Maine Geological Survey
DEPARTMENT OF CONSERVATION
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OPEN-FILE NO. 85-77

Title: Water Quality in Sand and Gravel Aquifers in York County, Maine

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Date: 1985

Financial Support: The preparation of this document was financially assisted by a 208 Water Quality Planning Grant from the Maine Department of Environmental Protection and the U.S. Environmental Protection Agency.

This report is preliminary and has not been edited or reviewed for conformity with Maine Geological Survey standards.

Contents: 91 page report and map

WATER QUALITY IN SAND AND GRAVEL AQUIFERS IN YORK COUNTY, MAINE

March 15, 1984

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Plate 1.

Map showing aquifer boundaries, recharge areas, municipal and monitoring well locations, and the locations of potential contamination sources in York County

SECTION I

INTRODUCTION

Approximately 20,000 years ago glaciers advanced across Maine and out beyond the present coastline. As the glaciers receded, vast amounts of sand and gravel were deposited in the form of eskers, deltas, outwash, kames and kame terraces (Thompson, 1978). Since glaciation, additional sand and gravel deposits have formed along the banks and floodplains of the state's rivers and streams.

These sand and gravel deposits, where saturated with ground water, are capable of yielding considerable amounts of water to domestic or municipal wells. In locations where sustainable yields of more than 10 gallons per minute of water can be obtained from a properly installed domestic well, the deposits are termed sand and gravel aquifers.

Most municipalities which use ground water for their water supply have their wells in sand and gravel aquifers. Many industries also utilize sand and gravel aquifers for their water supply, and a majority of homes in York County using private water supplies have point or dug wells in sand and gravel deposits (Maine Department of Health and Welfare, 1971-1973). Sand and gravel aquifers may also serve as recharge sources for underlying bedrock aquifers, into which many domestic wells are drilled.

Water is not the only substance which moves readily through sand and gravel aquifers. Sand and gravel deposits have a limited ability to attenuate contaminants, which may move freely through an aquifer and pollute water supplies. Once an aquifer is contaminated it is unlikely to be useable as a water source for many years or decades. This report contains information on the quality of ground water in sand and gravel aquifers in York County, both in areas not impacted by human activities and around 24 potential contamination sites. A map (plate 1) is included, showing:

1. The extent of sand and gravel aquifers capable of yielding more than 10 gallons of water per minute to a properly installed domestic well;
2. Areas of primary recharge to these aquifers;
3. The locations of test wells installed for this project; and
4. The locations of the potential contamination sites discussed in this report, and the primary direction of contaminant migration from these sites.

The report does not discuss some of the more abundant sources of contamination to ground water in York County. Contamination from road salt applications, malfunctioning or improperly installed septic tanks, fertilizer applications, manure storage, and pesticides were not studied due to the large numbers of such sources and the local nature of their ground water contamination.

SECTION II

BACKGROUND INFORMATION

LEGISLATIVE PROTECTION OF SAND AND GRAVEL AQUIFERS

In the past five years the Maine Legislature has repeatedly stressed the value of protecting sand and gravel aquifers. Many of the Legislature's actions have been the result of recommendations of the Ground Water Protection Commission (1980-81). In 1981, the Legislature ammended the "Site Law" (38 MRSA, Section 481) to read:

> "The Legislature further finds that certain geological formations particularly sand and gravel deposits, contain large amounts of high quality ground water. The ground water in these formations is an important public and private resource, for drinking water supplies and other industrial, commercial and agricultural uses. The ground water in these formations is particularly susceptible to injury from pollutants, and once polluted, may not recover for hundreds of years. It is the intent of the Legislature, that activities that discharge or may discharge pollutants to ground water may not be located on these formations."

The Board of Environmental Protection (BEP) has interpreted "activities that may discharge pollutants to groundwater" as follows (DEP Regulations, Chapter 375):

> "The Board operates under the rebuttable presumption that the storage and/or disposal of solid wastes, hazardous wastes, and leachable or liquid wastes, including petroleum products and septage, pose serious threats to public health, safety, and welfare through the potential pollution of the ground water when such storage and/or disposal occurs on or above sand and gravel aquifers or the recharge areas of sand and gravel aquifers."

In 1981 38 MRSA Section 482 was amended so that quantities of road salt in excess of one ton per year were added to the above list. In 1983, the legislature further amended 38 MRSA, directing the DEP and MGS to develop programs for the collection and analysis of information relating to the nature, extent and quality of aquifers and aquifer recharge areas (38 MRSA, Sections 401 and 402). In 38 MRSA Section 403 the information to be collected on sand and gravel aquifers was specified in detail:

> "1. Legislative intent. The Legislature finds that sand and gravel aquifers are important public and private resources for drinking water supplies and other industrial, commercial and agricultural uses. The ground water in these formations is particularly susceptible to contamination by pollutants and, once polluted, may not recover for hundreds of years. It is the intent of the legislature that information be developed which shall determine the degree that the state's sand and gravel aquifers have been contaminated and shall provide a base of knowledge from which decisions may be made to protect the aquifers.

2. Determination of ground water quality. The Department of Environmental Protection and the Department of Conservation shall delineate the primary recharge areas for all sand and gravel aquifers capable of yielding more than 10 gallons per minute. Utilizing existing water supply information and well drilling logs, the Department of Environmental Protection and the Department of Conservation shall determine depth to bedrock, depth to water table, surficial material stratigraphy and generalized ground water flow directions of the aquifers. The Department of Conservation shall also determine the extent and direction of contamination plumes originating from distinct sources within each area studied."

Other legislative actions taken to protect ground water have included a ban on halogenated septic cleaners, minimum lot size regulations for residential subsurface waste disposal, a ban on certain types of waste water disposal through underground injection wells, and the allocation of funds to restore and protect ground water from hazardous waste contamination.

THE SAND AND GRAVEL AQUIFER MAPPING PROGRAM

The Sand and Gravel Aquifer Mapping Program was initiated to provide a base of knowledge about sand and gravel aquifers in Maine as outlined in the previous section. This project is a joint undertaking of the Maine Department of Environmental Protection (DEP), the Maine Geological Survey (MGS) and the U.S. Geological Survey (USGS). Funding for this project has been provided by these three agencies, the State of Maine and the United States Environmental Protection Agency (208, Surface Impoundment Assessment and Underground Injection Control programs).

To date the Sand and Gravel Aquifer Mapping Program has provided a series of 59 maps at a scale of 1:50,000 showing preliminary aquifer boundaries and well inventory information. Six of these maps cover York County (maps 1-4, 12 and 13; W.B. Caswell, 1979 a-e). More detailed information on aquifer thickness, surficial geology, background water quality, bedrock surface topography, stratigraphic relationships and mapping methods is available in two additional reports: Hydrogeology of Significant Sand and Gravel Aquifers-Northern York and Southern Cumberland Counties, Maine (Tolman and others, 1983); and Hydrogeology and Water Quality of Significant Sand and Gravel Aquifers in parts of Androscoggin, Cumberland, Oxford, and York Counties, Maine: Sand and Gravel Maps 12, 13, 14, and 15 (Williams and others, in preparation).

AQUIFER LOCATION AND UTILIZATION IN YORK COUNTY

Reconnaissance mapping in 1979 indicated that 24.5 percent of York County's land area is underlain by sand and gravel aquifers. The distribution of these aquifers is not uniform throughout the county; the aquifers are concentrated in the inland and north central areas of the county.

Six municipal water districts serving the towns of Alfred, Limerick, South Berwick, Sanford, Springvale, Parsonsfield, Hiram and Porter utilize ground water supplied from sand and gravel aquifer sources. On an average daily basis these towns consume approximately 2.5 million gallons of water (US Army Corps of Engineers, 1982). The Cornish Water District utilizes ground water from two bedrock wells which are recharged by a sand and gravel aquifer (Michael Parker, Maine Department of Human Services, personal communication, 1984).

The largest single user of aquifer resources is the Sanford Water District, which uses an estimated 2.11 million gallons per day. The Sanford Water District pumps ground water from a well field containing 42 shallow driven points and also pumps from five gravel packed wells at several locations throughout the town. All gravel packed wells are capable of yielding at least 350 gallons per minute. The well field is normally pumped at a rate of 820 gallons per minute (Department of Human Services Water Utility Survey, 1972 & 1980).

Two other water districts access ground water from gravel packed wells and shallow driven points. The South Berwick Water District pumps approximately 215,000 gallons per day from gravel packed wells and a well field of 5 shallow driven points. Sixty gallons per minute are normally pumped from the well field, and each gravel packed well yields about 50 gallons per minute. The Maine Water Co. (Kezar Falls Division) serves the towns of Hiram, Parsonsfield and Porter with approximately 71,000 gallons per day. Ground water is obtained from a gravel packed well capable of yielding 280 gallons per minute. Two bedrock wells serve as an auxillary source (Department of Human Services Water Utility Survey, 1977).

The water districts of Alfred, Limerick and Shapleigh pump ground water from either dug wells or springs. Alfred's dug well supplies an average of 37,000 gallons per day from a well capable of yielding 200 gallons per minute. Limerick pumps from a dug well capable of yielding 300-600 gallons per minute. This water district also obtains water from a 565 foot deep bedrock well. In Shapleigh a dug well is pumped by the Pine Springs Development Co.

In addition to municipal uses, the majority of individual water systems in York County utilize sand and gravel aquifers. A Maine Department of Health and Welfare (1971-1973) study estimated that 24% of the homes in York County were serviced by private water supplies; 66% of these water supplies were derived from sand and gravel formations. Based on the information in this report, an estimated 33% of all homes in York County are dependent on water from sand and gravel aquifers for their water supply. This figure may be increased in the future if Hollis and Buxton develop water supplies in the extensive aquifer areas within their boundaries (US Army Corps of Engineers, 1982).

AQUIFER MAPPING

The aquifer boundaries shown on plate 1 were determined by geologic mapping, seismic surveys, well inventory and test hole drilling. The boundaries shown are taken primarily from mapping conducted in 1981 (Tolman and others, 1983). The northwestern portion of York County was mapped in 1983; a detailed mapping report for this region should be available in late 1985 (Williams and others, in preparation). Aquifers in the Kittery-York-Berwick area were mapped in a reconnaissance level investigation conducted in 1978 (Caswell, 1979, a, b).

Ground-water flow directions are not shown in plate 1 because of its scale. However, flow directions can be estimated from topography and drainage, as well as from depth-to-water data. Flow in shallow aquifer systems is generally from areas of higher elevation towards streams, springs, lakes, or bogs. These flows may not be paralleled by deeper flow systems. However, the largest quantity of water (and contaminants) is usually transported by the shallow flow system. The shallow flow system is the main source of water for dug wells, well points, springs and stream base flows.

Primary recharge areas have been defined by the Maine Legislature as "the surface area directly overlying sand and gravel formations that provide direct replenishment of groundwater in sand and gravel and fractured bedrock aquifers "(38 MRSA Section 482, sub Section 4-C). Using this definition, areas underlain by sand and gravel which is either unsaturated or incapable of yielding at least 10 gpm of water, and which is hydrologically connected to a mapped aquifer have been outlined on Plate 1. Three points about recharge areas should be kept in mind when utilizing this information:

1. The primary source for recharge to a sand and gravel aquifer is the area overlying the aquifer itself (Tolman and others, 1983).

2. Areas not outlined on plate 1 may also contribute recharge to the aquifers. Ground-water flow from till and bedrock has been shown to contribute significantly to sand and gravel aquifers near large pumping wells in Rhode Island (Handman, 1983). Thus, siting any development which may contaminate ground water near mapped aquifers should be regarded cautiously, and should not be permitted unless it can be shown that such development will not impact the mapped aquifer.

3. Ground-water contamination in aquifer recharge areas is a much more serious threat than contamination in discharge zones (usually near streams and rivers). Contamination from the McKin waste oil facility in East Gray is a good example of this. At that site contaminants were released in a recharge area for both a sand and gravel and bedrock aquifer. Contaminants travelled thousands of feet, requiring the town to run public water to a large area to avert the contamination problem. Had the waste oil site been near a ground-water discharge point, the contaminants would have quickly entered a stream or river, and perhaps been diluted to non-hazardous levels without seriously impacting the stream.

