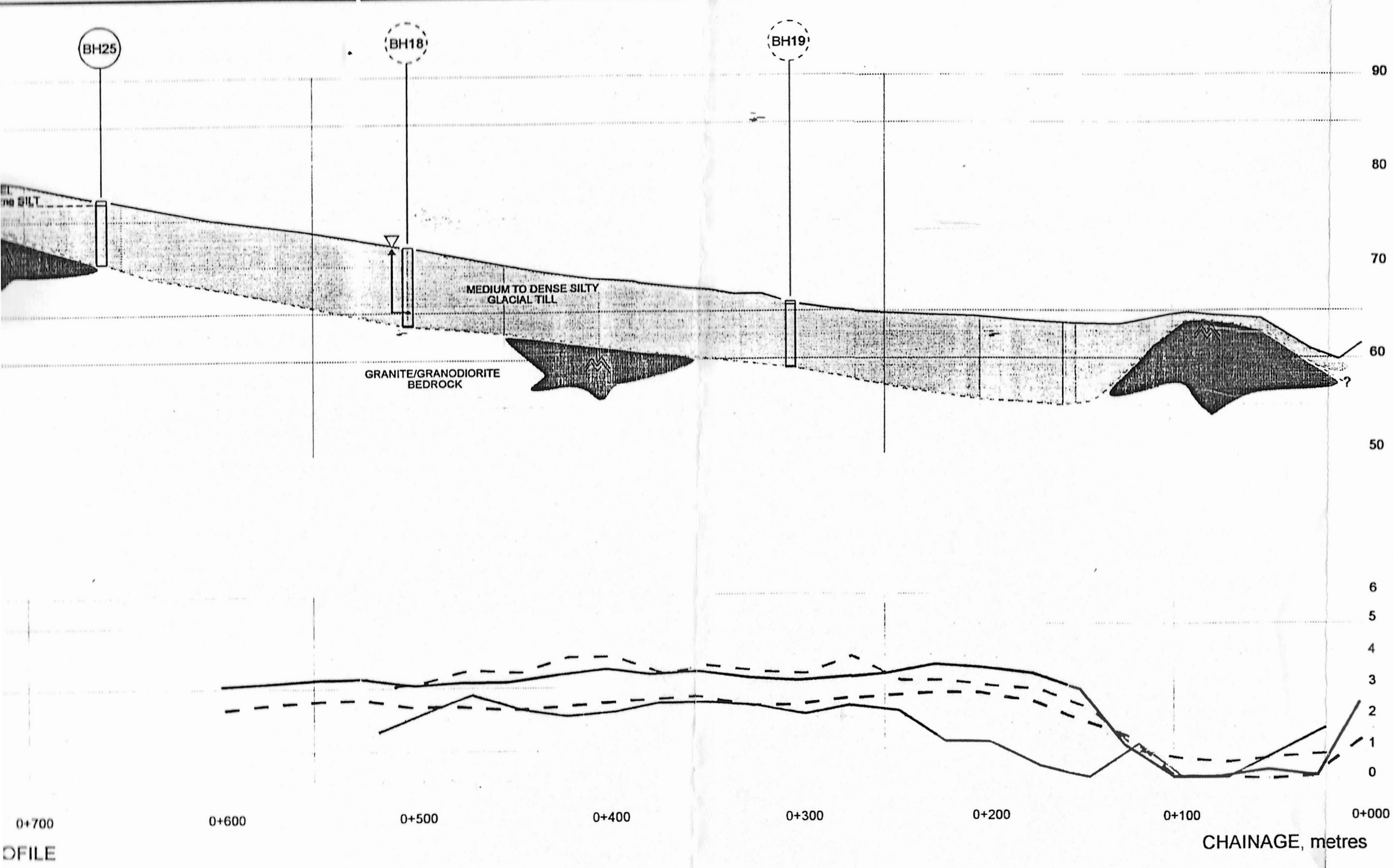
depth) is medium dense with Standard Penetration Test "N" values ranging from 10 to 30 blows per 300 mm. Below this depth, the till is dense to very dense with N values commonly exceeding 50 blows per 300 mm.

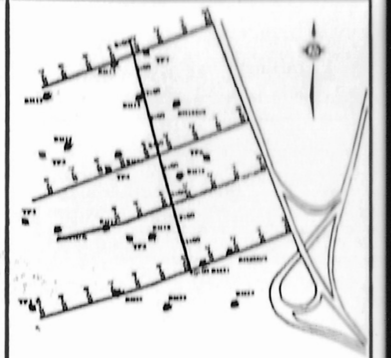
Both the medium dense and dense glacial till soils comprise a well-graded mixture of silt, sand and gravel with some clay and a few cobbles and boulders. The combined silt and clay fractions varied from 30.6 percent in a sample from borehole BH12 to 51.5 percent in a sample from BH18. The average silt and clay size was 37.3 percent. From the hydrometer data, up to 16 percent by weight proved to be finer than the 0.002 mm clay size. The natural moisture content of the till ranged from 5.9 to 13.7 percent, and averaged 8.7 percent. These values compare with typical liquid and plastic limits of 18 and 13 percent respectively. The plasticity index varied from 1.5 to 8.2 percent, and averaged 4.2 percent, which is relatively low. On this basis, the till would be classified as a silty sand with low plasticity fines.

The maximum dry density of samples of recompacted glacial till varied from 2,085 to 2,125 kg/m$^3$ at an optimum moisture content of 8.5 to 9.7 percent. The hydraulic conductivity of three composite samples of the till varied from 2.9 to $10^{-10}$ m/s to 4.5 x $10^{-10}$ m/s.

The overall average hydraulic conductivity of the reconstituted samples was 3.7 x $10^{-10}$ m/s, which is considered very low. Field-scale permeability is probably controlled by the presence of cracks or fissures within the till, and as such, may be considerably higher than that applicable to the remolded samples. The mean of three in situ hydraulic conductivity tests carried out in the glacial till was


BH17
BH25
BH18
BH19
90
80
70
60
50
Geodetic Elevation, metres
SAND and GRAVEL
some SILT
MEDIUM TO DENSE SILTY
GLACIAL TILL
GRANITE/GRANODIORITE
BEDROCK
INTERPRETED SECTION
SCALE 1:2000H
1:400V
6
5
4
3
2
1
0
Ground Conductivity
milliSiemens/m
0+800
0+700
0+600
0+500
0+400
0+300
0+200
0+100
GROUND CONDUCTIVITY PROFILE
CHAINAGE, m



KEY PLAN
NTS

LEGEND:

| | |
| --- | --- |
| (BH25) | Borehole on or close to line |
| (BH19) dashed | Borehole offset from line |

GROUND CONDUCTIVITY

| | | Approx. Penetration (metres) |
| --- | --- | --- |
| EM31H | dashed | 3 |
| EM31V | solid | 6 |
| EM34H | dashed | 30 |
| EM34V | solid | 60 |

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PROJECT
ENVIRONMENTAL IMPACT ASSESSMENT FOR THE FUNDY REGION

DRAWING
INTERPRETED SECTION and GROUND CONDUCTIVITY PROFILE CRANE MOUNTAIN SITE LINE 2

| | |
| --- | --- |
| SCALE: AS SHOWN | DATE: JULY, 1994 |
| PROJ. NO.: 20221.21 | DWG. NO.: FIGURE 4.5 |
| DRN. BY: SAF | CHKD. BY: GRED |

$2.0 \times 10^{-7}$ m/s. The remolded till is considered a good material for use as a liner or for final cover material. It could be utilized for daily cover but only in the summer months. When wet or frozen conditions prevail, cleaner granular material will most probably be required for daily cover.

