CAMBRIDGE TOWNSHIP WASTE DISPOSAL SITE
PART LOT 14, CONCESSION V
CAMBRIDGE TOWNSHIP, RUSSELL COUNTY

PRELIMINARY HYDROGEOLOGICAL REPORT

STANCON FILE NO.: 90-67

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EXECUTIVE SUMMARY

The Cambridge Township Municipal Landfill site, located on Part of Lot 14, Concession V, Township of Cambridge, Russell County, has the potential for continued operation and expansion.

The site is located on a plateau above an escarpment leading down to the South Nation River. Surface drainage occurs from the site into two ravines which drain northwards into the river.

An unconfined sand aquifer approximately 5 metres thick overlies a thick silty clay unit which acts to confine the common water supply aquifer located at depths of greater than 30 metres. Contamination from landfilling operations is expected to be confined to the upper aquifer. There are no records of dug wells in close proximity to the site although two dug wells are known to exist along Route 500 West; one at H2 and one at H3. The dug well at H2 is currently used only for livestock purposes.

Leachate movement from the landfill is expected to occur in a northerly direction towards the ravines and the South Nation River. This could not be confirmed from available information. Potential impacts on river water quality and on the neighbouring sand and gravel operations must be addressed through a reasonable use assessment of the landfill operations.

Although the site is potentially suitable to expanded operations, several recommendations have been made to gain more detailed information concerning the site's impact on surrounding water and soil character. These include:

1) Sampling and analysis of surface waters from the two ravines and at the four stations in the South Nation River previously sampled in 1984 by the MOE to determine potential impact on river water quality.

2) Geophysical surveying of the site to determine the direction of leachate plume migration and the optimum location and spacing for monitoring wells.

3) Soil sampling, and shallow groundwater sampling to determine the potential impact on neighbouring sand and gravel operations.

After analysis and assessment of these studies a re-evaluation of the future of the site can be made. All information gathered to this point will be useful in case of either continued operation or site closure.

Further recommendations include:

4) Installation and sampling of a minimum of three shallow groundwater monitoring wells on site to determine background and leachate water quality for reasonable use assessment.

and

5) Topographic mapping of the site.

These will be used to gain further detailed information on the site.

1.0 INTRODUCTION

StanCon Groundwater Engineering Limited (StanCon) was contracted by McNeely Engineering Limited in August of 1990, to conduct a preliminary hydrogeological assessment of an existing landfill site on the east half of Lot 14, Concession V, in the Township of Cambridge, Russell County. The landfill is owned and operated by Cambridge Township and has been in operation for over 15 years. A neighbouring landfill, owned and operated by the Village of Casselman, is located on the west half of Lot 14, Concession V.

There are currently no monitoring stations on site or monitoring programmes being carried out at the site. Available information on the site is limited. There is no information available concerning leachate quality, or direction of groundwater movement. One study, conducted by the Ontario Ministry of the Environment (MOE) in 1984 and relating to surface water quality in the South Nation River in the vicinity of the site is the only available source of data concerning the site's potential impact on neighbouring land/water uses.

The purpose of this study was to determine the suitability of the site, for the continued operation and potential expansion of a municipal landfill. If the site appeared capable of continued use from the results of the preliminary analysis, a monitoring programme was to be established. The use of geophysics was to be considered as a tool for the collection of information on the site.

1.1 Method of Study

A review of all available information pertaining to the site and surrounding areas was conducted. This included a review of available geological maps, hydrogeological reports, geophysical studies on the slope stability of the South Nation River, and MOE water well records.

A field traverse was conducted on August 14, 1990 in order to gain an understanding of general site characteristics. Discussions were held with the landfill operator, Mr. Langlois, to gain information on soil conditions and the depth to water table intersection on site. Water samples were collected from four nearby homes to establish background water quality data for the area.

A review of published papers and Geonics product information was undertaken to determine the suitability of geophysical surveys to determine hydrogeological information at municipal landfill sites in general. Discussions were held with two geophysical investigation firms to establish the application of the process to this particular site.

This report details the findings of the preliminary study and presents recommendations and conclusions based on hydrogeological information only. Consideration has not been given here for any economic, political, sociological or operations aspects of the site.