SECTION III
REGIONAL WATER QUALITY

FACTORS INFLUENCING WATER CHEMISTRY

The chemistry of ground water in sand and gravel aquifers is determined by a number of natural and man-made factors. The primary natural control is the chemical composition of the source material for the sand and gravel. Most of the sand and gravel in southern Maine is derived from non-calcareous crystalline bedrock. Water in regions such as this tends to have a low dissolved solids content (Matthess, 1982). Where the saturated thickness of surficial deposits is great, however, the water may have a long time to react with and dissolve soluble material from the aquifer, thereby raising the level of dissolved solids (Caswell, 1979). The manner in which the surficial materials were deposited can also affect residence time and thereby influence the chemical character of ground water.

The chemistry of precipitation can also affect ground water quality. In coastal regions where precipitation contains high levels of sea salt, sodium and chloride concentrations in ground water are typically higher than in inland areas (Matthess, 1982). High concentrations of sodium and chloride can also be the result of intrusion of salt water in coastal areas or the entrapment of sea water during the marine submergence which followed the retreat of the continental ice sheet more than 11,000 years ago (Tepper, 1980).

Human activities that may greatly alter the chemistry of ground water include:

1. Landfill disposal of household and industrial wastes.

2. The storage and spreading of road salt.

3. The introduction of human wastes into ground water through malfunctioning or improperly installed septic systems, disposal of septage, or by spreading or landfilling of sludge from municipal sewer systems.

4. Agricultural activities, which include stockpiling and spreading animal wastes, spreading commercial fertilizers, and pesticides applications.

5. Leaking waste-storage or disposal lagoons.

6. Leaking fuel or chemical storage tanks.

7. Spills of toxic or hazardous materials along transportation routes.

8. Overpumping: Heavy pumping of wells can lead to salt-water intrusion in coastal areas or to induced recharge of poor quality water where a well is adjacent to a body of contaminated surface water.

9. Atmospheric pollution: Contaminants in precipitation affect both ground water and surface water. For example, in the northeastern United States, "acid rain" has apparently caused the lowering of pH and subsequent increase in aluminum and trace metal concentrations in ground water in New Hampshire and New York (Bridge and Fairchild, 1981).

CHEMICAL CHARACTERISTICS OF GROUND WATER IN YORK COUNTY AQUIFERS

To determine the regional water quality in sand and gravel aquifers in York County, 24 monitoring wells were installed in locations where agricultural activity is minimal and no likely contamination sources were found. Some anthropogenic influences on water quality could not be avoided, especially road salting operations, the influence of septic tanks or fertilizers in certain areas, and atmospherically derived pollution.

The wells installed were 1.25 or 2 inch diameter PVC pipes, screened at the bottom with 2 to 5 feet of slotted PVC screens, and placed into holes bored using a 6-inch diameter hollow stem auger. Complete details of drilling methods are given in Tolman and others (1983). Sampling and analytical methodology is discussed under "Water Chemistry" in Section V.

The results of the water quality testing of 14 chemical parameters are listed in Table 1, summarized in Table 2, and detailed below. It should be pointed out that the presence of coliform bacteria is the most common reason that water is unfit to drink. Coliform bacteria counts were not made for this study, as they are usually indicators of local contamination problems (malfunctioning or improperly installed septic systems, animal wastes) and this study was concerned with regional ground-water conditions.

In the discussion of individual parameters which follows, a calculation of the "maximum expected background value" has been made. There is a 99% chance that water containing a higher concentration of a given parameter than this value has been affected by something that has not affected the background water quality samples (presumably man-made contamination). See Table 2 for details and assumptions used for this calculation.

Specific Conductance

The specific electrical conductance (conductivity) of water is a measure of its capacity to conduct an electrical current. The conductivity increases as the ion concentration increases; thus, the specific electrical conductance measurement provides an indication of the ionic concentration in a sample. The conductivity of water in its purest state is 0.042 umhos/cm. Distilled water has a conductivity from 0.5 to 5 umhos/cm (Matthess, 1982). Because specific conductance is only a generalized measurement of water quality, there are no drinking water standards set for it.

The background water quality samples had specific conductance values ranging from 20 to 140 umhos/cm, with a mean of 69 umhos/cm (Table 2). The maximum expected background value for specific conductance in York County sand and gravel aquifers is 170 umhos/cm.

Table 1. BACKGROUND WATER CHEMISTRY SUMMARY

Well NO.	Town	Depth (Ft.)	Date Sampled	Conductivity (uhmo/cm)	TDS*	pH	Alkalinity (mg/l as $CaCO_3$)	Chloride	Nitrate (mg/L as N)
02	Limerick	22	12-8-81	70	46	7.0	12	5.0	.11
03	Waterboro	20	12-9-81	99	64	6.6	61	6.5	.10
04	Limington	31	12-9-81	32	21	6.3	14	2.0	1.2
07	Hollis	28	12-9-81	40	26	6.7	15	3.0	.02
08	Shapleigh	80	11-3-81	25	16	5.4	20	<0.5	.25
09	Waterboro	26	11-2-81	55	36	5.8	21	8.0	.03
11	Hollis	48	12-9-81	38	25	6.1	9	5.5	.30
12	Waterboro	19	12-8-81	130*	85*	6.5	11	42*	.05
15	Hollis	21	12-8-81	100	65	6.2	8	6.5	<.01
16	Newfield	18	11-2-81	70	46	6.3	8	3.0	.02
17	Waterboro	25	12-14-81	58	38	N/A	N/A	N/A	N/A
18	Lyman	34	12-8-81	110	72	6.8	29	3.0	<.01
19	Lyman	19	12-8-81	55	36	6.6	17	2.0	.03
20	Lyman	18	12-8-81	20	13	6.6	6	1.5	.05
22	Sanford	25	11-17-81	80	52	6.5	31	2.0	.05
23	Kennebunk	32	11-17-81	71	46	6.9	13	3.0	.05
24	Kennebunk	27	11-17-81	42	27	6.7	16	2.0	.05
25	Kennebunk	39	11-20-81	38	25	6.1	11	2.5	.05
26	Kennebunk	28	11-17-81	105	68	7.3	30	9.0	.04
27	Sanford	20	11-20-81	214*	139*	6.3	82	19*	<.01
28	Wells	35	11-20-81	106	69	6.0	36	8.5	.04
29	Sanford	15	11-20-81	140	36	5.8	50	8.5	.04
30	Wells	56	11-20-81	122	79	5.3	12	4.5	.14
35	Cornish	28	11-1-83	51	33	5.8	9	4.5	2.8**

All Values in mg/L unless noted NA = not analyzed

TDS = Total Dissolved Solids in mg/L as estimated from conductivity values

*-Value believed to be influenced by road salt

**-Value believed to be influenced by septic system leachate

Table 1. (Continued) BACKGROUND WATER CHEMISTRY SUMMARY

Well	Town	Sulfate	Sodium	Potassium	Calcium	Magnesium	Hardness (mg/L as CaC03)	Iron	Manganese
02	Limerick	<10	9.5	4.5	29	4.8	92	.06	.09
03	Waterboro	<10	9.6	4.8	15	2.7	58	3.3	.24
04	Limington	<10	1.4	1.2	4.2	0.8	16	.31	.94
07	Hollis	<10	3.6	1.5	4.1	1.0	15	.08	.18
08	Shapleigh	17	5.7	1.2	12	1.4	36	.12	.11
09	Waterboro	< 5	8.8	1.6	7.8	1.1	27	1.1	.21
11	Hollis	<10	4.1	0.8	3.2	0.6	11	.05	.10
12	Waterboro	<10	20*	3.6	10	2.3	35	.04	.31
15	Hollis	<10	5.6	0.8	2.1	0.5	9	.36	.25
16	Newfield	< 5	3.9	1.2	5.2	0.6	16	.03	.09
17	Waterboro	NA	4.2	2.0	3.3	0.7	12	.32	.32
18	Lyman	<10	4.6	1.9	7.0	1.5	25	.28	.17
19	Lyman	<10	2.7	1.7	4.3	1.1	17	.37	.16
20	Lyman	<10	1.9	0.4	2.2	0.3	7	.03	.01
22	Sanford	< 5	5.0	3.0	8.6	2.6	61	10.	.87
23	Kennebunk	9	5.5	2.9	8.9	3.3	61	8.5	1.4
24	Kennebunk	7	2.8	1.6	3.6	1.1	20	2.0	.41
25	Kennebunk	12	3.8	2.5	3.0	0.8	12	.37	.33
26	Kennebunk	18	9.9	2.3	8.8	2.5	35	.11	1.5
27	Sanford	10	52*	2.8	8.0	3.7	37	.37	.58
28	Wells	7	11	2.3	9.8	3.3	41	.30	.97
29	Sanford	7	11	2.8	15	5.9	65	.75	.97
30	Wells	14	5.5	2.4	5.5	1.4	21	.40	.36
35	Cornish	3	5.8	0.9	3.2	0.6	11	.08	.02

All values in mg/L unless noted NA= not analysed

* Value believed to be influenced by road salt

TABLE 2
STATISTICAL SUMMARY OF BACKGROUND WATER CHEMISTRY

Parameter[a]	N[b]	Mean	Standard Deviation	Range	Statistical Maximum[c]	Recommended Limits[d]
Conductivity	22	69	33	20-140	170	None
Total Dissolved Solids	22	44	19	13-79	100	500
pH	23	6.0[e]	--	5.3-7.3	---	6.5-8.5
Alkalinity	23	23	19	6-82	80	None
Chloride	21	4.3	2.6	<0.5-9.0	12	250
Nitrate	22	0.12	0.24	<0.01-1.2	0.84	10
Sulfate	23	7.0	4.3	<5-18	20	250
Sodium	22	5.7	2.9	1.4-11	14	20
Potassium	24	2.1	1.1	0.4-4.8	5.4	None
Calcium	24	9.2	5.8	2.1-29	25	None
Magnesium	24	1.7	1.4	0.3-5.9	6.1	None
Hardness	24	1.9	22	7-92	97	None
Iron	24	1.2	2.5	0.03-10	8.7	0.3
Manganese	24	.44	0.42	.01-1.5	1.7	0.05

a All values in mg/L except conductivity (umhos/cm), alkalinity and hardness (mg/L as $CaCO_3$), nitrate (mg/L as N), and pH

b Samples influenced by road salt or septic system leachate not included in statistical summary

c The maximum concentrations expected in uncontaminated ground water in sand and gravel aquifers in York County. This value equals the mean plus 3 times the standard deviation. Statistically, there is a 99 percent probability that water containing a higher concentration of a given parameter than that listed has been influenced by something that has not affected the background water quality samples. Two assumptions were made to calculate this value:

1. These samples are representative of background water quality in York County as a whole.
2. The concentrations of each parameter follow a normal distribution pattern.

d Department of Human Services (DHS, 1983) Limits, except pH, which is the EPA secondary limit (USEPA, 1979)

e Calculated from H^+concentration

Total Dissolved Solids (TDS)

TDS levels (in mg/L) can be estimated by multiplying the specific conductance of water in umhos/cm by 0.65 (Matthess, 1982). Water containing high levels of TDS can have detrimental effects on crops when used for irrigation purposes, can cause precipitates to form in boilers and other heating units, shortening their usable life, can corrode washing machines and other appliances, and can have adverse taste effects (USEPA, 1979). The Environmental Protection Agency (EPA) and the Maine Department of Human Services (DHS) have set secondary recommended contaminant levels of 500 mg/L for TDS in domestic water supplies (DHS, 1983). TDS levels as low as 200 mg/L can lead to plumbing problems, but this level of dissolved solids was determined to be unrealistic for a secondary standard in many parts of the country.

The background water quality samples had TDS levels ranging from 13 to 79 mg/L with a mean of 44 mg/L (Table 2). The maximum expected background TDS level in York County sand and gravel aquifers is 100 mg/L.

pH

The pH of water is a measurement of the amount of free hydrogen ions in solution. The pH scale is logarithmic, and designed such that lower pH values indicate higher hydrogen ion (or acidity) levels.

pH is an important parameter in water chemistry because it determines the solubility of many elements, especially metals. High hydrogen ion levels (low pH) cause water to be corrosive, dissolving soil particles, distribution lines and plumbing fixtures. This can increase concentrations of copper, zinc, cadmium, aluminum, lead, or other metals which are toxic when consumed in high concentrations (Sharpe and Clarkson, 1983). Low pH waters require heavier doses of chlorine for disinfection purpose, and have an unpleasant taste (USEPA, 1979).

High pH waters also have a bitter taste and require more chlorination for disinfection. High pH also allows the formation of toxic trihalomethanes during water treatment procedures. Thus, the EPA has set pH 6.5 as a minimum secondary standard for drinking water, and pH 8.5 as a maximum secondary standard (USEPA, 1979).