The stratigraphy, petrology and structural geology of this region are described in some detail in a report by Ruitenberg *et al.* (1979). The general area is referred to stratigraphically as the western intrusive belt. The site is underlain by the Cambrian Age Milkish Head Pluton, which forms a band approximately 2.2 kilometres wide underlying Grand Bay, Morna, Belmont and a portion of Ketepec. The unit extends southwestward, and its southern edge lies at the northern edge of Carr and Patchell Lakes, as shown in Figure 4.4. The rock types include gray medium-grained quartz diorite and tonalite, gradational to pink coarse grained biotite-hornblende granodiorite.

The pluton is located in what is described as the Kennebecasis deformed zone, but being somewhat younger, these rocks are less deformed than are the surrounding volcanics.

Immediately south of the Milkish Head granitoid rocks are the metasediments of the Cambrian to Pre-Cambrian Age Ashburn Lake Formation. These rocks comprise bluish gray marble, white orthoquartzite, minor sandstone and marble-quartzite conglomerate. This bedrock underlies Acamac, the majority of the Mill Creek drainage system, and the southern portion of Ketepec.

A small wedge of Cambrian Age sedimentary rocks comprising polymictic conglomerate and sandstone occur beneath the area occupied by the unnamed brook which joins the Saint John River at Martinon Beach. At the river, this sedimentary unit is at its maximum width of 200 metres, but it pinches out to nothing at Route 177. Figure 4.6 is an interpreted subsurface section from Martinon to Morna showing the probable location of the sedimentary unit and the associated depression in the bedrock surface, which is now infilled with silt and clay overburden.

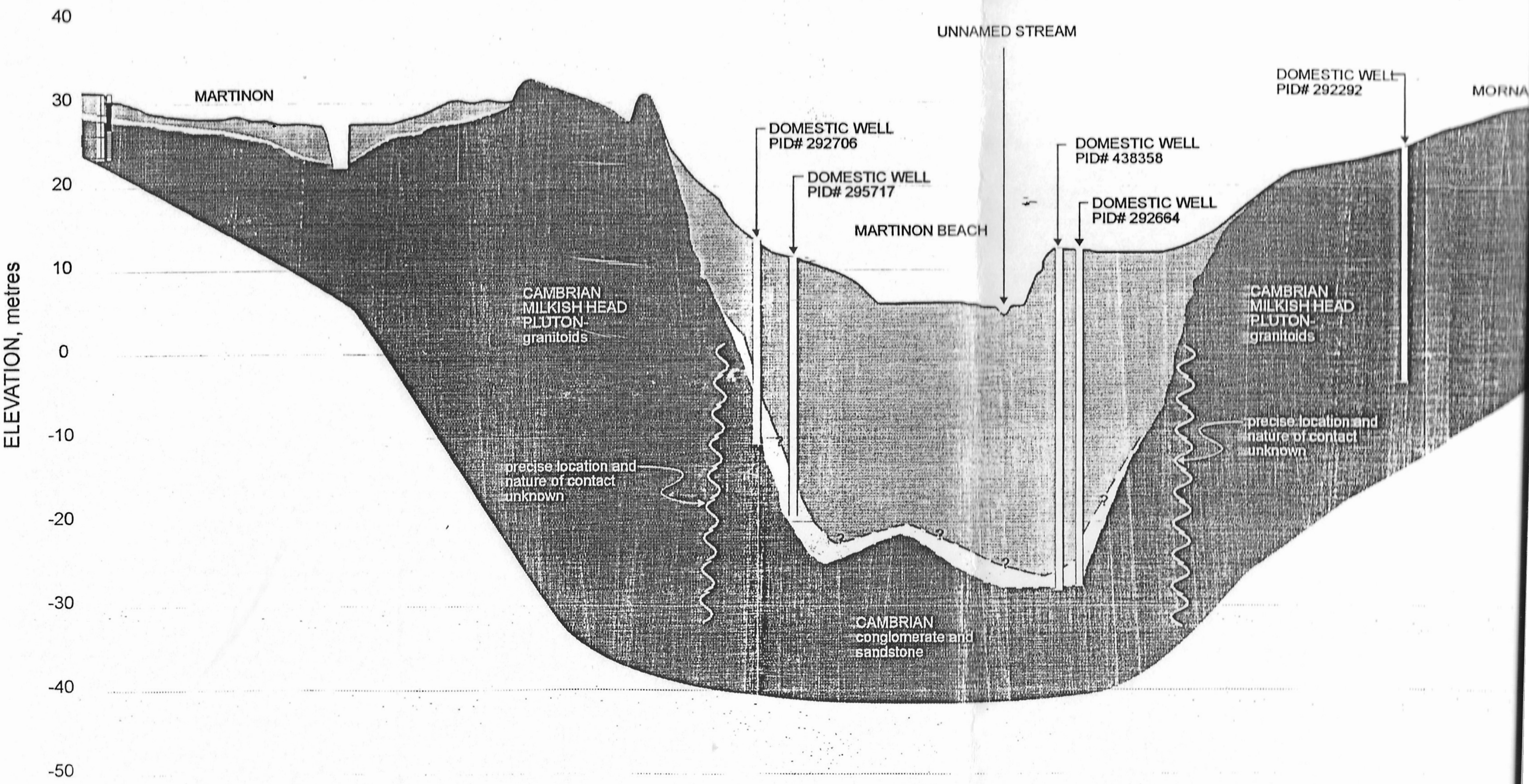
Bedrock was proven at three borehole locations (BH16 D/S (deep and shallow), BH17 D/S and BH22 D/S) by rock coring. At BH16S the bedrock here proved to be a green to black, fine grained mafic volcanic or metasediment. This rock was highly fractured with a typical fracture spacing of 10 to 100 mm and an associated RQD[1] of 0 to 25 percent. Minor pyrite and thin calcite veins were present at depths of below 16.8 metres.

At BH17D the bedrock was a medium to coarse grained granite/granodiorite and included a diabase dike. The rock has numerous fractures spaced at 30 to 400 mm, and even more highly broken zones which were up to 150 mm thick. The RQD varied from zero to 60 percent.