2.0 PHYSIOGRAPHY AND GEOLOGY

2.1 Topography and Drainage

The site is located on an area of flat land above an escarpment overlooking the South Nation River. This escarpment was the subject of a slope stability study by Golder Associates in 1988. Two investigative boreholes were drilled near the site: BH 20, located approximately 300 metres upstream of the site and, BH21, located approximately 320 metres downstream of the site (Figure 2).

Golders report indicates that although the potential for flowside retrogression exists along most of the South Nation River shoreline studied in their report, this was not the case for the site at BH 21. Golders also stated that sites BH20 and BH21 do not have the potential for earth flow should initial slope failure or subsequent retrogression reach the slope crest area. The occurrence of a wide midslope floodplain reduces the risk of major landslide retrogression. The area between BH20 and BH21 was shown by Golders to have the lowest calculated retrogressive distance of all test holes along the river. There is no history of retrogressive landsliding within one kilometer of each of boreholes 20 and 21. From this it is inferred that there is minimal risk of major landsliding occurring at the landfill site.

Two ravines with visible and audible water flows occur on-site. The largest ravine, running approximately north-south, cuts back of the current fill area. This ravine, henceforward called R1, divides the Township landfill site from the neighbouring Village of Casselman landfill. The second ravine, R2, begins immediately north of the current excavated fill area. Both ravines discharge into the South Nation River at the base of the escarpment. Each has an estimated flow on the order of 68 to 114 litres/minute.

A third ravine, R3, which does not have visible water at its base, is located between R1 and R2 at the far northern edge of the site. Figure 1 illustrates the location of these features.

Ponded water occurs at the base of the current fill area. This water drains through a self-made channel to the north, eventually joining up with a man-made ditch at the northern front of the excavated area and discharging into R2.

Ponded water is visible over much of the site in areas to the north, northeast and east of the site. This appears to be due to the removal of surface sands down to the top of the water table. Drainage on-site seems to be largely controlled by the man-made ditches and the ravines.

2.2 Surficial Geology

A thick sequence of overburden materials is present at the site. The upper surface of the plateau consists of fine to medium grained deltaic and estuarine sands. Below this a stiff brown/grey silty clay is present which includes lenses, bars and channel fills of sand and pockets of non-marine silt formed during terrace (or channel) cutting. The degree of interconnection between these inclusions is unknown. A black gravel of variable thickness occurs beneath the clay overlying bedrock. This sequence is consistent across the site.

Actual thicknesses of each unit may vary, however, the upper sand is believed to be between 3 and 5 metres thick; the clay is on the order of 20 to 30 metres thick and the black gravel varies from 1 to 15 metres thick. The overall thickness of the overburden sequence is expected to be between 30 and 40 metres.

2.3 Bedrock Geology

A review of bedrock geology maps for the area reveal that the site is underlain by the Ottawa Formation Limestone.

3.0 HYDROGEOLOGY

3.1 Hydrostratigraphy

There are two overburden aquifers and at least one bedrock aquifer on site. The surficial water table aquifer occurs in the upper fine to medium grained sands. Quicksand conditions are said to exist on site within this unit. The exact depth to water table is not known, however approximate estimates put it at 3 metres below the original ground level.

The occurrence of a lower permeability silty clay unit underlying the sands, will aid in the formation of "quicksands". Large negative vertical (downwards) hydraulic gradients are expected to be a result of this "mounding" of water in the surficial aquifer. There are few known uses for the surficial aquifer. A dug well used for livestock purposes at the Belisle farm across Route 500 West is located approximately 800 metres from the site. The well at H4 sampled during this study is also reported to be a dug well, although this has not been confirmed.

A confined black gravel aquifer occurs at depth below the silty clay. This aquifer serves as the main water supply for the surrounding area. The thick sequence of silty clay is expected to effectively separate the two surficial aquifers.

Water samples were taken from four homes in the vicinity of the site for water quality testing. Three of these homes (H1, H2, H3) are known to have drilled wells finished in the confined overburden aquifer.

The confined bedrock aquifer, consists of fracture zones in the Ottawa Formation Limestone. Of the 15 MOE well records studied for the area, only three wells are finished in the bedrock aquifer. None of the wells sampled were completed in this unit.

3.2 Groundwater Flow Direction

The deep confined groundwater flow direction has been described as approximately north-northeastwards by Charron (1978). This determination was based on an analysis of hydrochemical data and groundwater evolution.