Ground waters are naturally buffered with carbon dioxide and hydrogen carbonate, and thus rarely are found below pH 5.0 or above pH 8.0. However, acid deposition (acid rain) has lowered the pH in some shallow ground water wells in Sweden to as low as 4.0 (Swedish Ministry of Agriculture, 1982). Shallow ground-water in New York State has also been found to be acidified and, as a result, to have high aluminum levels (Fuhs, 1981). In both of these areas the aquifers are composed of siliceous poorly buffered materials, as they are in much of York County.

The background water quality samples had pH values ranging from 5.3 to 7.3, with a mean of 6.0 (Table 2.). The wide variety of pH levels in these samples prevents a determination of "contaminated" vs. "uncontaminated" pH values. Thirteen of 24 samples have pH values below the EPA recommended minimum of 6.5 (Table 1); in fact, the mean pH of 6.0 is below this limit. It is not known whether these low pH values are naturally derived, or are a result of acid deposition. The Maine Water Company (Kezar Falls Division) is treating its water with soda ash for pH adjustment (U.S. Army Corps of Engineers, 1982). It is the only municipal water supply in York County known to be doing so.

Alkalinity

Alkalinity is a measure of the capacity of a solution to resist a change in pH as an acid is added to it. In the pH and geologic conditions found in York County ground waters, alkalinity is determined primarily by the concentration of hydrogen carbonate ions and undissociated carbonic acid. At higher pH's carbonate ions also contribute to the alkalinity; at landfills organic acids may be important contributors to the total alkalinity (Matthess, 1982).

As discussed in the previous section, poorly buffered groundwaters (alkalinity less than 20 mg/L) are the most susceptible to the effects of acid deposition. There are no state or federal limits for alkalinity in drinking water.

The background water quality samples had alkalinity values ranging from 6 to 82 mg/L as $CaCO_3$, with a mean of 23 mg/L (Table 2). The maximum expected background alkalinity value in York County sand and gravel aquifers is 80 mg/L.

Chloride

Chloride concentrations of a few mg/L are expected naturally in ground water in Maine. The chloride is derived from trace amounts found in rocks and from chloride derived from the atmosphere. Higher chloride concentrations are commonly associated with contamination from salt water intrusion, septic tanks, and, most commonly in Maine, highway de-icing operations and salt storage facilities. Chloride is a highly mobile ion; once released it travels freely through the aquifer.

There are no known health effects associated with drinking water containing high chloride levels. However, high concentrations of chloride can impart a salty taste to the water, and high salt levels in water can corrode pipes, pumps and plumbing fixtures (USEPA, 1979). Thus the DHS and the EPA have set secondary drinking water standards for chloride of 250 mg/L. Chloride levels above 100 mg/L can cause a decline in the life of plumbing fixtures and appliances (Lawrence, 1975).

The background water quality samples had chloride concentrations ranging from less than 0.5 to 9.0 mg/L, with a mean of 4.3 mg/L (Table 2). The maximum expected background chloride concentration in York County sand and gravel aquifers is 12 mg/L.

Nitrate

Nitrogen compounds are commonly found in uncontaminated ground water in only trace amounts. The compounds are derived primarily from rainfall containing ammonia, nitrate and trace amounts of nitrite. The nitrogen compounds are transformed by biological processes and oxidation to nitrate. Plants take up nitrate from the soil, only releasing it to ground water when nitrate is available in excess of the plant's needs (Matthess, 1982).

Nitrogen is added to ground water through a number of man-made sources, including municipal and industrial waste waters, landfills, animal feed lots, fertilizer use, and septic tanks. Ground water from shallow wells tends to have higher nitrate concentrations than water from deep wells (Larson and Henley, 1966).

The Limerick Water District, which is supplied by a 12 ft deep dug well, frequently has a problem with nitrate contamination of their water supply. The primary source of this nitrate is apparently residential septic tank leaching fields located upgradient of the supply source (US Army Corp of Engineers, 1982).

Nitrate-N (nitrate expressed in terms of an equivalent amount of nitrogen) in drinking water in concentrations below 1000 mg/L is not directly toxic to adults. However, the alkaline stomachs of infants younger than 4 months old will support the growth of nitrate reducing bacteria, which reduce nitrate to nitrite. Nitrite is directly toxic, causing methemoglobinemia (blue-baby syndrome) which is lethal. Nitrite also can form potent carcinogenic compounds. (National Research Council, 1977).

A primary drinking standard of 10 mg/L for nitrate-N in drinking water has been set by the EPA (USEPA, 1971) and the DHS (1983). Methemoglobinemia has not been recorded in infants drinking water with a lower nitrate concentration than this, although it has been noted in infants being supplied with water containing nitrate-N only slightly in excess of 10 mg/L. The recommended concentration limit for nitrate-N in livestock water supplies is also 10 mg/L, because nitrate can be reduced to nitrite in the stomach of ruminants and in the cecum and colon of horses (National Research Council, 1977).

The background water quality samples had nitrate concentrations ranging from less than 0.01 to 1.2 mg/L as N, with a mean of 0.12 mg/L (Table 2). The maximum expected background nitrate concentration in York County sand and gravel aquifers is 0.84 mg/L.

Sulfate

Sulfate is added to ground water from a variety natural sources, including atmospheric deposition, the breakdown of organic substances, and the oxidation of sulfide bearing minerals. Man-made sulfate sources include air pollutants, fertilizers, landfills, sewage disposal sites, tanneries, pulp mills and textile plants (Matthess, 1982; National Research Council, 1977).

Sulfate in drinking water has a laxative effect at concentrations above 600 mg/L, but has no other known health effect. Sulfate causes a taste in water to most individuals when present at 300 to 400 mg/L. Water containing appreciable amounts of sulfate tends to form scale in boilers and heat exchangers (USEPA, 1979). For these reasons, the EPA and DHS (1983) have set secondary limits for sulfate in drinking water of 250 mg/L.

Under anaerobic conditions sulfate can be reduced to hydrogen sulfide. Hydrogen sulfide has a "rotten egg" odor which even at concentrations of less than 1 mg/L makes water unappealing to drink. Hydrogen sulfide gas is a problem in many drilled wells in York County, but is not generally a problem in wells or springs in sand and gravel aquifers.

The background water quality samples had sulfate concentrations ranging from less than 5 to 18 mg/L, with a mean of 7.0 mg/L (Table 2.). The maximum expected background sulfate concentration in York County sand and gravel aquifers is 20 mg/L.

Sodium

Sodium is a major constituent of rocks and soils. It enters the ground water from the decomposition of sodium aluminum silicates, the incorporation of sea salts into rainfall, and the intrusion of sea water into fresh water aquifers (National Research Council, 1977). Salt spray from the seas is often the major source of sodium ions to ground water in coastal regions such as York County. Other major sources of sodium to drinking water in Maine include the leaching of highway de-icing salts from roadways and storage facilities and the addition of sodium via water softeners. (Sheharta, 1983).

High levels of sodium intake have been shown to cause hypertension and high blood pressure in humans, which in turn increases the risk of cardiovascular disease. An estimated 7.8% of adult Americans must restrict their daily intake of sodium, often to a limit of 500 mg/L to maintain their blood pressure at normal levels. Because it is not feasible to reduce sodium intake from food to less than 440 mg/day, adverse health affects may occur in these people if water containing more than 20 mg/L of sodium is consumed regularly. British studies have also suggested that "crib deaths" due to hypernatremia may be linked to the consumption of water with a high sodium concentration (National Research Council, 1977). Thus, the Maine Department of Human Services (1983) has set the limit for sodium in drinking water in Maine at 20 mg/L. Most individuals, however, would not be harmed by drinking water containing less than 100 mg/L of sodium (National Research Council, 1977).

The background water quality samples had sodium concentrations ranging from 1.4 to 11 mg/L, with a mean of 5.7 mg/L (Table 2). The maximum expected background sodium level in York County sand and gravel aquifers is 14 mg/L.

Potassium

Potassium is another abundant chemical in rocks and soils. However, due to its lower geochemical mobility, in ground water potassium is usually found in much lower concentrations than sodium. Potassium is used as an agricultural fertilizer, which can lead to significantly higher potassium concentrations in ground water below fertilized fields (Matthess, 1982).

Potassium is an abundant and necessary nutrient in human foods. It is not toxic unless taken in very large doses, which would be unlikely to be supplied through drinking water. Thus, there are no state or federal limits for potassium in drinking water.

The background water quality samples had potassium concentrations ranging from 0.4 to 4.8 mg/L with a mean of 2.1 mg/L (Table 2).The maximum expected background potassium concentration in York County sand and gravel aquifers is 5.4 mg/L.

Calcium

Calcium is the most abundant cation in most ground waters, being derived from mineral dissolution and atmospheric sources (Matthess, 1982). Calcium is also commonly introduced to ground water through man-made sources, including municipal sewage wastes, landfills, and agricultural liming activities.

Calcium is a necessary nutrient for humans, and has not been shown to be toxic even when consumed in large quantities. Kidney stones have been associated with large intakes of calcium, however. The levels of calcium found in drinking water are well below those known to produce human health problems; thus, there are no federal or state limits on calcium concentrations in drinking water (National Research Council, 1980). High calcium concentrations can lead to nuisance problems associated with hard water, as discussed in the section describing hardness.

The background water quality samples had calcium concentrations ranging from 2.1 to 29 mg/L with a mean of 7.7 mg/L (Table 2). The maximum expected background calcium concentration in York County sand and gravel aquifers is 25 mg/L.

Magnesium

Most magnesium compounds are very soluble in fresh water, and are therefore abundant in most ground water. Magnesium behaves similarly to calcium in aquatic environments but because it is less abundant than calcium in most rocks, it is usually found in lower concentrations than calcium in ground water. Magnesium is introduced to ground water through municipal sewage wastes, landfills, and agricultural liming activities.

Magnesium is an essential element in human nutrition. It is generally non-toxic, but can have a laxative effect when consumed in concentrations above 400 to 700 mg/L. Magnesium imparts an unpleasant taste to water in concentrations above 500 mg/L (100 mg/L in sensitive persons). The World Health Organization has recommended a limit of 150 mg/L for magnesium in drinking water, but because magnesium is not thought to be harmful to human health in concentrations below that which will cause water to be unpalatable due to its unpleasant taste, there are no state or federal limits on magnesium in drinking water (National Research Council, 1977).

The background water quality samples had magnesium concentrations ranging from 0.3 to 5.9 mg/L, with a mean of 1.9 mg/L (Table 2). The maximum expected background magnesium level in York County sand and gravel aquifers is 6.1 mg/L.

Hardness

Hardness is an measure of the combined concentrations in water of calcium, magnesium, and other polyvalent cations, expressed as the equivalent concentration of calcium carbonate in mg/L. Hardness provides an indication of how soap will react with the water. Hard waters (above 60 mg/L) require considerable amounts of soap to produce a lather, and cause scale in hot-water pipes, boilers and other units that use hot water (Tolman and others, 1983).

Some studies in the United States and Canada have shown that populations using very soft water may have 15 to 20% higher cardiovascular mortality rates than populations using hard water. Whether this is due to one or more of the elements associated with hardness having a protective effect on cardiovascular function, harmful metals being more prevalent in soft, acidic water, or some other factor is not known (National Research Council, 1977).

There are no state or federal limits for hardness, but when hardness exceeds 80-100 mg/L in municipal water supplies, water treatment is often applied (Clark and others, 1977). Home water softening systems generally work by exchanging sodium ions for calcium and magnesium. These systems should not be hooked to the drinking water supply lines to avoid problems with excessive sodium consumption.

The background water quality samples had hardness values ranging from 7 to 92 mg/L, with a mean of 31 mg/L (Table 2). The maximum expected background hardness value in York County sand and gravel aquifers is 97 mg/L.

Iron

Iron is one of the most abundant constituents in rocks and soils. Its concentration in ground water is controlled largely by the pH, carbonate, sulfate and oxygen content of the water. Because these factors change as the water table rises or falls, iron contents between nearby wells or within the same well over time can be quite variable (Matthess, 1982).

In highly oxygenated waters iron concentrations are usually quite low. In reducing environments, especially in iron sulfide rich rocks or in the presence of organic matter, iron concentrations in ground water tend to be much higher. Human activities, such as landfilling of wastes, can also cause high iron concentrations in ground water.