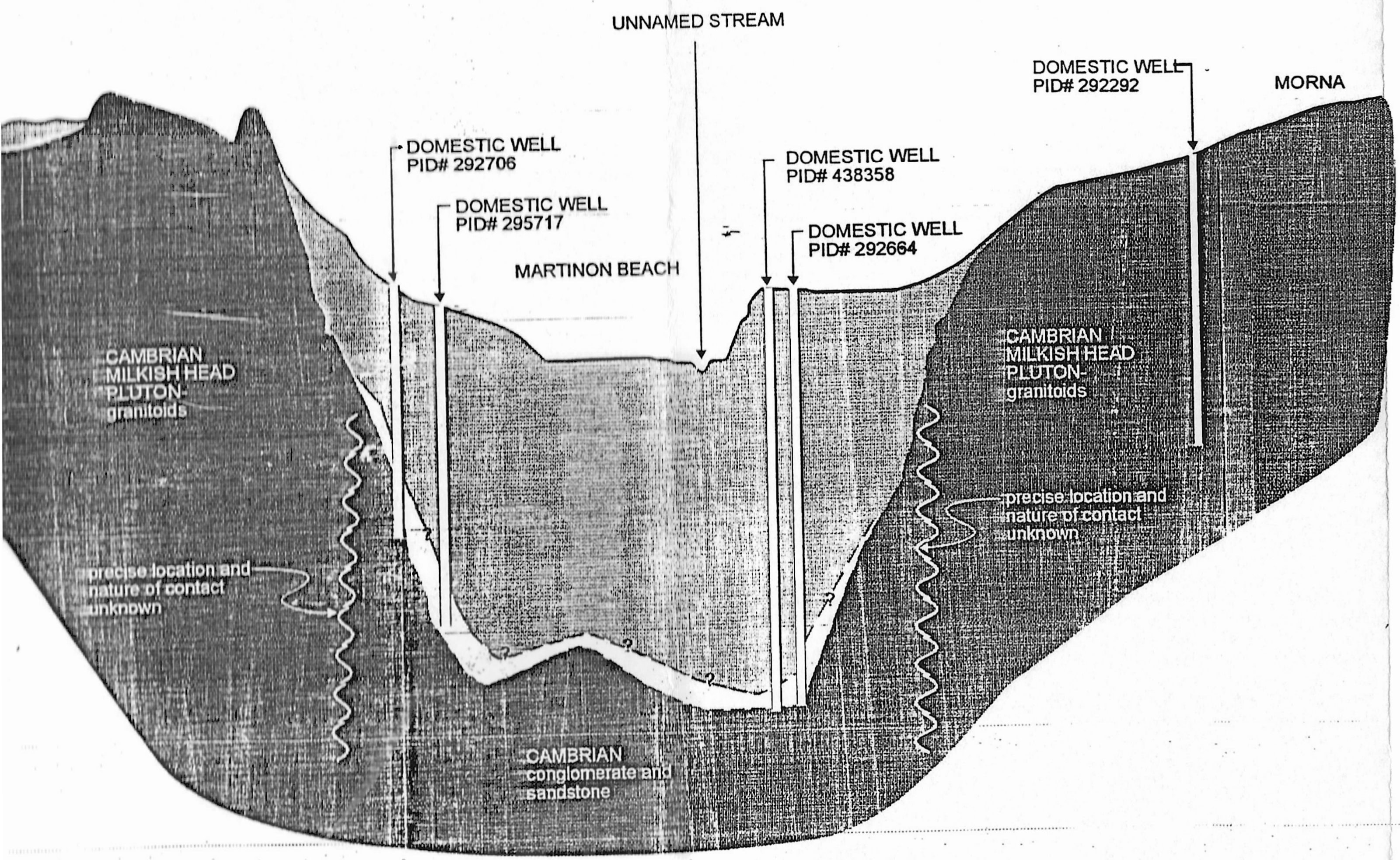
At borehole BH22D, rock was a fine to medium-grained diorite with minor granodiorite and gabbro. The fracture spacing varied from 5

---

1 RQD - Rock Quality Designation - The percentage of drilled rock core recovered in lengths of 100 mm or greater.



40
30
20
10
0
-10
-20
-30
-40
-50
ELEVATION, metres
MARTINON
UNNAMED STREAM
DOMESTIC WELL
PID# 292706
DOMESTIC WELL
PID# 295717
MARTINON BEACH
DOMESTIC WELL
PID# 438358
DOMESTIC WELL
PID# 292664
DOMESTIC WELL
PID# 292292
MORNA
CAMBRIAN
MILKISH HEAD
PLUTON-
granitoids
CAMBRIAN
MILKISH HEAD
PLUTON-
granitoids
precise location and
nature of contact
unknown
precise location and
nature of contact
unknown
CAMBRIAN
conglomerate and
sandstone




*LEGEND*

- SILT/CLAY
- SAND & GRAVEL
- BEDROCK

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PROJECT
ENVIRONMENTAL IMPACT ASSESSMENT FOR THE FUNDY REGION

DRAWING
INTERPRETED SUBSURFACE SECTION MARTINON TO MORNA

| | |
|---|---|
| SCALE 1:5000H 1:500V | DATE AUGUST, 1994 |
| PROJ. NO. 20221.21 | DWG. NO. FIGURE 4.6 |
| DRN. BY SAF | CHKD. BY NET |

to 300 mm with abundant small shear zones of up to 300 mm in width. The RQD ranged from zero to 30 percent.

Although a number of fracture zones have been identified in boreholes drilled at this site, and no doubt occur elsewhere in the area proposed for development, there is no reason to believe that major structural discontinuities within the bedrock which might affect the proposed landfill, are present. Both the structural mapping by others, and the ground conductivity traverses carried out as part of the detailed site investigation work, support this conclusion.

### 4.4.2 Hydrogeology

The Crane Mountain site is located on relatively high ground at the upper end of the small drainage basin of the unnamed stream. As such, recharge conditions characterized by downward components of groundwater flow were expected to prevail, and indeed were confirmed by the potentiometric data obtained during detailed site investigation. Supplementary water levels were obtained as part of the EIA process, these data being presented with the previously obtained information in Appendix E. It was concluded that although a downward component of flow occurs within the bedrock, the hydraulic gradient between upper and lower surfaces of the glacial till was very low. The in situ hydraulic conductivities, K, of the various soil and bedrock units are summarized in Table 4-6. The geometric means of the K values were $2.0 \times 10^{-7}$ m/s for the till and $1.3 \times 10^{-6}$ m/s for the bedrock.

In view of the presence of downgradient receptors, these being residential wells located primarily along the shore of Grand Bay, it was resolved that a more detailed assessment of the regional flow system be made for EIA purposes. A numerical finite-difference groundwater flow model, MODFLOW, was therefore compiled for the 3.5 x 5.5 square kilometre area identified in Figure 4.4.