Groundwater flow within the surficial sand is most probably controlled by the local topography and underlying silty clay layer. Due to the presence of ravine cut slopes, the break out of shallow groundwaters along these slopes and subsequent downwards flow along the slope is suspected, although, this was not observed during the field traverse. The resultant general groundwater flow direction is, until further information can be gathered, inferred to be towards the slopes to the north and northwest.

The presence of a waste fill area will result in water table mounding in the fill and resultant radial flow away from the waste mound. On a local scale leachate produced in and under the waste fill area will therefore likely be flowing radially outwards from the fill area.

Further information will be required in order to identify the exact directions of groundwater flow and leachate movement.

3.3 Water Chemistry Results

Tha following paragraphs summarize the results of the water sampling programme. Detailed results are contained in Appendix A.

The water chemistry at H1, H2 and H3 are all very similar. These three homes have drilled wells finished in the confined black gravel aquifer. The water is potable and not one of the parameters included in the analysis is present in excess of MOE recommended maximum concentrations. Sodium is present at concentrations necessitating a warning to users with certain heart conditions. This warning has been passed onto the home owners by StanCon.

H4, reputed to be a dug well, has a distinctly different chemical make-up. The water is very hard and has a total dissolved solids count of 816 mg/l (500 mg/l higher than H1, H2 and H3). Chloride and iron are present in excess of the MOE recommended maximums at 269 and 0.49 ppm respectively. These are aesthetic and not health related parameters. Sodium is also elevated in these waters at 137 ppm.

The quality in this well is said to be consistent with other dug wells in the area. The recommended sampling programme on site should confirm this.

Bacterial contamination in H4, although not above health warning levels, warranted notification of the home owner. The District Health Unit was also notified and recommendations were made by StanCon for resampling. Bacteria counts were 1 Faecal and 4 Total Coliform per 100 ml.

4.0 SITE ASSESSMENT AND SUMMARY

The hydrostratigraphy of the site has both positive and negative impacts on the hydrogeologic integrity of the site. The effect of the confining clay layer, in particular, plays an important role in the assessment of the site with respect to its suitability for waste disposal operations.

The confining clay layer protects the underlying water supply aquifers from contamination caused by the downwards percolation of landfill leachates. The location of the site downgradient of any water supply wells is also a positive factor to be taken into account in the assessment of the site.

The confining layer results in high pore water pressures in the unconfined aquifer and resultant quicksand conditions and a relatively shallow water table thereby restricting the depth of excavation and filling operations on site. This will govern the method of operation at the site.

The hydrogeologic environment at the site is relatively simple. The hydrogeologic unit expected to contain most or all of the contamination produced on site is the unconfined water table aquifer which consists of a relatively homogeneous fine to medium grained sand. This unit appears to be laterally continuous and extensive.

Chloride, iron and sodium are believed to be naturally present in elevated concentrations in the shallow aquifer. This will be confirmed with proposed future sampling programmes.

The occurrence of ravines in close proximity to the fill area provides a direct route for contamination, either via direct runoff or seepage breakout, to reach the South Nation River. In particular, the flow of ponded water from the base of the current fill through R2 directly into the river must be addressed.

Past filling operations resulted in the placement of waste at the extreme western edge of the ravine R1. Waste is visible down the whole length of the slope and at the bottom in the small brook running at the base. Waste materials are also located at the bottom of the dry ravine, R3.

The major concerns identified during this study at this site are the potential degradation of water quality in the South Nation River and potential degradation of neighbouring property uses, in particular the sand and gravel operation on the neighbouring property to the east. Due to the natural effectiveness of surface water in diluting landfill leachates, the impact of the landfill on the quality of the South Nation River is expected to be minimal.

Containment of R2 flow may be possible with the construction of a ditch and berm system between the fill area and the ravine. Collection and treatment of the leachate may be required if the impact of discharge on river water quality exceeds reasonable use. Remediation of R1 will be much more difficult due to lack of land area between the waste and the ravine for the construction of a collection system. There is a lack of natural land area to act as a buffer area to provide in-situ treatment or to construct a ditch and berm leachate collection system between the waste along the western edge of the site and R1. If contamination exists in the flow in this ravine it may be difficult to determine which waste disposal site, Township or Village, is responsible for the contamination.

The site is believed to have the potential for continued use if the above concerns are fully addressed.