In very high doses iron is a toxic element. In the range of iron concentrations found in ground water, it is usually beneficial to health (National Research Council, 1980). However, iron contents in domestic water supplies is undesirable from an aesthetic viewpoint. At iron concentrations above 0.05 mg/L a brownish staining of fixtures and laundered goods may occur. Iron imparts a bitter taste to water when present in concentrations above 0.1 to 1.0 mg/L. Because of these undesirable effects, the USEPA and Maine Department of Human Services have set secondary maximum contaminant levels for iron in drinking water at 0.3 mg/L. This limit was determined to represent a reasonable level at which taste effects and staining problems would be minimized (USEPA, 1979).

The background water quality samples had iron values ranging from 0.03 to 10.0 mg/L, with a mean of 1.2 mg/L (Table 2). Fifty four percent of these wells had iron concentrations exceeding the DHS/EPA limit of 0.3 mg/L. Due to the high concentrations of iron in natural ground water in York County, iron concentrations exceeding the DHS limits cannot necessarily be attributed to man-made sources. However, as explained in Table 2, it is highly probable that ground water in York County sand and gravel aquifers with iron concentrations above 8.7 mg/L has been influenced by some anthropogenic source.

Manganese

Similar to iron, manganese concentrations in ground water are largely controlled by the pH and oxygen content of the water. Because manganese is less abundant than iron in rocks and soils, it is usually found in lower concentrations in ground water (Matthess, 1982).

Water grossly polluted with manganese and zinc has proven toxic in Japan, but manganese in drinking water acts, in general, as an essential trace element for man (National Research Council, 1977). High manganese concentrations are a problem in domestic water supplies because manganese stains plumbing fixtures and laundry, and impairs the taste of drinking water. These problems become apparent at concentrations as low as 0.01 - 0.02 mg/L (USEPA, 1979). The Maine Department of Human Services and the EPA have set a secondary maximum contaminant level for manganese of 0.05 mg/L.

The background water quality samples had manganese values ranging from 0.01 to 1.50 mg/L, with a mean of 0.44 mg/L (Table 2). Twenty two of these 24 samples (92%) had manganese concentrations exceeding the EPA and DHS limits. The mean manganese concentration of these samples is 8 times as high as the recommended limit. Due to the high concentrations of manganese in natural ground water in York County, manganese concentrations exceeding the DHS limit cannot necessarily be attributed to man-made sources. The maximum expected background manganese concentration in York County sand and gravel aquifers is 1.7.

Iron and manganese can be removed from private water supplies through filtration. In public supplies iron and manganese are removed by a combination of chemical treatment and filtration.

Due to the high cost of treatment none of the municipal water districts in York County currently treat their water supplies to remove excess iron and manganese. Instead, both South Berwick and Sanford have abandoned certain wells in which excessive iron and manganese concentrations were present (DHS, 1972).

Volatile Organic Priority Pollutants

Volatile priority pollutants include more than 30 organic compounds which boil between 40° and 120°C. These compounds include many of the most toxic hazardous substances found in ground water. Sources for the volatile priority pollutants include petroleum products, cleaning solvents, paints, herbicides, and pesticides.

No volatile organic compounds were detected in background wells in York County (at a detection limit of 1 microgram/L for trichloroethane), with the exception of tetrahydrofuran (THF). THF was only found in those wells which were installed using PVC cement to join plastic pipe sections; in those wells THF concentrations as high as 300 mg/L were present. While THF is not known to cause health problems, its presence in these samples interfered with both volatile organic and total organic carbon analyses. Thus, the use of PVC cement on monitoring wells should be avoided. The National Research Council (1982) has found that methyl ethyl ketone and cyclohexanone are also leached from PVC cement.

Volatile organic compounds found in contamination site monitoring wells in York County include xylene; tetrachloroethylene; trichloroethylene; ethylbenzene; methylene chloride; toluene; dichloroethylene; dichloroethane, and 1, 1, 1 trichloroethane. A summary of information about these compounds from the National Research Council (1977, 1980, 1982, 1983) is given in Table 3.

Barium, Cadmium, Chromium, Lead

Trace metals were not analyzed in the background water quality samples. However, they should be present only in very low concentrations in natural groundwaters. Analyses for barium, cadmium, chromium and lead were made in several contamination site ground water samples, and found to exceed recommended drinking water standards in some cases.

Barium is very insoluble in water, and is therefore rarely found in concentrations exceeding 1 mg/L. Barium can be highly toxic when ingested. Symptoms of barium poisoning include nerve blockage and muscle, heart and bladder disorders (National Research Council, 1979). The EPA/DHS recommended limit for barium in drinking water is 1 mg/L.

Cadmium is used in electroplating operations and is an impurity in some galvanized metal. There are no known beneficial effects from the consumption of cadmium. Harmful effects include nausea, vomiting, diarrhea, bronchitis, anemia and renal stones. When consumed in high quantities cadmium poisoning can lead to death. (National Research Council; 1977, 1980). The EPA and DHS recommended limit for cadmium in drinking water is 10 ug/L.

Chromium in the trivalent state is an essential nutrient for humans. However, in the hexavalent state excessive chromium consumption can cause tubular necrosis, hypertension, and hypoglycemia, and increase the risk of lung cancer (National Research Council, 1977). The EPA/DHS recommended limit for chromium in drinking water is 50 ug/L.

Lead is used in insecticides and in high octane gasoline. Most natural ground waters contain lead in concentrations of 0 to 20 ug/L (Matthess, 1982). There are no known beneficial effects of lead for humans. Lead consumption can cause mental defects, central nervous disorders, and kidney disorders leading to death in extreme cases. The EPA/DHS recommended limit for lead in drinking water is 50 ug/L.

Table 3. Properties of certain volatile organic compounds detected in York County Ground Water.

Compound	Uses	Health Effects	SNARL 1 Day	SNARL 7 Days	SNARL Long-Term
xylenes	petroleum distillation aviation gas rubber cements solvent manufacture paints	eye irritation lung congestion hemorrhage liver damage death	21	11.2	NE
tetrachlor-oethylene	solvents dry cleaning	depressant liver injury inebriation unconciousness death	172	24.5	NE
trichlor-oethylene	solvents metal degreasing dry cleaning refrigerants fumigants	nervous system disorders incoordination nausea vomiting carcinogenic	105	15	NE
methylene chloride	paint removers insecticides solvents fire extinguishers	nervous system disorders	35	5	NE
toluene	petroleum refining perfumes medicines gasoline detergents	nervous system disorders narcotic effect kidney damage disorientation muscular problems	420	35	0.34
1,1,1-tri-chloroeth-ane	metal cleaner degreaser spot remover solvent	nervous system disorders respiratory damage nausea carcinogenic	490	70	3.8

All data from National Research Council (1977, 1980, 1982, 1983).

SNARL = Suggested No Adverse Response Level (mg/L). No adverse effects should occur from drinking water containing these compounds in concentrations below these levels over 1,7, or many days.

NE = not established.

SECTION V
THE IMPACT OF POTENTIAL CONTAMINATION SOURCES ON WATER QUALITY

SELECTION OF SITES FOR STUDY

One of the initial goals of this project was to identify and investigate all potential sources of contamination to sand and gravel aquifers in York County. This proved too ambitious an undertaking, due to the difficulty of assessing the impact from non-point contamination sources, and the large number of small sources of contamination. Thus, the impacts of road salt application, malfunctioning septic tanks, and agricultural activities were not studied.

Excluding these sources, 40 sites which could potentially contaminate sand and gravel aquifers in York County were initially identified. A review of existing information and a reconnaissance level investigation of most of these sites was conducted in 1981. These findings were summarized in Tolman and others (1983). Seventeen of these sites were subsequently studied in more detail, as were seven sites not identified in the earlier study. Reports on the impact on ground-water quality of these 24 sites are presented in this section. The references cited follow each site description, and are not included in Section VII.

SITE INVESTIGATION METHODOLOGY

At each site a survey of previous studies was conducted. This was followed, at most sites, with a reconnaissance level investigation of geologic materials, hydrologic conditions, and site operation. At many sites, this information was supplemented by aquifer characterizations, including data from seismic refraction soundings, resistivity profiling, terrain conductivity measurements, and conductivity surveys of surface and ground water. At some sites water from existing monitoring wells, nearby homeowner's wells, and test wells installed specifically for this project was chemically analysed. A discussion of each of these techniques follows.

Seismic Refraction

Seismic refraction techniques were used to estimate both depth to water table and depth to bedrock. A graph of wave arrival time versus distance from the wave propagation point to each geophone location was used to determine depths of saturated and unsaturated overburden according to the methods of Mooney (1980) and Zohdy (1973). A Soiltest MD9A one-channel seismograph was used at most sites. At a few sites a 12-channel EG-C Geometrics Nimbus ES-RIOF seismograph was used.

Resistivity

Resistivity surveys were used to locate leachate plumes and to delineate their flow direction and magnitude. Electrical resistivity is a measurement of conductivity, i.e., the relative ease with which an electrical current will pass through the geologic substrate. The current will pass more easily through saturated sand and gravel than through unsaturated material, and will pass still more easily through saturated material which contains conductive ions in solution.

Electrical resistivity was measured with a Bison Model 2350B resistivity meter, using a 4-electrode Shlumberger array. Linked sounding lines were run in the downgradient direction, with electrode spacings on each line ranging from 10 feet to approximately twice the suspected depth of contamination. After data had been reduced using the computer program VES-INV (Zodhy, 1973), geoelectrical cross sections were constructed.

Resistivity values are expressed in ohm-feet units. Resistivity is the reciprocal of conductivity: lower resistivity numbers correspond to higher conductivity values. In sand and gravel deposits contaminated water generally had resistivity values of less than 500 ohm-feet and concentrated leachate had values of less than 100 ohm-feet. Saturated but uncontaminated sand and gravel deposits had resistivity values ranging from 1000 to 5000 ohm-feet. Saturated clay had resistivity values in the hundreds of ohm-feet. Because saturated clay and sand saturated with leachate yield similar resistivity values, results have been interpreted with due caution where clay was present.

Terrain Conductivity

Another method of locating leachate plumes, similar to electrical resistivity, is terrain conductivity profiling. In terrain conductivity profiling, electromagnetic currents are induced into the ground through a transmitter coil. A separate receiver coil detects the magnitude of the magnetic fields generated by these currents. Through the use of electromagnetic techniques, ground contact is avoided and it is possible to map terrain conductivity at a relatively rapid rate (McNeill, 1980a).

Terrain conductivity was measured using a Geonics Model EM 34-3 meter. Measurements were made at spacings of 10, 20 and 40 meters, using both vertical and horizontal intercoil orientations. The meter integrates the conductivity of the surficial material to an infinite depth. However, 75% of the meter's response is derived from the material between the ground surface and the following depths (McNeill, 1980b):

Spacing	Horizontal Dipole (meters)	Vertical Dipole (meters)
10m	7.5	15
20m	15	30
40m	30	60

The EM-34 meter gives conductivity readings in units of millimhos per meter. The conductivity values in mmhos/m can be converted to resistivity units (ohm-meters) by dividing them into 1000, (or dividing into 300 for ohm-feet).

Terrain conductivity readings are influenced by the chemistry of the ground water, by the depth to water, and by the nature of the geologic materials encountered. Thus, values at each site are best interpreted in relation to background readings made near, but upgradient of the contamination plume. Terrain conductivity values are not considered significantly increased unless they are at least twice background levels.

Water chemistry

Specific conductivity measurements were made directly at accessible ground water discharge points. Readings, made with either a YSI model 33 or a Beckman RB3 solu-bridge meter, were taken both upgradient and downgradient of each site, where possible.

Prior to sampling, monitoring wells were bailed or pumped until a minimum of 3 well volumes of water were removed, and temperature and conductivity stabilized. Surface grab samples were taken from the ground water fed ponds, springs and seeps.

Measurements of pH were made with a portable electronic meter (Orion, Model 399A with a glass electrode). Alkalinity was measured in the field using a gran-plot titration method (Stumm and Morgan, 1970).

Unfiltered samples for nitrate, chloride, sulfate and total organic carbon were collected in a plastic "Cubitainer" rinsed three times with well water. Samples for metal analyses were also collected in rinsed "Cubitainers", but were first filtered and then acidified with NHO_3. Samples for volatile organic analyses were collected in rinsed glass vials and immediately sealed with no air space remaining in the vial.

All samples were kept on ice and returned to the DEP laboratories within 48 hours. Metals were analyzed by atomic absorption spectrophotometry. Chloride was analyzed by the Argentometric method (Standard Method #407A), nitrate-nitrite and sulfate by an automated Technicron method and total organic carbon by a combustion tube infrared technique. Volatile organic analyses were run on a gas chromatograph equipped with a mass spectrophotometer, using a purge and trap method.