The computational results are sensitive to the assumptions made concerning the boundary conditions and the hydraulic conductivities of the rock units. In order to be conservative, that is to say to produce a "worst case" simulation, the presence of the relatively low permeability glacial till soil was ignored. The hydraulic conductivity of the bedrock was then adjusted such that the recharge required so as to be compatible with the boundary conditions, would be of reasonable magnitude.

From field observation, it was noted that the potentiometric head within the bedrock in this area is typically at or close to the ground surface. As a boundary condition, the water levels in the uppermost cells of the model were therefore set as being equal to the ground surface. The model then calculates how much water must be added (by infiltration) or removed (by discharge) so as to achieve this condition. The inflow through the model is then compared with the amount of water which typically enters the ground, this being a fraction of and certainly no more than the precipitation less evapotranspiration. If one were to increase the assumed bulk K value by a factor of 10, the amount of water entering the model would increase proportionately.

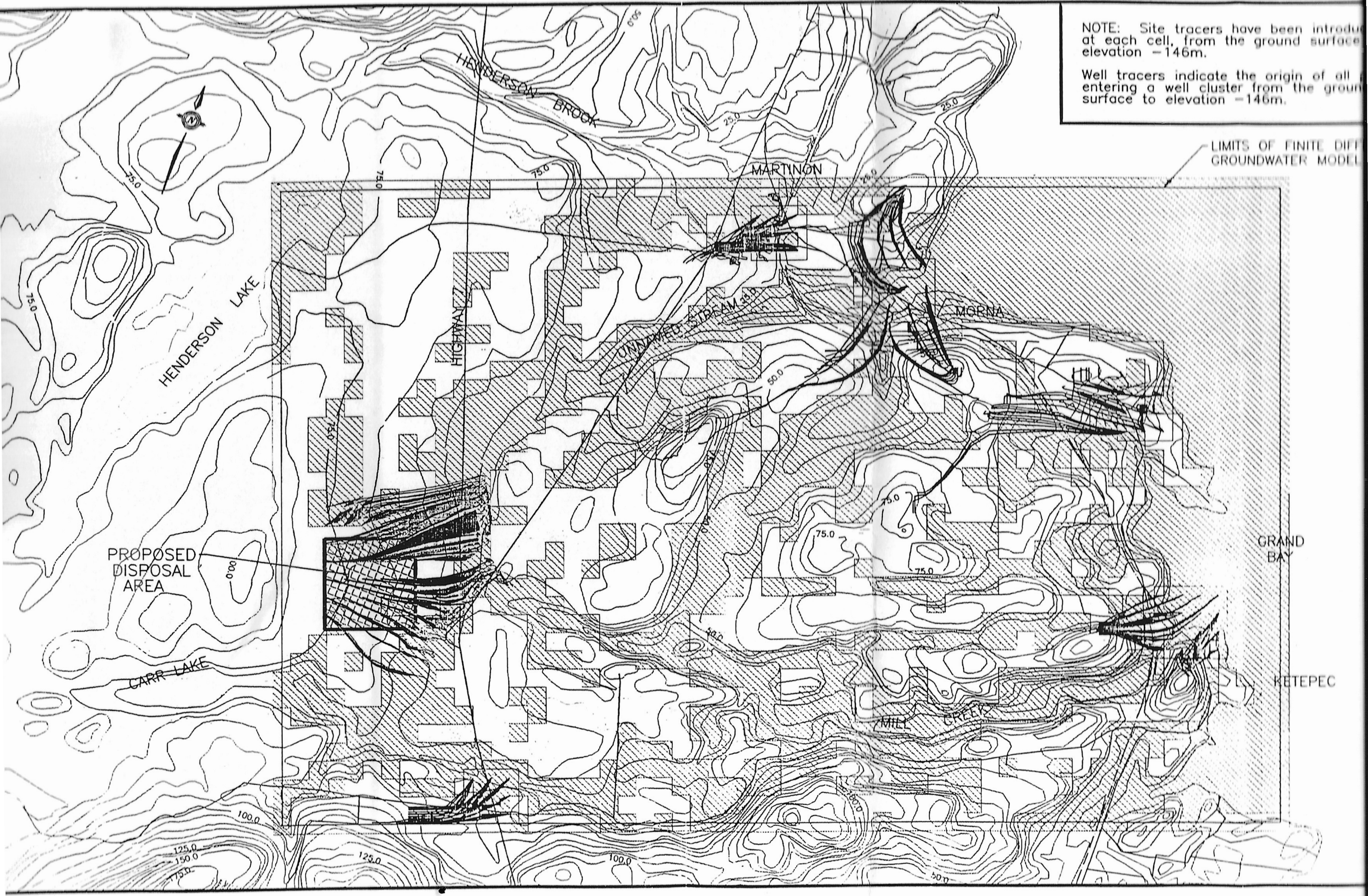
Table 4-6

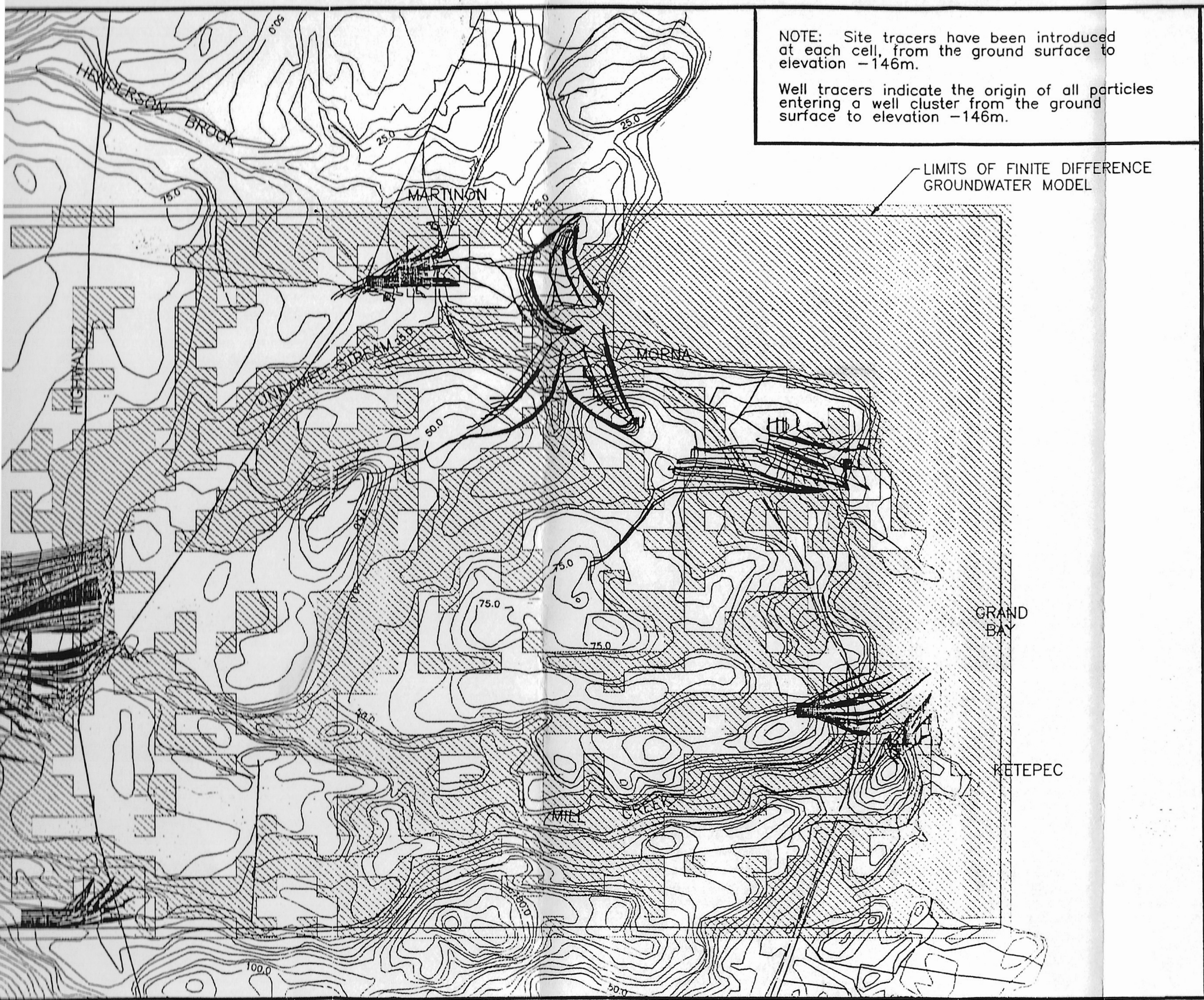
Hydraulic Conductivity Data - Crane Mountain Site