5.0 RECOMMENDATIONS

An assessment of the site with respect to Regulation 15-08 (Reasonable Use) will be required by the MOE if continued operation is planned or the site is planned for closure. This will involve detailed information pertaining to the direction of groundwater movement, quality of leachate on site and potential impact on neighbouring water and/or property uses.

It is not recommended for deep monitoring wells to be installed through the confining clays into the black gravel aquifer due to the potential for creating a direct hydraulic connection between the upper and lower aquifers. If new information becomes available suggesting a connection between these aquifers may exist the geophysical survey can be expanded to include measurements at two additional depths in order to obtain a depth profile of contamination at the site. This would confirm or deny the occurrence of contaminant migration with depth.

The following recommendations have been presented in a phased approach in order to gain the information required for a full assessment of the suitability of the site for continued operation first at minimal cost to the client prior to conducting further detailed studies. Each step may be conducted as a separate study or steps 1 through 3 can be completed as Phase I, and steps 4 and 5 conducted after discussion of the results from Phase I. Rough cost estimates have been given for each of the recommended steps.

<u>Phase I</u>

1) Sampling of the two ravine flows for standard leachate parameters (Appendix B) and sampling of the four river water at stations both up- and

down-stream of the site (Figure 2). Determination of reasonable use with respect to surface water quality. Approximate Cost: $ 3600.00

2) Conduct a preliminary geophysical survey of the site using a shallow depth (<6 m) Geonics EM-31 or EM-34 at 10 metre line spacing and 10 metre station spacing. This will need to be corrected for topographic changes on-site in order to be useful. The area recommended for surveying is shown on Figure 3 and includes much of the current fill area. Approximate Cost: $ 9700.00

3) Soil sampling and shallow groundwater quality analysis for determination of reasonable use impacts on neighbouring sand and gravel operations. Approximate Cost: $ 2775.00

After these three preliminary studies are completed, a reanalysis of the site's suitability may be made with respect to its expansion and continued operation or it's closure and required monitoring. If the site is planned for continued operation the following steps are recommended:

Phase II

4) Installation and sampling of a minimum of three (3) shallow monitoring wells on site in order to determine leachate quality characteristics, background water quality characteristics and groundwater flow direction. The actual number and location of these wells will be determined from geophysical survey results. Approximate Cost: $ 5175.00 (for three wells).

5) Topographic mapping of the site including fill areas and surrounding areas to the property boundaries to the east, west and to the South Nation River shoreline to the north. This will form a base map required for detailed interpretation of hydrogeological and geophysical data and will be useful in all subsequent operations and hydrogeological reports to the MOE. It is assumed that this will also be required for the new C of A. Approximate Cost: see McNeely Engineering Limited.

5.1 Monitoring Programme

As outlined in the recommendations two monitoring programmes have been suggested for the preliminary study phase: one for surface water and one for groundwater. Each of these will involve the analysis for the same parameters and at this stage will be more detailed than on-going monitoring programmes will require for either site closure or continued operations monitoring programmes.

Surface Water

Analyses of water samples taken from the two ravine flows should be analysed for the full suite of Leachate Parameters as outlined in Appendix B. This will help to characterize the discharge from the site and flag indicator parameters which can be used in short suite analyses during regular surface water monitoring programmes.

It is also recommended that water samples be taken from midstream at mid-depth in the South Nation River at the same sampling locations used in the MOE 1984 surface water sampling programme (Figure 2). These four samples should be analysed for the same parameters as listed in the Leachate Parameters List (Appendix B).

Groundwater

Groundwater monitoring stations should be placed such that at least one of the wells is finished in waters believed to be unaffected by leachate contamination while one should be completed in the centre of the old fill area in an aim to intercept the most contaminated leachate on site. Characterization of leachate quality is required by the MOE and will be necessary to reasonable use analysis. Background water quality is also required for this reason. The requirement for and location of other monitoring wells will be determined from the geophysical survey results.