ALFRED- GERRISH SEPTAGE SITE

Site Operation and Geology

This licensed septage disposal site is underlain by poorly sorted kame deposits, consisting primarily of moderately permeable sand and gravel. The sand and gravel deposits do not constitute a significant aquifer.

Project Investigation

A dug well southwest of the septage spreading area was sampled, as was the Mousam River, which is located east of the site. The river sample was collected downstream (south) of the site. Neither sample showed any signs of contamination (Table 4).

Summary of Sites Impact on Ground-Water Quality

This site is having no measurable impact on ground-water quality. A nearby domestic well and the Mousam River near the sludge spreading site were tested; neither showed any signs of contamination. The site is not located directly over a mapped aquifer or recharge area.

Table 4: WATER CHEMISTRY IN A DUG WELL AND THE MOUSAM RIVER NEAR THE ALFRED-GERRISH SEPTAGE SITE

	Dug Well	Mousam River	Background Max*
Date Sampled	11-8-81	11-8-81	--
Temperature (°C)	8	NA	--
Conductivity (umhos/cm)	70	NA	170
pH	5.0	NA	--
Alkalinity (mg/L as $CaCO_3$)	14	NA	80
Chloride (mg/L)	4.0	2.0	12
Nitrate "	1.1	0.02	0.84
Sulfate "	<5	<5	20
Sodium "	3.8	2.8	14
Potassium "	0.88	0.55	5.4
Calcium "	6.0	2.9	25
Magnesium "	5.2	0.68	6.1
Hardness "	36	NA	97
Iron "	0.030	0.027	8.7
Manganese "	0.016	0.020	1.7

* maximum level expected in uncontaminated ground water as determined in Section III of this report.

NA = not analysed

ALFRED TRANSFER STATION

Operational History

This site was used as a dump for domestic waste from 1937 to 1979. Since 1979 the facility has operated as a transfer station. The old dump has been covered. This site is located 150 meters northwest of the Alfred Water Company well. This well services 215 households, with an average withdrawal of 37,000 gallons per day.

Site Geology

The site is located in highly permeable and well drained ice contact and outwash deposits in a glacial delta. Seismic profiling indicates that bedrock depths east of the dump range from 40 to 80 feet below land surface, with the water table from 0 to 20 feet below the land surface (Figure 1). A test well drilled to the southeast of the dump encountered the following materials:

Depth (feet)	Materials
0-2	gravel, 2-3 inch diameter
2-11	coarse sand, gravel
11-15	gravel
15-21	coarse sand, gravel cobbles
21-85	very coarse sand, gravel pebbles
85-87	till
87	bedrock

Project Investigation and Water Chemistry

In addition to seismic and drilling work mentioned above, 9 resistivity and 16 terrain conductivity soundings were taken east of the site (Figures 1 and 2), the specific conductance of surface water and seeps in 4 locations was determined, and water from the project test well was chemically analysed (Table 5).

Resistivity values as low as 40 ohm-feet were found below the old dump site. Low resistivity values were also found to the southeast of the site, near the municipal well. This location also had elevated terrain conductivity values. These readings may be influenced by the presence of clay or buried metal objects.

Neither resistivity nor terrain conductivity measurements showed a well defined plume of contaminated ground water. Terrain conductivity values were slightly elevated north of a small brook shown in Figure 2, but this is likely to have been caused by changes in the geologic substrate. Specific conductance values in the wet area east of the dump were elevated.

Water in the Alfred Water Company well is of high quality, according to Maine Department of Human Services records (Table 5). The project test well is also uncontaminated.

Summary of Sites Impact on Ground-Water Quality

The closed Alfred dump is causing some ground and surface water contamination to its east, but does not appear to have affected water quality in a nearby municipal well. Because extent of the contamination plume has not been well defined, complete chemical analyses of the municipal and project monitoring wells should be done on a semi-annual basis.

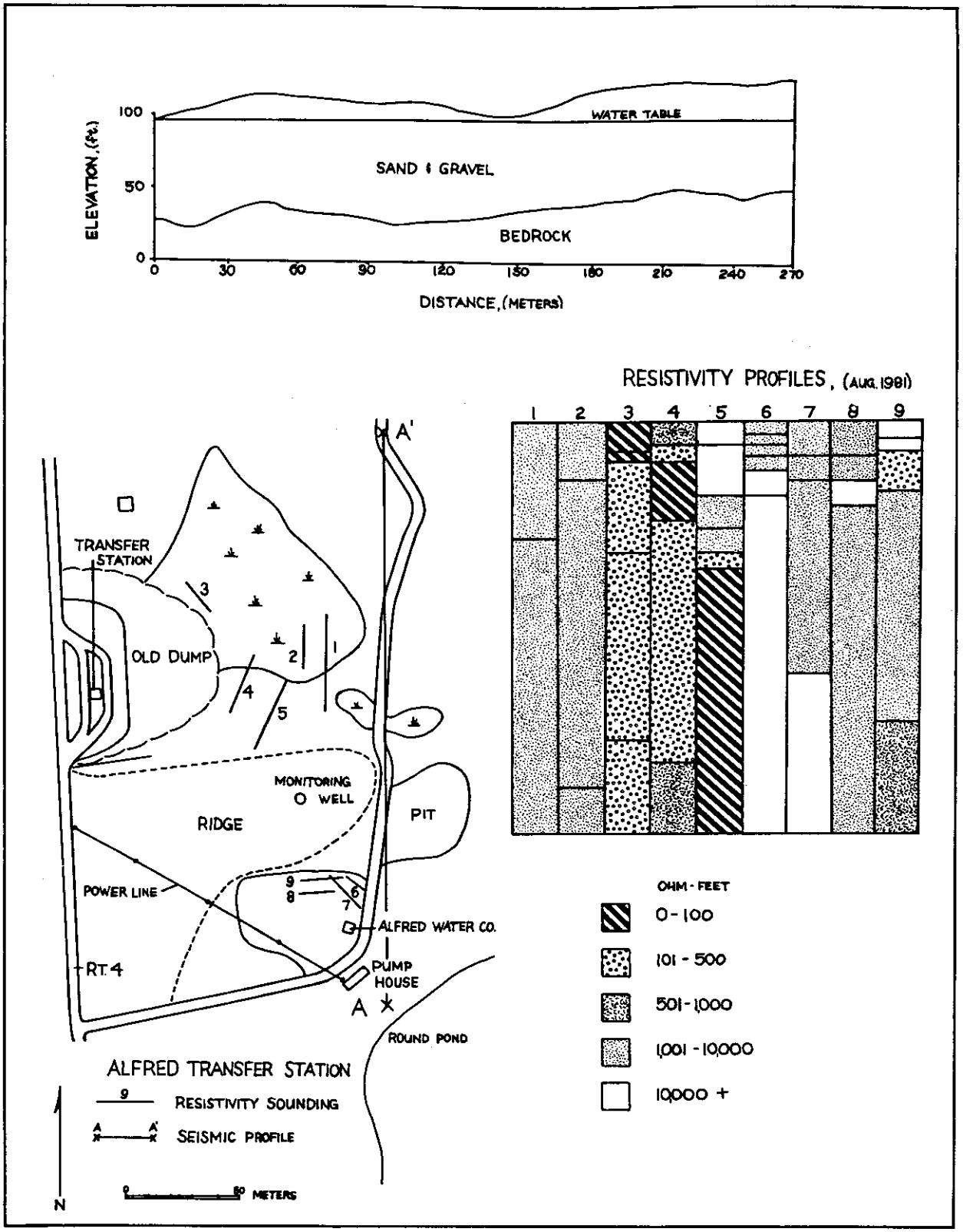

Figure 1. Alfred Transfer Station: Resistivity soundings, seismic profiles.

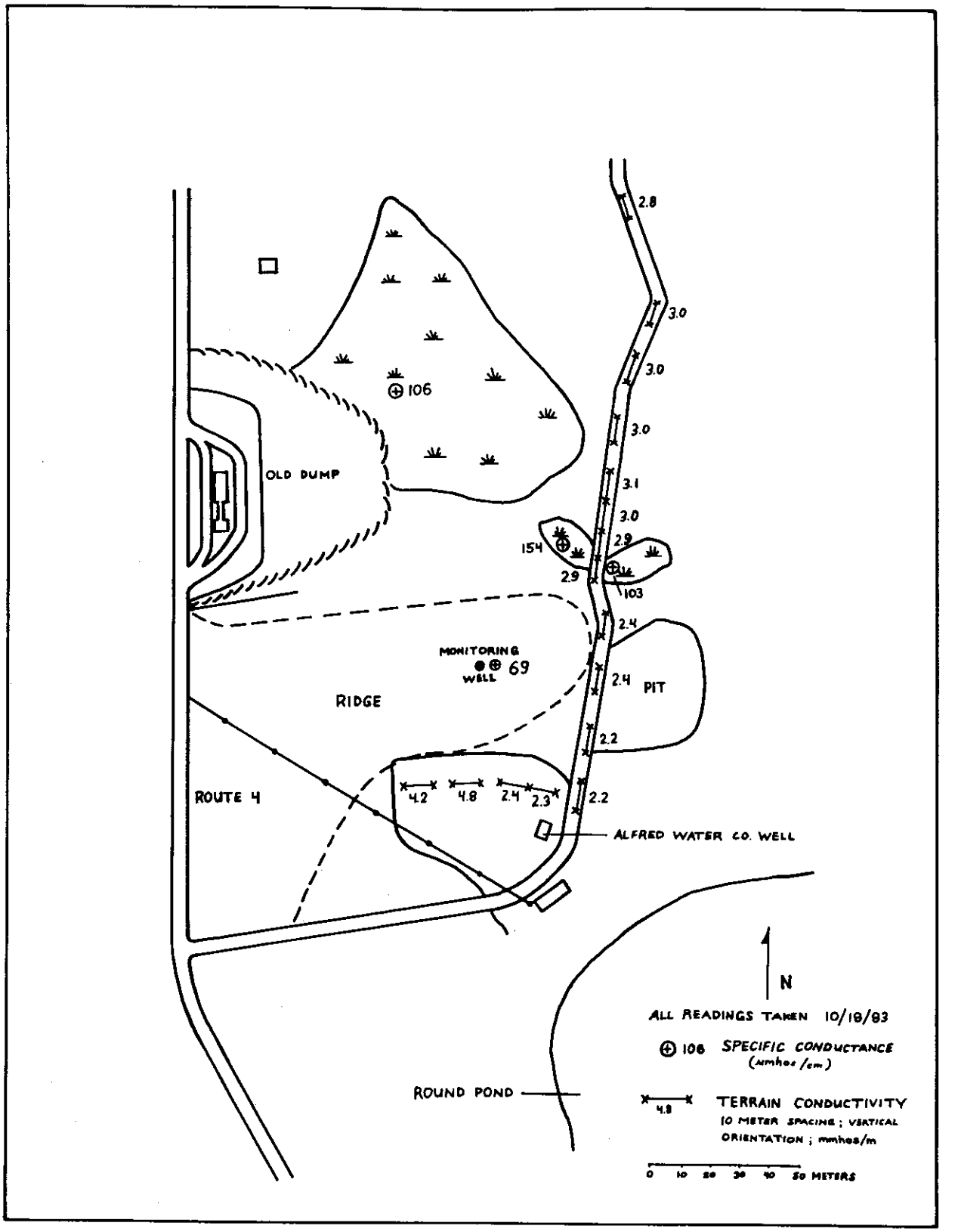

Figure 2. Alfred Transfer Station: Terrain conductivity readings, specific conductance values.

Table 5. WATER CHEMISTRY IN ALFRED DUMP MONITORING WELL AND ALFRED WATER COMPANY WELL.

A. Alfred Dump Monitoring Well

	11-19-81	10-18-83	Background Max*
Temperature(°C)	8.7	10	---
Conductivity (umhos/cm)	55	69	170
pH	5.4	---	---
Alkalinity (mg/L as $CaCO_3$)	19	---	80
Chloride (mg/L)	2.0	5.5	12
Nitrate (mg/L as N)	0.06	1.0	0.84
Sulfate (mg/L)	<5	6	20
Sodium (mg/L)	3.0	3.5	14
Potassium (mg/L)	2.6	---	5.4
Calcium (mg/L)	5.3	6.9	25
Magnesium (mg/L)	1.3	2.0	6.1
Iron (mg/L)	0.69	0.57	8.7
Manganese (mg/L)	0.29	0.05	1.7
Volatile Organic Pollutants (ug/L)	none detected (<1)	none detected (<1)	none

* Maximum level expected in uncontaminated ground water as determined in section III of this report.