| Borehole | Site | Hydraulic Conductivity m/s | Stratum | Type | Date |
|---|---|---|---|---|---|
| BH15 | Crane Mountain | 2.6E-07 | Overburden | Sand+gravel/till | June, 1994 |
| BH16S | Crane Mountain | 2.4E-06 | Bedrock | Metasediment ? | June, 1994 |
| BH16D | Crane Mountain | 2.4E-06 | Bedrock | Metasediment ? | November, 1993 |
| BH17S | Crane Mountain | 8.6E-07 | Bedrock | Granite/granodiorite | November 1993 |
| BH17D | Crane Mountain | 5.6E-06 | Bedrock | Granodiorite | November, 1993 |
| BH17S | Crane Mountain | 1.2E-05 | Bedrock | Granite/granodiorite | July, 1994 |
| BH18 | Crane Mountain | 3.4E-07 | Overburden | Glacial till | June, 1994 |
| BH22S | Crane Mountain | 2.5E-08 | Bedrock | Granite | June, 1994 |
| BH22D | Crane Mountain | 7.9E-07 | Bedrock | Granite | June, 1994 |
| BH23S | Crane Mountain | 8.8E-08 | Overburden | Glacial till | June, 1994 |

| | |
|---|---|
| Minimum | 2.5E-08 m/s |
| Maximum | 1.2E-05 m/s |
| Geometric Mean - Overburden | 2.0E-07 m/s |
| Geometric Mean - Bedrock | 1.3E-06 m/s |

Figures 4.7 and 4.8 show the modelling results for two simplifying assumptions as to the hydraulic conductivities of the bedrock. In Figure 4.7, the vertical and horizontal hydraulic conductivities are assumed equal (isotropic conditions). Recharge and discharge areas are identified under these conditions and a number of flow path lines have been generated to reveal both the nature of


NOTE: Site tracers have been introdu
at each cell, from the ground surface
elevation −146m.
Well tracers indicate the origin of all
entering a well cluster from the groun
surface to elevation −146m.
LIMITS OF FINITE DIFF
GROUNDWATER MODEL
HENDERSON BROOK
HENDERSON LAKE
HIGHWAY 7
UNNAMED STREAM
MARTINON
MORNA
PROPOSED
DISPOSAL
AREA
CARR LAKE
GRAND
BAY
KETEPEC
MILL CREEK
75.0
50.0
25.0
100.0
125.0
150.0




NOTE: Site tracers have been introduced at each cell, from the ground surface to elevation −146m.

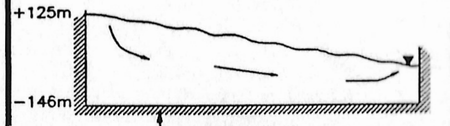
Well tracers indicate the origin of all particles entering a well cluster from the ground surface to elevation −146m.

***LEGEND***

- 75.0 — CONTOUR, metres
- DISCHARGE AREA
- WELL TRACERS
- SITE TRACERS ORIGINATING WITHIN 10m OF GROUND SURFACE
- SITE TRACERS ORIGINATING BELOW 10m OF GROUND SURFACE
- LANDFILL FOOTPRINT
- WELL CLUSTER

ASSUMPTIONS:

- WATER TABLE IS LOCATED AT THE GROUND SURFACE
- Kh=Kv
- 100 x 100m FINITE DIFFERENCE GRID
- 35 LAYERS

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PROJECT

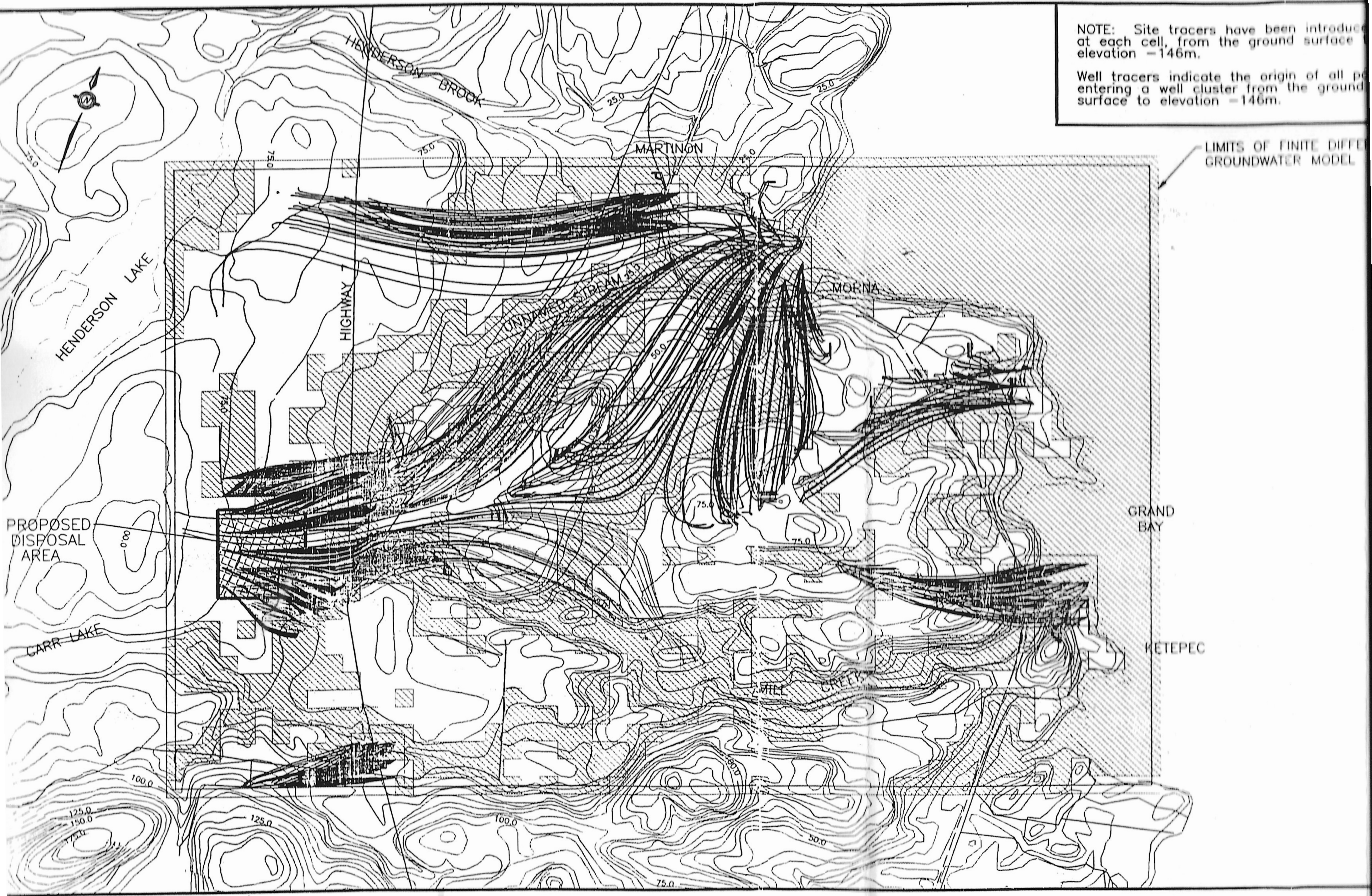
ENVIRONMENTAL IMPACT ASSESSMENT FOR THE FUNDY REGION

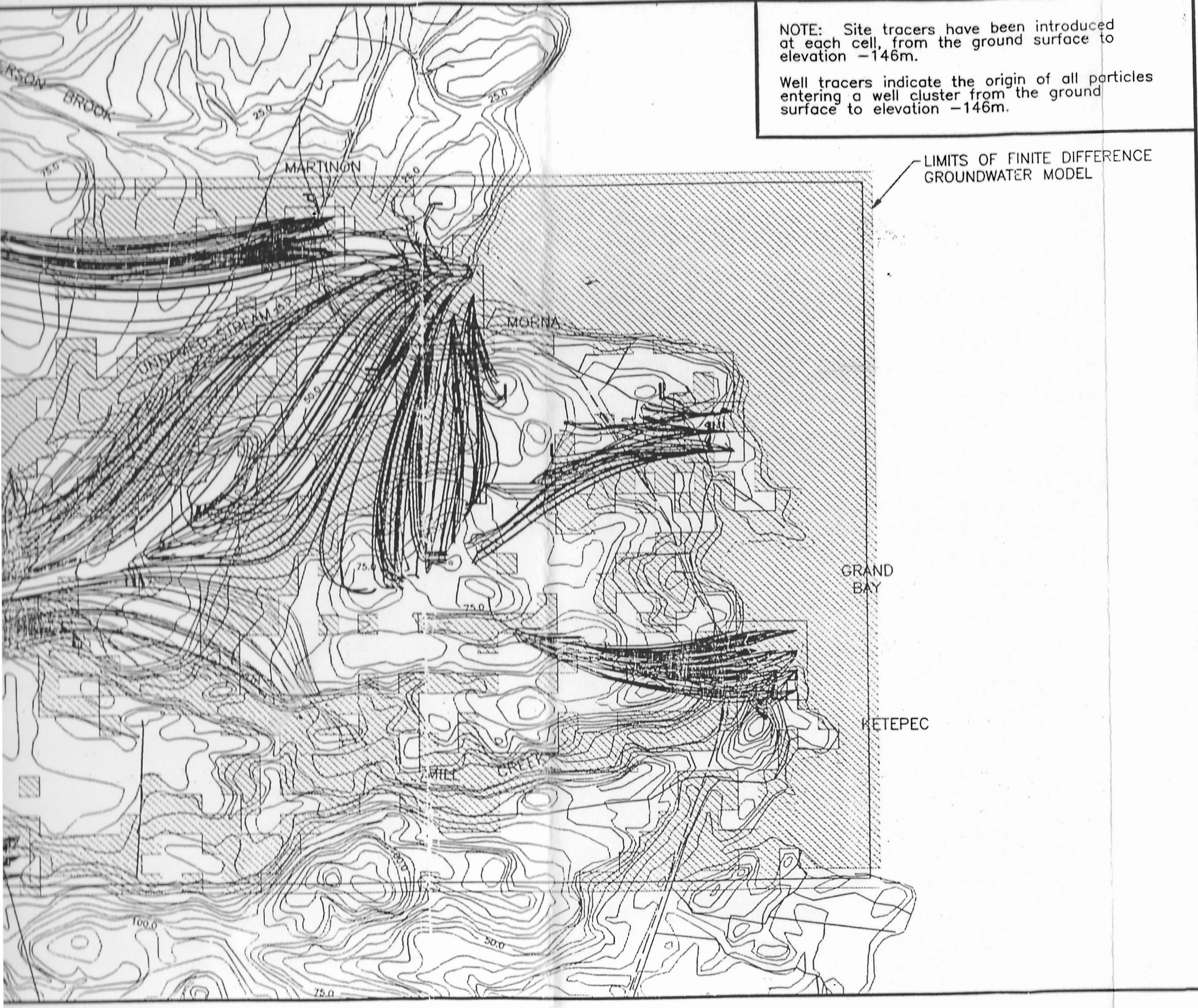
DRAWING

GROUNDWATER FLOW MODELLING CRANE MOUNTAIN – CASE 1

SCALE 1:20 000
0 500 1000m

| PROJ.No. | DWG.No. |
| --- | --- |
| 20221.21 | FIGURE 4.7 |
| DATE | DRN.BY |
| OCTOBER 1994 | CGH |


NOTE: Site tracers have been introduc
at each cell, from the ground surface
elevation −146m.
Well tracers indicate the origin of all p
entering a well cluster from the ground
surface to elevation −146m.
LIMITS OF FINITE DIFFE
GROUNDWATER MODEL
HENDERSON BROOK
MARTINON
HENDERSON LAKE
HIGHWAY
MORNA
GRAND BAY
PROPOSED DISPOSAL AREA
CARR LAKE
KETEPEC
MILL CREEK
25.0
50.0
75.0
100.0
125.0
150.0