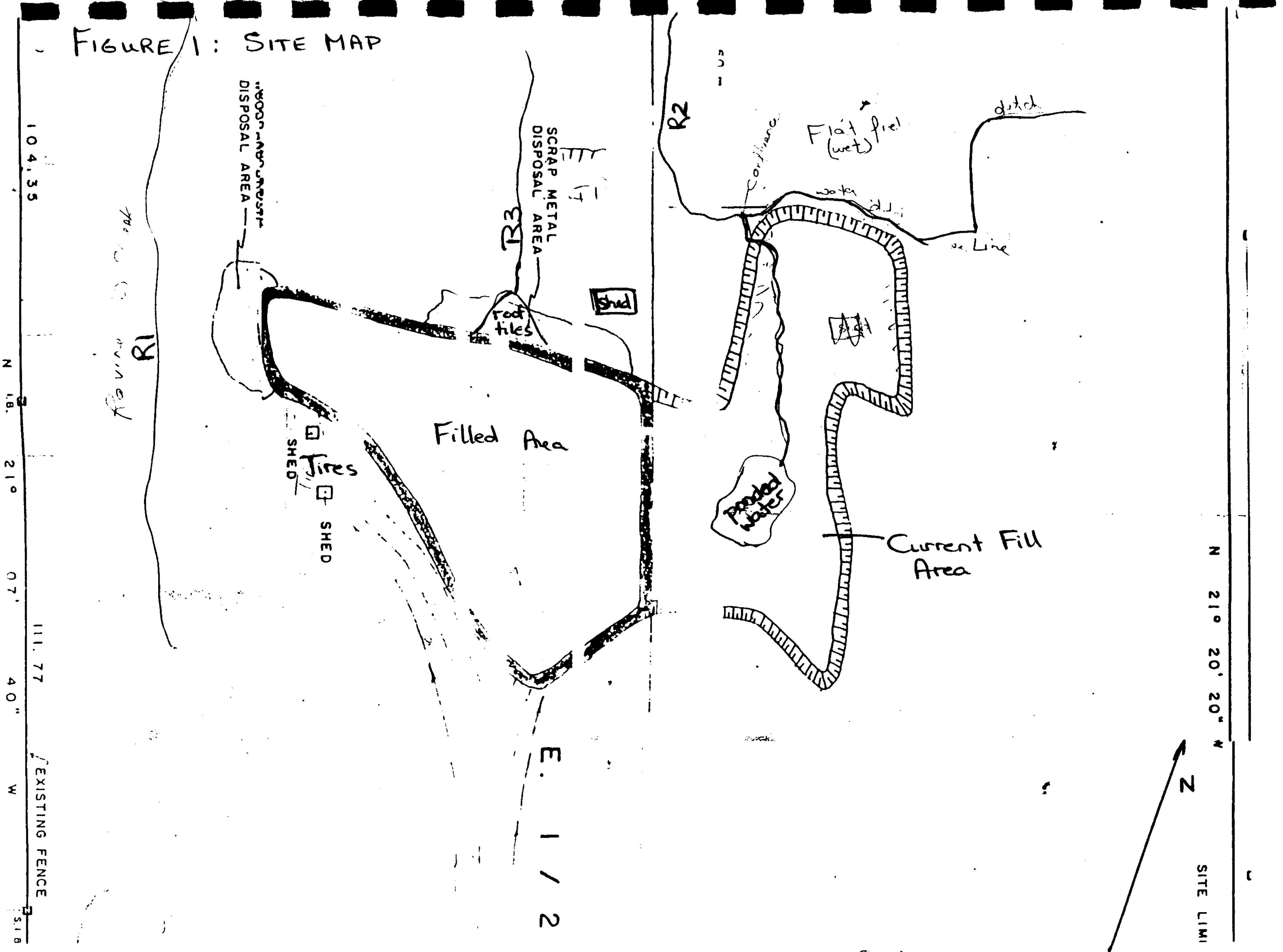
Groundwater samples taken from the monitoring wells installed on-site should be analysed for the same compounds as outlined in Appendix B. This includes a full organics scan to include Freon 12, CCl_2F_2, since several empty canisters of this component (Genetron 12) were observed at the site.