B. Alfred Water Company Well[1]

	4-7-82	5-4-83	DHS Limit
pH	7.1	--	--
Chloride (mg/L)	13	--	250
Nitrate (mg/L as N))	0.4	0.35	10
Sodium (mg/L)	9	6.9	20
Hardness "	16	--	--
Iron "	ND	--	0.3
Manganese "	0.02	--	0.05
Arsenic "	ND	--	0.05
Barium "	ND	--	1
Cadmium "	ND	--	0.01
Chromium "	ND	--	0.05
Lead "	0.002	--	0.05
Mercury "	ND	--	0.002
Selenium "	ND	--	0.01
Silver "	ND	--	0.05
Zinc "	ND	--	5

1= Information from the Maine Department of Human Services
ND= not detected

ARUNDEL LANDFILL

Operational History

This site has been in operation since sometime before 1972, at first as an open, burning dump, and more recently as a landfill. The facility serves a population of nearly 2000. An uncovered, unlined sand-salt pile is stored at the northern end of the site.

Site Hydrogeology

The site is underlain by shallow, very sandy Agawam-Ninigret soils. Bedrock is exposed northeast of the site. The water table is very near the ground surface. There is a small pond in a pit northeast of the site, and numerous seeps south of the landfill.

Project Investigation

Terrain conductivity was run around the circumference of the site, using 10 meter spacing in a vertical orientation (Figure 3). Two areas of high conductivity were found; one southwest of the sand-salt pile and another south of the landfill. The specific conductance of the small pond northeast of the site was 21 umhos/cm; two seeps south of the landfill had conductivities of 870 and 980 umhos/cm.

Summary of Sites Impact on Ground-Water Quality

The landfill and sand-salt pile are causing contamination of the ground water in an area south and southwest of the site. Due to the thin overburden under the site, the area is not mapped as a sand and gravel aquifer. However, there are three residences located approximately 1000 feet south of the landfill which use wells for their water supply. The water quality of these residential wells should be monitored regularly.

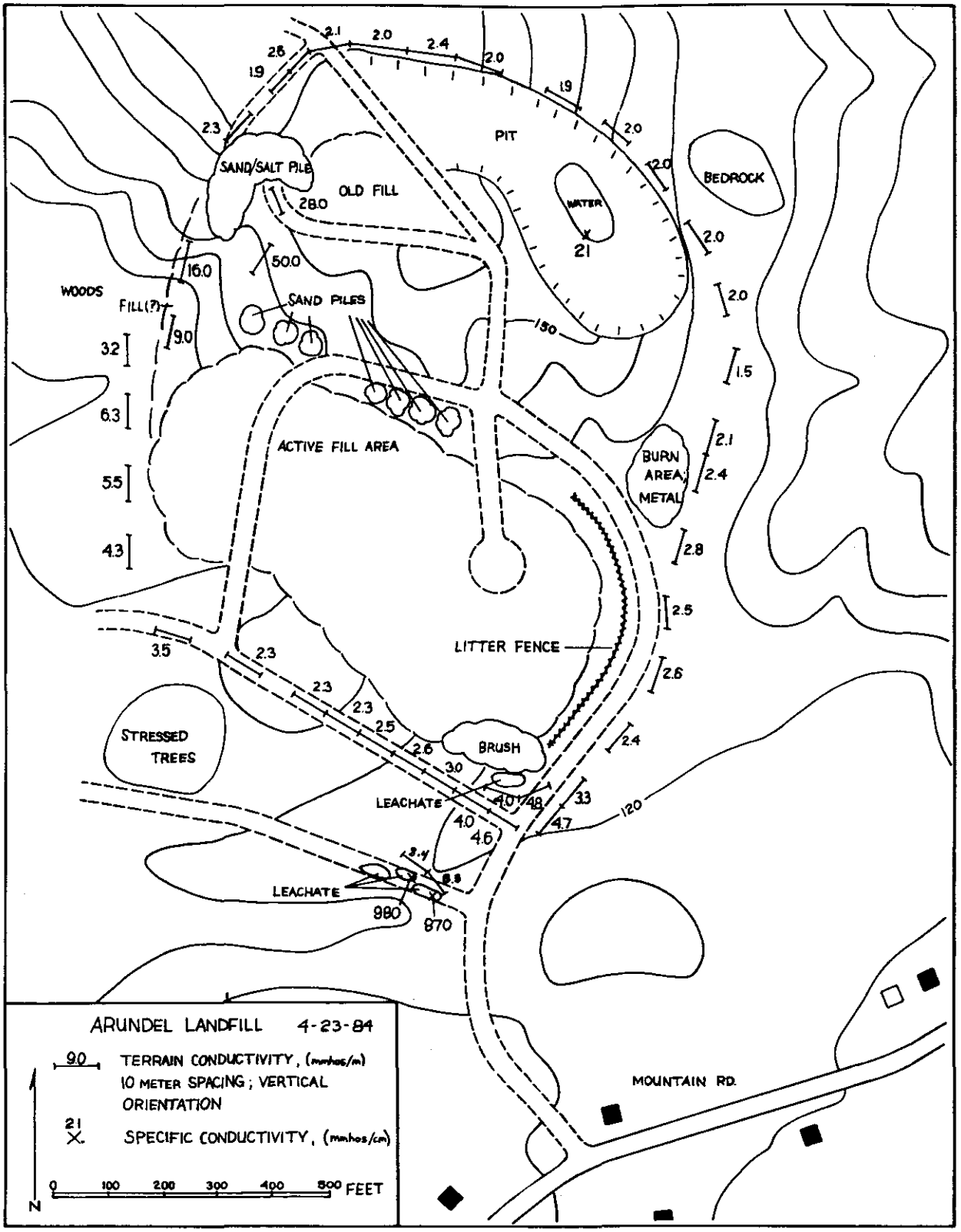

Figure 3. Arundel Landfill: Terrain conductivity readings, specific conductance values.

BIDDEFORD LANDFILL

Operational History

Since the early 1970's Biddeford has operated a landfill one mile north of Route 111, near the town's southern boundary with Arundel. Approximately 12,500 tons/year of industrial and municipal wastes are disposed of in an abandoned gravel pit. Forty-five hundred cubic yards/year of municipal wastewater treatment plant sludge is also disposed of in an impoundment adjacent to a small surface water body on site. An estimated 13 million gallons of leachate per year are generated at this site; nearly 10 million gallons/year enters bedrock and surficial aquifers (EC Jordan Co,. 1983).

Previous Studies

In 1979 the Department of Environmental Protection conducted a study of the landfill (Farrell and Day, 1980). Four monitoring wells were installed and surface and ground water samples were taken. In 1982 William Holland and Stanley Walker of the E.C. Jordan Company conducted a bedrock fracture analysis of the site. This study was used to develop a closing plan for the landfill (Jordan, 1983) which recommended the installation of 11 monitoring wells. Eight of these wells were installed in the fall of 1983.

Project Investigation

A geologic site evaluation was conducted for this project by Edward Bradley, consulting geologist, on July 8, 1982, confirming previous surficial and bedrock geologic investigations. Surface water specific conductivities were also taken in this evaluation.

Site Geology

The surficial deposits at this site consist of thin, ice-contact coarse sand and gravel. These outwash pockets are contained in a north-south trending bedrock trough. Outwash thickness varies from 0 to 15 feet, with gravelly sand and cobbles overlying fine sand and bedrock (Farrell and Day, 1980).

Ground water is present from 0 to 15 feet below the ground surface. The probable direction of ground-water flow is southerly. A large leachate seep is visible immediately downgradient and south of the landfill. A small stream, Thacher Brook, flows southeasterly from the landfill and leachate seep area. Leachate is discharging from the landfill into this stream.

The site is situated on top of a bedrock ridge over a ground-water recharge area. Bedrock consists of fractured granodiorite and outcrops in several areas throughout the site (Holland and Walker, 1982). Several downgradient residences and a mobile home park use the bedrock aquifer system for their water supply.

The landfill area was mapped as an aquifer in 1979 (Caswell, 1979). More detailed mapping showed that the area should not be considered a significant sand and gravel aquifer (plate 1).

Water Chemistry

Analyses of water samples taken in 1979 (Farrell and Day, 1980) showed that the landfill is contaminating both ground and surface water. Immediately south of the landfill the conductivity of ground water in a monitoring well installed in the surficial aquifer was as high as 1110 umhos/cm. Sodium, iron, manganese, chromium and lead concentrations all exceeded primary drinking water standards in this well. A seep south of the site was also contaminated. Impact to Thacher Brook was measured at a distance of greater than 260 feet from the landfill, where the conductivity was 250 umhos/cm.

Conductivity measurements of Thacher Brook were also taken by Edward Bradley on July 8, 1982. A very high specific conductivity (1210 umhos/cm) was found 250 feet downgradient of the landfill. The specific conductivity of Thacher Brook was 441 umhos/cm where Route 111 crosses the brook, approximately 1/2 mile downgradient of the landfill. Conductivity of the brook in 1984 was as high as 3200 umhos/cm (Cote, 1984).

Six of the monitoring wells installed in 1983 are contaminated. In these wells conductivities range from 440 to 3440 umhos/cm, and iron, lead, sodium and chloride levels exceed drinking water standards (Cote; 1984, 1985). These wells are south and east of the landfill. Three are screened in the surficial aquifer, the others in the bedrock aquifer. Two monitoring wells northwest of the site are not affected by the landfill operation; these wells have conductivities ranging from 70 to 100 umhos/cm. There has been no testing for volatile organic compounds at this site.

Water quality in the water supply wells south of the landfill has been monitored regularly since 1979. Sodium and chloride levels have been elevated in several wells in the winter, presumably due to road salting, but otherwise water quality in these wells has been very good.

Summary of Sites Impact on Ground-Water Quality

Large surface leachate seeps are visible southwest of the landfill. These seeps flow into and have an impact on Thacher Brook. Because the site is situated over thin, sandy soils in a recharge area, ground water in both the surficial and bedrock aquifers south of the site has been contaminated. The landfill has not had any impact on nearby residential wells to date.

A consent agreement between the Town of Biddeford and the Department of Environmental Protection to close the landfill is in progress. A phased closeout is planned and closure should be completed by the end of 1986. Biddeford plans to build and operate an incinerator for solid waste disposal.

References

Caswell, W.B.,1979, Sand and gravel aquifers, map 4.

Cote, G.H., Jr. (E.C. Jordan Co.), 1985, Andrews Road Landfill quarterly monitoring report, December, 1984.

_____, 1984, Andrews Road Landfill quarterly monitoring report, October, 1984.

E.C. Jordan Co., 1983, City of Biddeford solid waste disposal facility final closing plan, 46 p. plus appendices.

Farrell, R.S. and A.R. Day, 1980, Groundwater monitoring at selected solid waste disposal sites, Maine Department of Environmental Protection report, 193 p.

Holland, W. R. and S.E. Walker, E.C. Jordan Co., 1982, Letter to Donald Kale, Maine DEP about the bedrock hydrology of the Biddeford Municipal Landfill.

BUXTON CLOSED DUMP, SALT SHED

Operational History

This site is the former dump for the Town of Buxton. The dump was closed in 1979; it has since been covered and re-vegetated. Salt is stored at this site in an enclosed shed. There is no mixed sand-salt pile at this location.

Site Geology

The site is located in the distal portion of a marine delta. It is underlain by fine sand which may be interbedded with silt and clay.

Project Investigation

Resistivity traverses were run in several locations around the site. Low resistivity readings were encountered to the northeast and south-southwest of the site, but these may have been influenced by the presence of marine clay. A 41 foot point driven well, 100 feet northeast of the site, was sampled (Table 6). No contamination was detected in the well water.

Summary of Sites Impact on Ground-Water Quality

This site does not appear to be causing detectable ground-water contamination at present. This is probably attributable to the dump having been properly closed and the fact that salt is not stored uncovered in a unlined sand-salt pile.