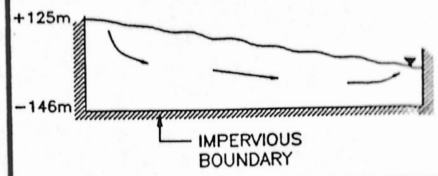



**LEGEND**

| | |
|---|---|
| 75.0 | CONTOUR, metres |
| | DISCHARGE AREA |
| | WELL TRACERS |
| | SITE TRACERS ORIGINATING WITHIN 10m OF GROUND SURFACE |
| | SITE TRACERS ORIGINATING BELOW 10m OF GROUND SURFACE |
| | LANDFILL FOOTPRINT |
| | WELL CLUSTER |

ASSUMPTIONS:

- WATER TABLE IS LOCATED AT THE GROUND SURFACE
- Kh/Kv=10
- 100 x 100m FINITE DIFFERENCE GRID
- 35 LAYERS




GEMTEC LIMITED
GROUND ENGINEERING & MATERIALS TECHNOLOGY

PROJECT
ENVIRONMENTAL IMPACT ASSESSMENT FOR THE FUNDY REGION

DRAWING
GROUNDWATER FLOW MODELLING CRANE MOUNTAIN − CASE 2

SCALE 1:20 000
0 500 1000m

| PROJ.No. | DWG.No. |
|---|---|
| 20221.21 | FIGURE 4.8 |
| DATE | DRN.BY |
| OCTOBER 1994 | CGH |

groundwater flow from the proposed site and also that of the flow occurring to each of a series of existing domestic wells selectively placed in the inhabited parts of the downgradient area. The analysis reveals that groundwater infiltrating into the bedrock beneath the site crosses Route 7 and then flows upwards to discharge into the unnamed brook. The contributing areas to each of the well clusters are also relatively small, that is to say the wells receive recharge from the local rather than regional groundwater system.

In Figure 4.8, the ratio of horizontal to vertical hydraulic conductivity of the rock, $K_H/K_v$, has been increased to 10. Using this assumption, a different picture emerges as to the distribution of discharge and recharge areas, with a greater proportion of the map area being under recharge conditions than occurs in the isotropic case. The path lines for both the groundwater and water leaving the landfill site and that water which eventually reaches the individual wells are considerably longer. Most of the groundwater originating beneath the site flows to the east and northeast in a broad band which discharges either to the unnamed stream or to the upper reaches of Mill Creek.

Groundwater flow in the bedrock is in practice controlled by a network of fractures and as such the actual groundwater flow patterns are likely to be more complex than those presented above. Nevertheless, the model can be utilized to simulate the effects of an inadvertent release of contaminant at the site on downgradient wells, an issue discussed at greater length in **Section 6.**

In the area from Martinon to South Bay there are approximately 900 private residences and commercial buildings which are serviced by individual wells and sewerage systems. Of these, 100 or so private residences are located within the un-named watershed, while 23 occur within the Mill Creek drainage basin. One of the homes within the Mill Creek watershed is located on the Acamac Backlands Road, on the west side of Route 7, approximately 1,200 metres south of the proposed site. It is believed that the well servicing this multi-family dwelling is developed in bedrock to a depth of 134 metres.

Within the un-named watershed (Martinon, Martinon Beach) residents derive their water supplies from wells drilled into both bedrock and the granular overburden. The majority of homes are supplied from wells developed in the granitoid bedrock of the Milkish Head Pluton. A lesser number of wells extract water from a sand and gravel unit located at the base of a clay layer which has infilled the un-named brook valley in the vicinity of Mellinger Road (Old Route 2), as shown earlier in Figure 4.6. With the exception of this stream valley, bedrock occurs within a few metres of or is exposed on surface within this watershed.

A review of the water well records data base developed by the New Brunswick Department of the Environment and conversations with water well drillers from the Saint John area have identified well depths and yields from about thirty residences in the Martinon and Martinon Beach areas. Well depths in the granitoid bedrock average approximately 140 metres and typical yields are 5 to 15 L/m (1-3 igpm). The domestic wells along Mellinger Road and Martinon Beach extract water from the gravel unit at depths of between 30 to 100 metres. The yields are reportedly similar to those developed in the bedrock.

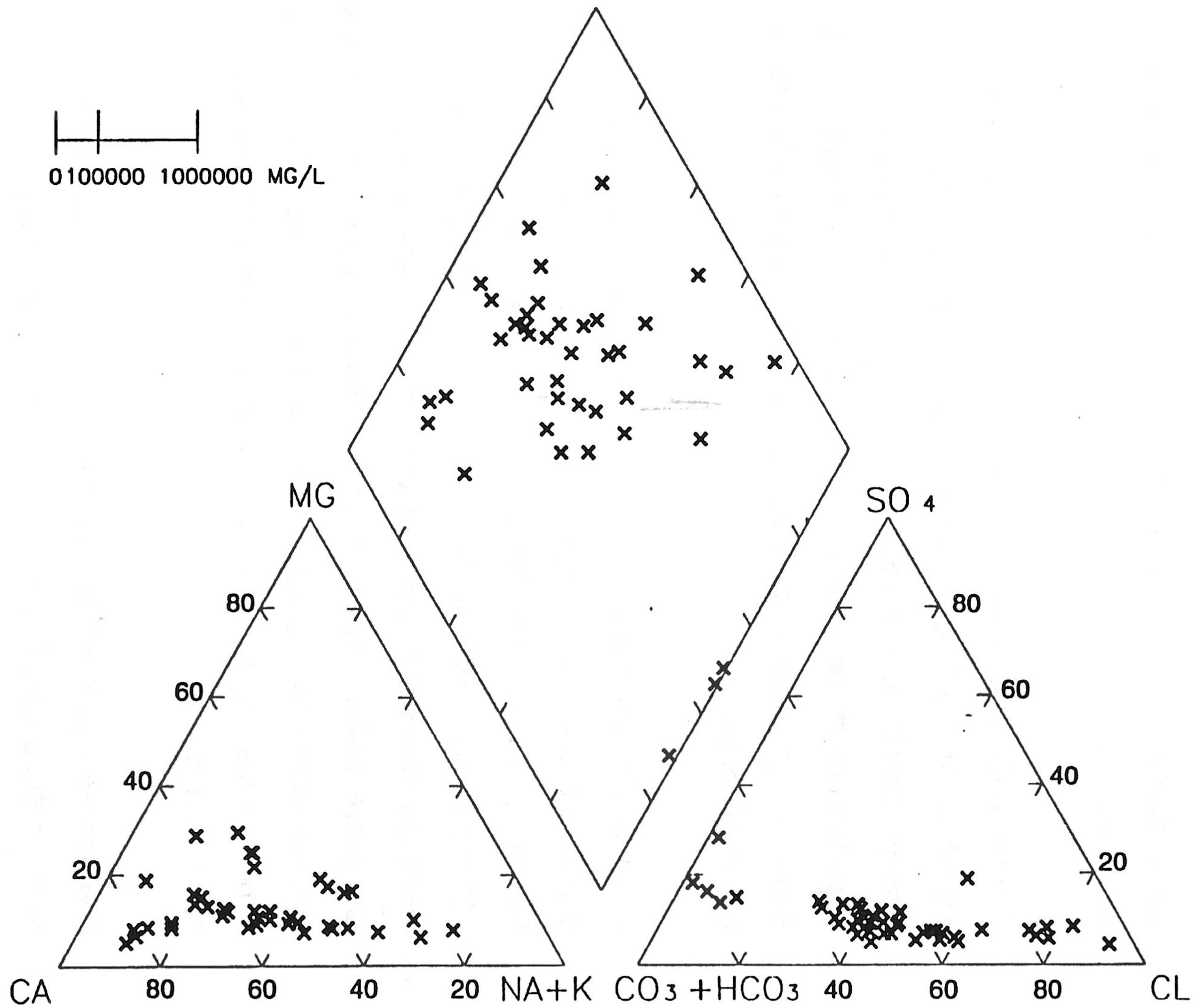
The communities of Morna, Morna Heights and Belmont are outside the un-named brook and Mill Creek watersheds. In Morna and Morna Heights, the granitoid bedrock is reportedly difficult to drill and well depths vary from as little 20 metres to as much as 100 metres. Reported yields are typically 5-15 L/m (1-3 igpm). Although the same Milkish Head Pluton bedrock underlies the Belmont area and is commonly exposed at surface, the rock is apparently easier to drill. Yields of 5 to 15 L/m (1-3 igpm) are typically obtained from wells drilled an average depth of 30 metres.