Future Monitoring Programmes

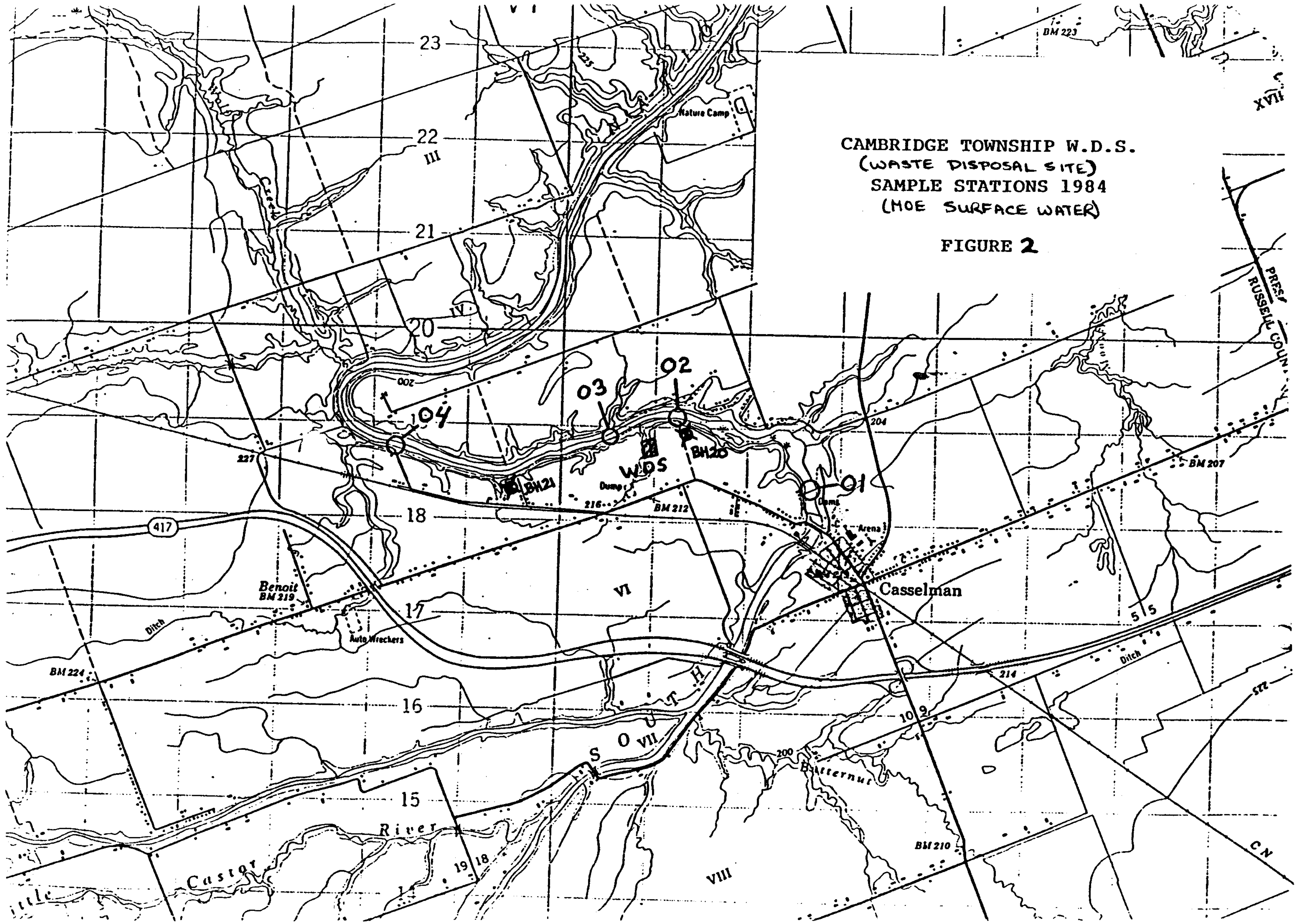
Future monitoring of both surface and groundwaters will be dependent on the final fate of the site; continued operation or site closure. The final design of the monitoring programme will, therefore, be dependent on the findings of this study. By defining characteristic parameters of the contamination on site at this time it will be possible to analyse for shorter lists of indicator parameters in future programmes.

Linda C.M. Elliott, M.Eng.,
Hydrogeologist

FIGURE 1: SITE MAP



Scale 1:1000



CAMBRIDGE TOWNSHIP W.D.S.
(WASTE DISPOSAL SITE)
SAMPLE STATIONS 1984
(MOE SURFACE WATER)