Table 6. WATER CHEMISTRY IN POINT DRIVEN WELL 100 FEET NORTHEAST OF THE CLOSED BUXTON DUMP

	Well	Background Maximum*
Date Sampled	12-1-81	---
Temperature(^{o}C)	10.0	---
Conductivity (umhos/cm)	40	170
Alkalinity (mg/l as $CaCO_3$)	12	80
Chloride (mg/L)	3.0	12
Nitrate (mg/L)	0.92	0.84
Sodium (mg/L)	4.3	14
Potassium (mg/L)	0.89	5.4
Calcium (mg/L)	4.4	25
Magnesium (ug/L)	0.64	6.1
Hardness (mg/L)	14	97
Iron (mg/L)	0.11	8.7
Manganese (mg/l)	0.006	1.7

* Maximum level expected in uncontaminated ground water as determined in Section III of this report.

BUXTON LANDFILL

Operational History

This site was operated as an open, burning dump until 1975. At that time the dump was covered and a landfill was opened in an area southwest of the former dump site. Presently an estimated 35,000 cubic yards of domestic and industrial waste are disposed at this site each year. There are many houses to the south and west of the landfill which use dug or driven wells for their domestic water supply.

Site Hydrogeology

The consulting firm of Coffin and Richardson had a number of test holes dug in the area around the landfill. A wide variety of materials, predominantly sandy clays, were encountered in these holes. Seismic work revealed depths to bedrock ranging from 20 to 55 feet, with the water table from 0 to 15 feet below the ground surface. The site is located immediately east of a sand and gravel aquifer (plate 1). There are many houses to the south and west of the landfill which use dug or point driven wells for their water supply.

Project Investigation

Terrain conductivity measurements were taken around the perimeter of the entire landfill area. Elevated readings were found in the northern portion of this area, below the old dump, and in isolated locations where buried metal may have influenced the readings (Figure 4).

Specific conductance values were taken in a brook which is located north of the landfill. These values doubled downstream of the old dump area. The conductivity of a seep north of the active landfill was slightly elevated.

Three wells south of the landfill and one to the west were sampled (figure 5, Table 7). Two of the wells (Cote and Bryant) are located very near the Town Farm Road and had elevated sodium and chloride values, presumably from road salting. None of the wells appear to be affected by contamination from the landfill.

Summary of Sites Impact on Ground-Water Quality

The landfill leachate is apparently discharging into a wet area and stream immediately north of the site, causing minimal contamination of ground water. There are many domestic wells south and east of the landfill. While some of these wells have been affected by road salt, there is no apparent impact on these wells from the landfill.

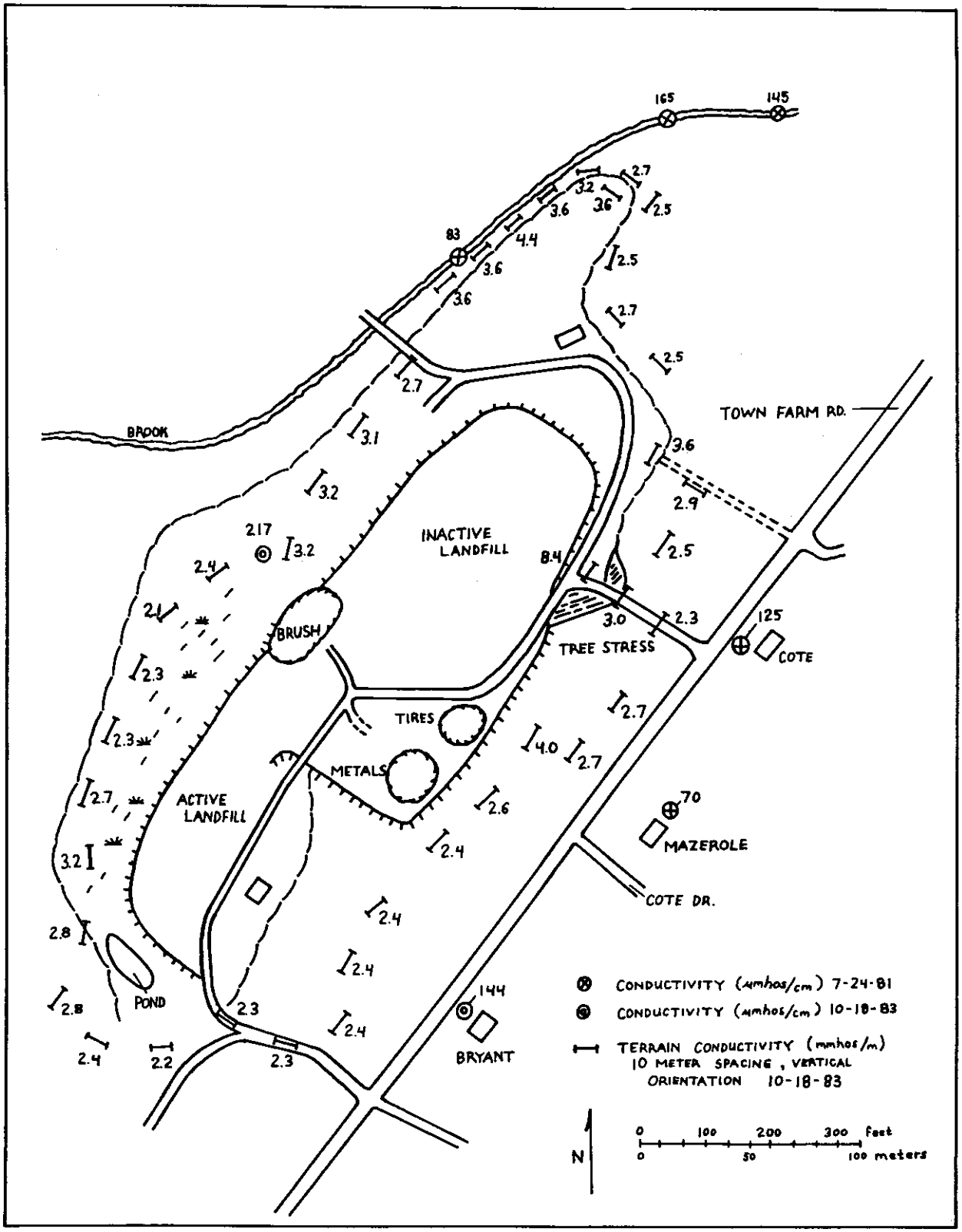

Figure 4. Buxton Landfill: Terrain conductivity, specific conductance values.

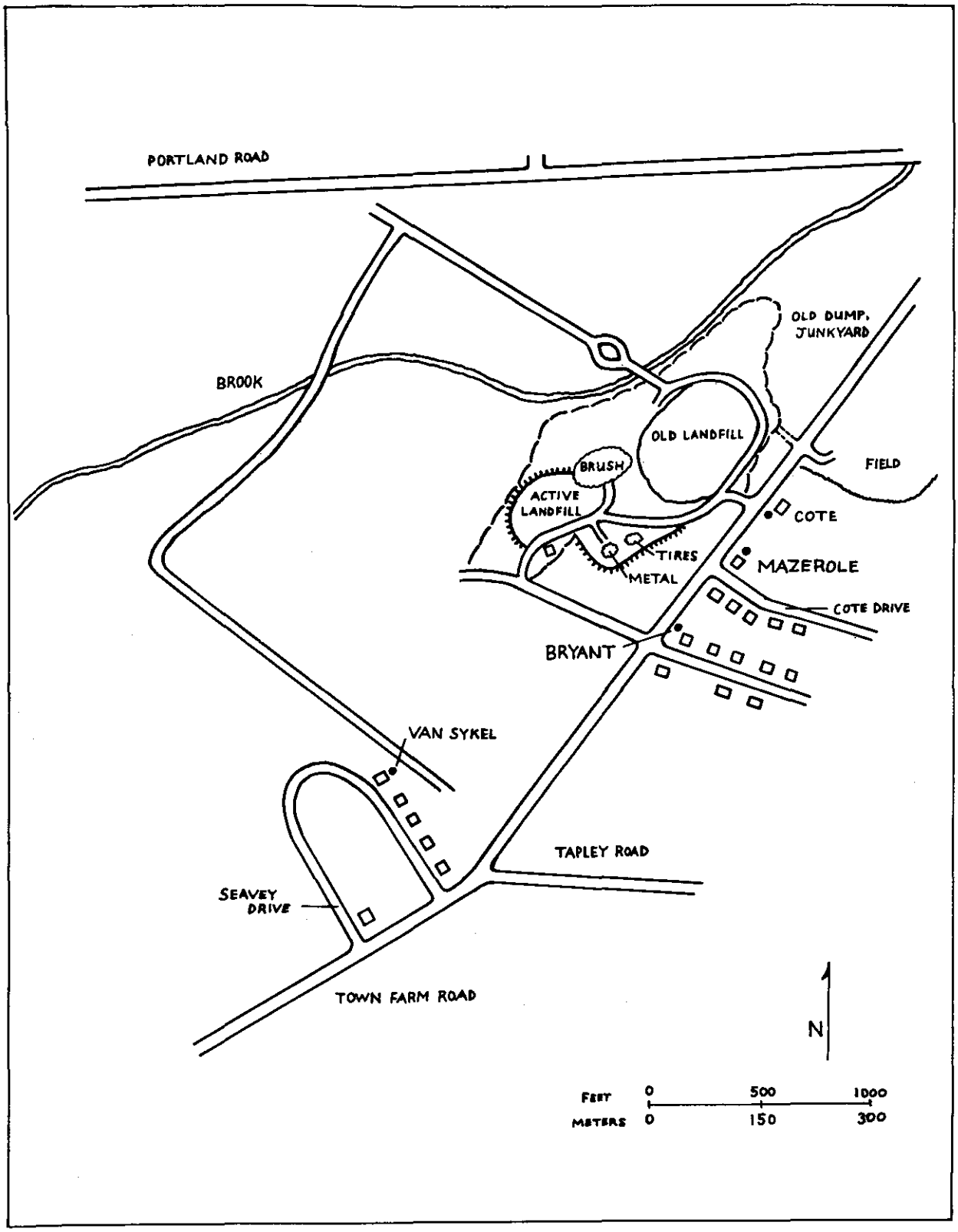

Figure 5. Buxton Landfill: Well sampling locations.

Table 7. CHEMISTRY OF WELLS NEAR THE BUXTON LANDFILL

	Cote	Mazerole	VanSycle	Bryant
Well Type	dug	point	point	dug
Well Depth (feet)	14	25	27	?
Date Sampled	12-1-81	12-1-81	12-1-81	10-18-83
Temperature (^oC)	9	12	5	16
Conductivity (umhos/cm)	125	70	45	144
pH	5.6	5.5	---	---
Alkalinity (mg/L as $CaCO_3$)	14	21	17	---
Chloride (mg/L)	37	7	4	25
Nitrate (mg/L as N)	0.29	0.60	0.16	0.59
Sulfate (mg/L)	<10	<10	<10	<3
Sodium (mg/L)	22	5.7	5.4	17
Potassium (mg/L)	1.4	1.6	1.2	---
Calcium (mg/L)	7.6	7.4	4.9	9.5
Magnesium (mg/L)	1.3	1.0	0.7	1.2
Hardness (mg/L as $CaCO_3$)	24	23	15	30
Iron (mg/L)	0.17	0.06	0.11	0.13
Manganese (mg/L)	0.011	0.005	0.008	0.01
Volatile Organics (ug/L)	<1	<1	<1	<1
Total Organic Carbon (mg/L)	3	<1	1	1

CORNISH DOT SALT STORAGE AREA

Operational History

Salt is stored at this site in an enclosed shed and in an unlined, uncovered sand-salt pile. Used asphalt from highway reconstruction and numerous metal barrels have been dumped in several locations at this site.

Site Geology

The site is located over coarse grained gravels and sand from a kame deposit. To the east of the site finer grained sediments from the Saco River flood plain overlie the coarse sand and gravel. In the area of the finer-grained sediments a large wetland has formed.

Project Investigation

Thirty eight terrain conductivity soundings were made around the perimeter of the site (Figure 6). The soundings identified a wide area of contamination between the site and the adjacent wetland. Specific conductance measurements made in the wetlands show that the ground water in much of the wetland area is contaminated, as is an intermittent stream which drains this area. This stream discharges into the Saco River, which should not be impacted due to dilution.

Summary of Sites Impact on Ground-Water Quality

Salt is being leached from this site and discharged into an adjacent wetland to the east. The contaminated water moves through the wetland to a small brook and pond, both of which have elevated conductivities. The salty water is finally discharged to the Saco River, where it should be rapidly diluted.