The Mill Creek watershed encompasses substantially all of the northern and southern portions of Ketepec Road that straddle Red Bridge Lake. The contact between the Milkish Head granitoid rocks to the north and the limestones and quartzites of the Ashburn Lake Formation to the south traverses Red Bridge Lake on an east-west axis between the two segments of Ketepec Road. Wells completed on the north side of the geological contact within the granitoids average 40 metres in depth producing 1 to about 3 igpm. Wells drilled on the south side of the contact and average 80 metres in depth and produce about 1 igpm.

Precipitation which percolates into the ground is relatively mineral-free but becomes increasing mineralized with increased time of travel. One would therefore expect that water derived from deep wells would be more heavily mineralized than water derived from shallow wells. The near-surface water contributing to the recharge of a well probably originates near to and upgradient of the well. Travel times may be so short that dissolution of natural minerals is limited; however, the near surface groundwater system is vulnerable to contamination from surface spills, leaks or applications.

Available groundwater chemistry records for water withdrawn from domestic and commercial wells in the Martinon to Acamac area were requested from the NBDOE. The analytical results from 47 homes/businesses water supplies were reviewed for inorganic parameters such as major chemical ions (e.g. calcium, sodium, sulphate, chloride), metals (iron, manganese), and nutrients such as nitrate-nitrate and ammonia. The results were compared to the Canadian Drinking Water Guidelines (CDWG). Figure 4.10 presents the analytical data by major ion, on a piper trilinear diagram. The groundwater is typically a calcium bicarbonate type although some are sodium chloride type reflecting the impact of road salting operations or the pressure of nearby domestic septic systems.

Ninety-four percent of the 47 water samples from this area contained detectable concentrations of nitrate-nitrite ($NO_2^-$ - $NO_3^-$)




F:\22121\FIG4-10.CDR

| PROJECT: No:221.21 | DRAWING: TRILINEAR DIAGRAM- CRANE MOUNTAIN | | |
|---|---|---|---|
| ENVIRONMENTAL IMPACT ASSESSMENT FOR THE FUNDY REGION | SCALE: NTS | DWG No: FIGURE 4.10 | GEMTEC LIMITED GROUND ENGINEERING & MATERIALS TECHNOLOGY |
| | DATE: AUGUST, 1994 | DRN. BY: SAF | |

and 47 percent contained nitrate-nitrite at concentrations in excess of 1 mg/L. Although the CDWG value for nitrate is 10 mg/L, elevated concentrations of nitrate-nitrite (> 1 mg/L) in drinking water indicates that the water is being impacted by surface water carrying sewage and/or fertilizers. Well water containing detectable nitrate concentrations should be tested for faecal and total bacteria.

Ammonia ($NH_3$) was present in twenty six percent of the water samples. Ammonia is produced by decomposition of organic nitrogen and is the reduced form of nitrogen typical of anaerobic chemical conditions such as that in leachate and sewage. Water supplies with ammonia concentrations should again be tested for bacterial content.

Chloride ($Cl^-$) concentrations in excess of 250 mg/L the CDWG standard occurred in nine percent of the water samples. However, 51 percent of the samples contained in excess of 100 mg/L, which represents an elevated value for groundwater extracted from wells completed in granitoid, quartzite, limestone and gravel wells. The presence of chloride is a good indicator that surface water carrying road salt and/or sewage may be impacting drinking water supplies, or alternatively that salt water intrusion has occurred.

Manganese and iron ($Mn^{2+}$ and $Fe^{2+}$) are common elements that degrade the aesthetic aspects of a drinking water supply. The CDWG guideline concentrations for these elements are 0.05 and 0.3 mg/L, respectively. Sixty-four and twenty-one percent of samples contained concentrations of manganese and iron, respectively that exceeded the CDWG.

Hardness is another aesthetic consideration of water quality. A water supply with a hardness value in excess of 180 mg/L (as $CaCO_3$) is referred to as being very hard. Practically speaking, hard water consumes more soap to generate a lather as opposed to a water that is soft. Fifty-one percent of the water samples could be referred to as being very hard.

### 4.4.3 Site Flora and Fauna

#### Flora

All pertinent literature relating to rare plants in the area was surveyed. No documents were found that directly refer to the sites except forest survey abstracts which were too general to be of much help. Hinds (1983) was also consulted. Topographic, aerial, forest survey and geological maps were consulted. Geological map information showed little geological variation in each area on the scale to produce special habitats.

Areas were walked over along survey lines and two cross diagonals. All vascular plants species were noted in the vicinity of the survey lines and their relative abundance estimated immediately following each survey. General notes on vegetative types, dominants and topography was also recorded. The following is a general description of the site:

#### High Ground

Mesic forest of mixed hard and softwoods, with well developed understorey. Overstory dominated by red maple, yellow birch and