FIGURE 2

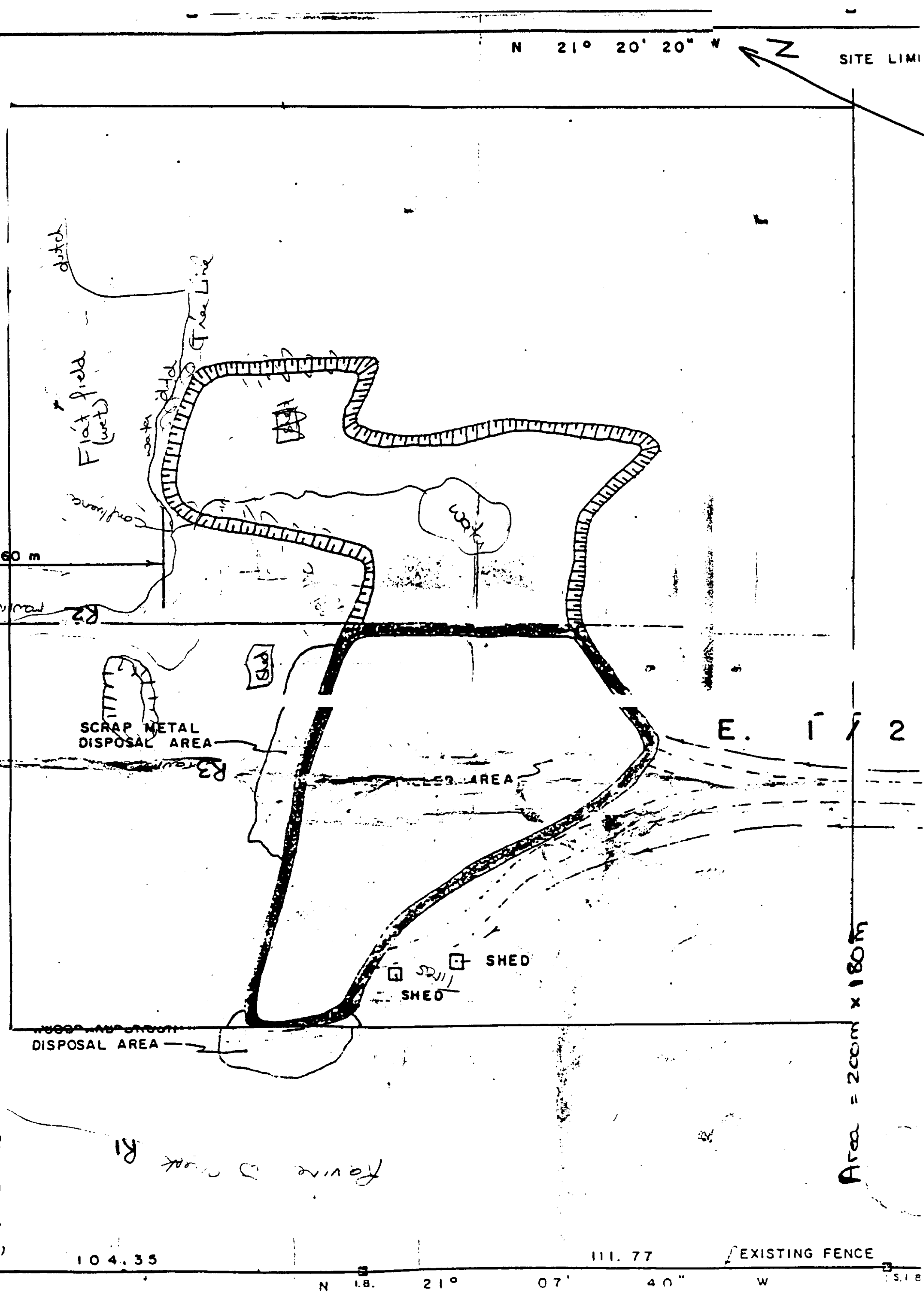


FIGURE 3: Proposed Area for Geophysical Survey

APPENDIX A

WATER CHEMISTRY RESULTS

Bondar-Clegg & Company Ltd.
5420 Canotek Road
Ottawa, Ontario
K1J 9G2
(613) 749-2220 Telex 053-3233

BONDAR-CLEGG

A DIVISION OF INCHCAPE INSPECTION & TESTING SERVICES

Certificate of Analysis

RECEIVED AUG 2 9 1990

STANCON GROUND WATER ENGINEERING
LINDA ELLIOTT
236 WESTBROOK RD.
WEST CARLETON IND. PARK
CARP, ONT. K0A 1L0

Bondar-Clegg & Company Ltd.
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BONDAR-CLEGG

Certificate of Analysis

A DIVISION OF INCHCAPE INSPECTION & TESTING SERVICES

REPORT: 090-41705.8 (COMPLETE)

REFERENCE INFO: 90-67

CLIENT: STANCON GROUND WATER ENGINEERING
PROJECT: NONE

SUBMITTED BY:
DATE PRINTED: 24-AUG-90

ORDER	CHEM. ABS. SERVICE #	ELEMENT/COMPOUND NAME		NUMBER OF ANALYSES	DETECTION LIMIT	METHOD
1		Alk	Alkalinity as CaCO3	4	PPM	
2		Ca	Calcium	4	1 PPM	Atomic Absorption
3		Cl	Chloride	4	PPM	
4		CO3	CO3	4	PPM	
5		Fec C	Fecal Coliform/100ml	4	/ML	
6		Fe tot	Iron (total)	4	0.01 PPM	Atomic Absorption
7		HCO3	HCO3	4	PPM	
8		K	Potassium	4	1 PPM	Atomic Absorption
9		Mg	Magnesium	4	1 PPM	Atomic Absorption
10		Mn	Manganese	4	0.05 PPM	Atomic Absorption
11		Na	Sodium	4	1 PPM	Atomic Absorption
12		N-NO3	Nitrate Nitrogen	4	PPM	
13		pH	pH	4		
14		SO4	Sulphate	4	PPM	
15		Tot C	Total Coliform/100ml	4	/ML	
16		TDS	Tot Dissolved Solids	4	mg/l	
17		T Hard	Tot Hardness - CaCO3	4	PPM	

SAMPLE TYPES	NUMBER	SIZE FRACTIONS	NUMBER	SAMPLE PREPARATIONS	NUMBER
WATER	4	AS RECEIVED	4	As Received, No SP	4

REPORT COPIES TO: LINDA ELLIOTT

INVOICE TO: LINDA ELLIOTT

Bondar-Clegg & Company Ltd.
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BONDAR-CLEGG

Certificate of Analysis

A DIVISION OF INCHCAPE INSPECTION & TESTING SERVICES

DATE PRINTED: 24-AUG-90

REPORT: 090-41705.8

PROJECT: NONE

Compound or C.A.S. Number	Units	Det. Limit	H1	H2	H3	H4
Alkalinity as CaCO3	PPM		224	229	226	218
Calcium	PPM	1	25	24	27	135
Chloride	PPM		41.8	41.1	42.5	269.0
CO3	PPM		1.2	3.6	4.8	<1.0
Fecal Coliform/100ml	/ML		<1	<1	<1	1
Iron (total)	PPM	0.01	<0.05	0.36	0.09	0.49
HCO3	PPM		271	272	266	266
Potassium	PPM	1	10	10	10	2
Magnesium	PPM	1	23	21	22	13
Manganese	PPM	0.05	<0.05	<0.05	<0.05	<0.05
Sodium	PPM	1	67	65	60	137
Nitrate Nitrogen	PPM		0.10	0.10	<0.10	0.54
pH			8.36	8.42	8.49	7.76
Sulphate	PPM		6.76	4.27	5.52	53.00
Total Coliform/100ml	/ML		<2	<2	<2	4
Tot Dissolved Solids	mg/l		328	324	312	816
Tot Hardness - CaCO3	PPM		160	146	158	392

Lab Supervisor

APPENDIX B

LANDFILL LEACHATE PARAMETERS

LANDFILL LEACHATE PARAMETERS

Inorganic Parameters

Physical Parameters

Total Dissolved Solids	TDS
Alkalinity	
pH	
Hardness	
Chemical Oxygen Demand	COD

Salts

Ammonia	NH3
Ammonium	NH4
Bicarbonate	HCO3
Carbonate	CO3
Calcium	Ca
Chloride	Cl
Hydroxide	OH
Iron	Fe
Magnesium	Mg
Manganese	Mn
Nitrate	NO3
Potassium	K
Sodium	Na
Sulphate	SO4
Total Nitrogen	TKN
Phosphorous	PO4

Heavy Metals

Copper	Cu
Lead	Pb
Mercury	Hg
Nickel	Ni
Zinc	Zn

Organic Parameters

Volatile Organics

Ethylbenzene
Xylene
Benzene
Toluene

Other

Dissolved Organic Carbon	DOC
Dichlorodifluoromethane	
Chlorobenzene	
Trichloroethylene	

Bacteria

Total Coliform

Fecal Coliform