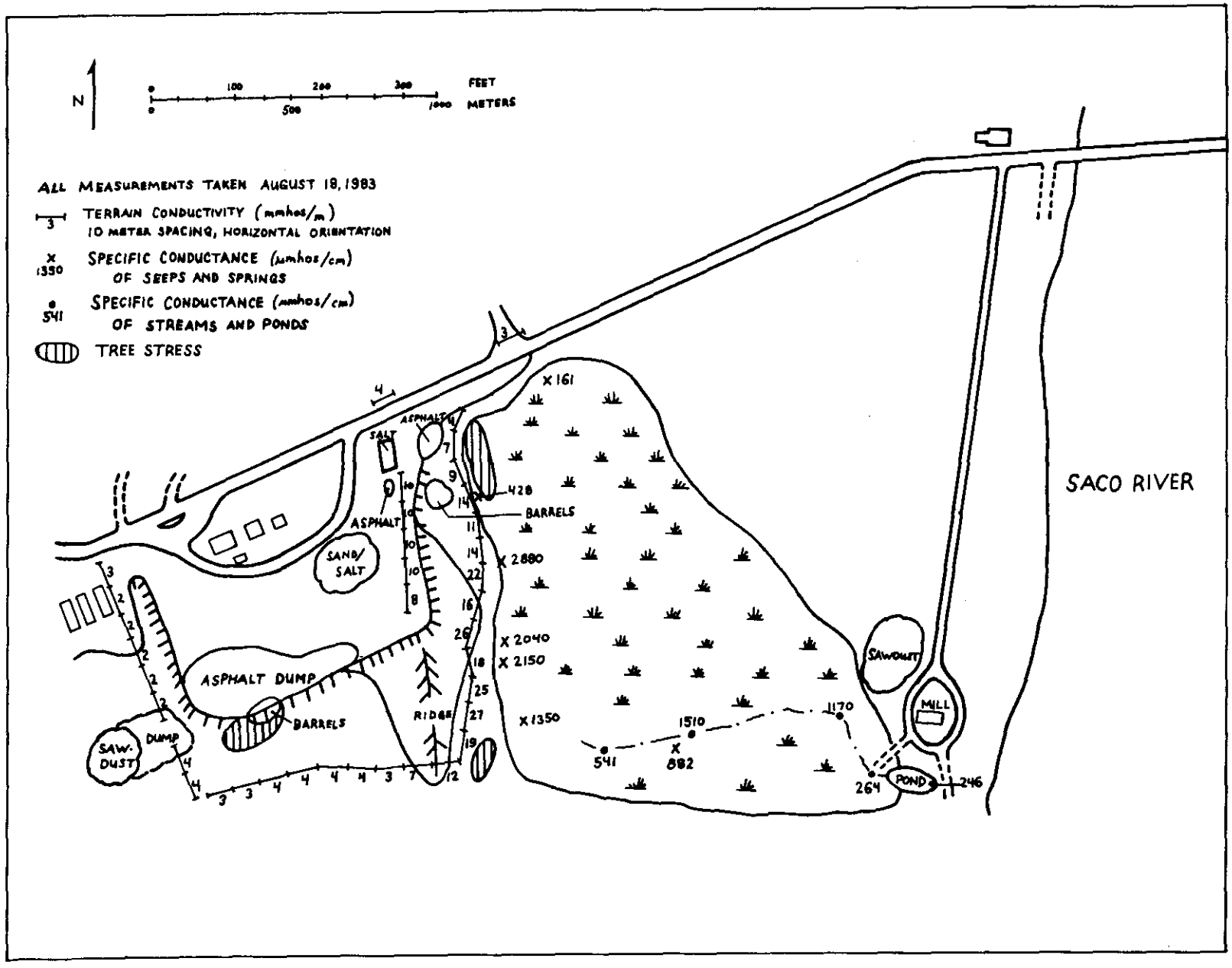

Figure 6. Cornish DOT Salt Storage Area: Terrain conductivity, specific conductance.

HOLLIS EQUESTRIAN PARK-FORMER DUMP

Operational History

The Hollis equestrian park was operated as an open, burning dump until 1970, when it was closed and a new landfill was established. The site has been covered and revegetated, and is currently in use as a riding ring. No subsidence or settlement of waste were noted at this site. No record of previous site investigations was found.

Site Geology

A test hole drilled upgradient of the site showed 35 feet of sand overlying 32 feet of interbedded sand and marine clay, and 7 feet of till. Bedrock is at 74 feet. The water table is approximately 15 feet below land surface. Downgradient of the site, a series of springs occurs at approximately the sand/clay interface. The site drains southwesterly towards Cooks Brook. A well point driven through the fill yields several gallons of water per minute.

Project Investigation

A series of resistivity soundings were run downgradient from the toe of the fill. An area of low resistivity, indicating a small, shallow plume was found. The conductivity of the springs between the fill and Cook's Brook ranged from 55 to 70 umhos/cm. The upgradient project test well and an existing well point in the fill were sampled (Table 8). Concentrations of nitrate, chloride, sodium, and calcium were higher in the through-fill well.

Summary of Sites Impact on Ground-Water Quality

This small dump has been closed for more than ten years. It was operated as a burning dump, reducing the organic leachables available. It is located near a ground-water discharge area. The impact of the site on ground-water quality is small and is confined to the immediate area of the site. It is, however, interesting to note that even in this relatively optimal circumstance contamination persists for many years after closure.

Table 8. WATER CHEMISTRY IN HOLLIS EQUESTRIAN PARK WELLS

	Upgradient Well	In-Fill Well
Date Sampled	12-8-81	12-8-81
Well Depth (feet)	21	19
Temperature (^oC)	10	8
Conductivity (umhos/cm)	100	100
pH	6.2	5.8
Alkalinity (mg/L as $CaCO_3$)	8	5
Chloride (mg/L)	6.5	27
Nitrate-N (mg/L as N)	<0.01	0.03
Sulfate (mg/L)	<10	<10
Sodium (mg/L)	5.6	19
Potassium (mg/L)	0.8	0.43
Calcium (mg/L)	2.1	4.5
Magnesium (mg/L)	0.5	0.82
Hardness (mg/L as$CaCO_3$)	9	15
Iron (mg/L)	0.36	0.080
Manganese (mg/L)	0.25	0.054

KENNEBUNK SOLID WASTE FACILITY

Operational History

This site has been in operation for many years, first as an open, burning dump, and since the 1970's as an unlicensed, non-secure landfill. Household wastes are the primary source of material to the facility. Small amounts of municipal sewage treatment plant grease and scum are also permitted to be dumped at the site. There have been reports of treatment plant sludge being illegally dumped at this site for the past few years. Sludge has apparently been dumped in large quantities since the spring of 1983. An unlined, uncovered sand-salt pile is stored northeast of the landfill area.

The residents of the Heath Road, which is located approximately 2000 feet east of the fill area (Figure 7), have become increasingly worried about the possibility of their wells becoming polluted because of the landfill activities. While most of the homes near the solid waste facility are serviced by municipal water, all homeowners on the Heath Road have their own wells. These wells are primarily driven points and are located in a high yield sand and gravel aquifer (plate 1).

Site Geology

The site is underlain by deltaic sand and gravel, which is interbedded in some areas with clay and silt. Logs from three test wells which were installed for this project in 1981, and five wells installed in 1984 by DuBois and King, Inc. (Figure 7) are shown in Table 9.

The sand and gravel varies from 15 to more than 50 feet thick in the landfill area according to test borings and seismic refraction profiling. The sand and gravel is very coarse and highly permeable in most of the test boring locations.

Hydrogeologic Investigation and Ground-Water Chemistry

Resistivity soundings were made in several locations. In each sounding there were layers of low resistance, but it could not be determined if this was due to clay, old landfill material, or groundwater contamination. Terrain conductivity readings had similar interpretation problems.

Water table elevations, determined in June, 1984 by DuBois and King, Inc. (1984 a&b) dip toward the south and west, indicating that ground-water flow should be toward the Mousam River (Figure 7). This flow direction is supported by the water chemistry results from the eight monitoring wells drilled at this site by DEP and DuBois and King, Inc. (Table 10). Three wells south of the landfill, W1 and W2 (which are no longer in existence), and B4 (drilled in 1984) have high chloride, sodium, calcium, and magnesium concentrations. Well B4 also has high iron, COD, and TOC levels. Wells W1 and W2 had detectable levels of several volatile organic priority pollutants in the 1983 sampling.

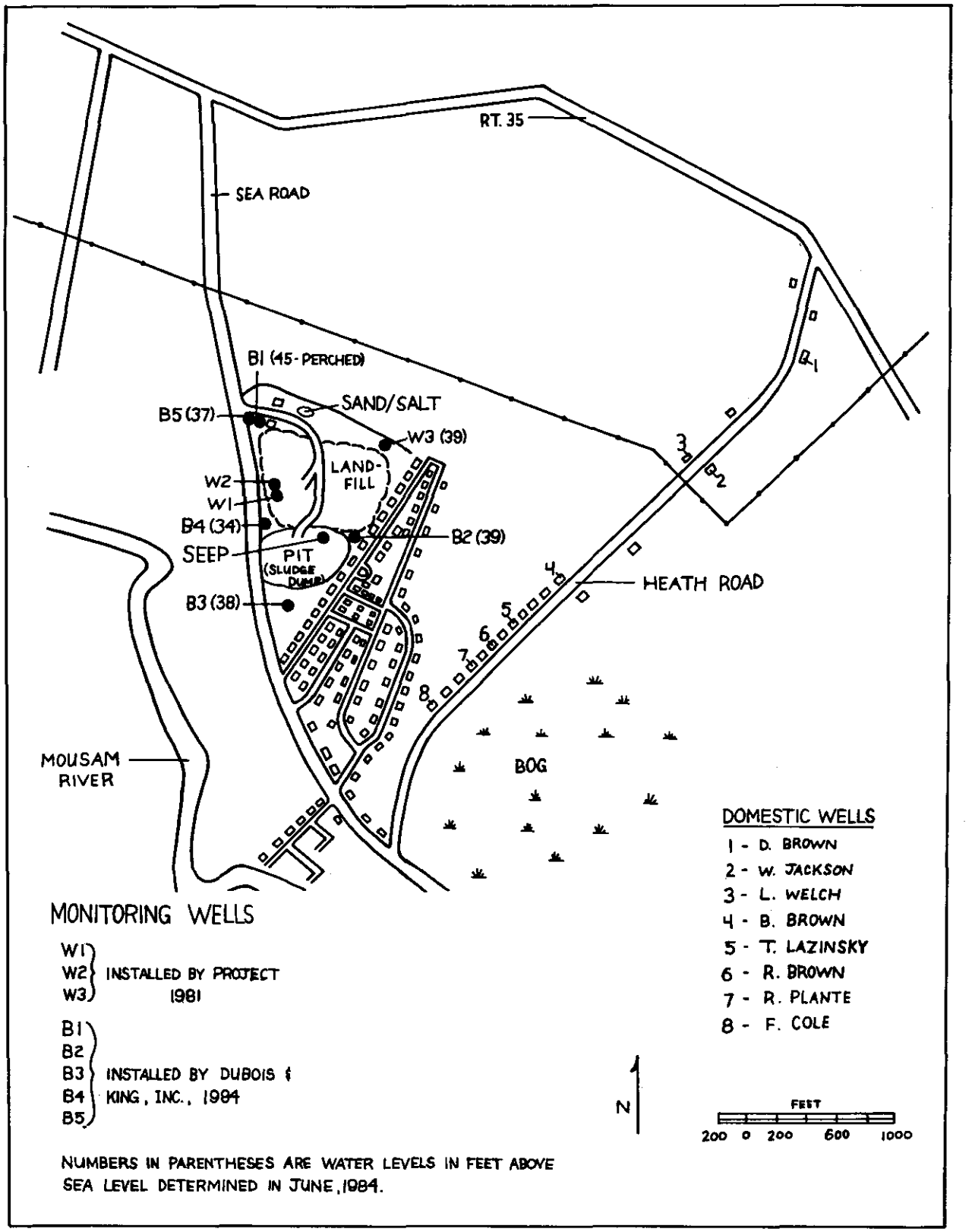

Figure 7. Kennebunk Solid Waste Facility: Locations of monitoring wells and residences where water samples were collected.

Table 9. KENNEBUNK SOLID WASTE FACILITY WELL LOGS

Well 1 and 2

Depth (ft)	Material
0-9	Medium sand
9-21	Coarse sand
21-31	Coarse sand, gravel
31-41	Coarse gravel
41-51	Gravel and cobbles
51	Refusal (bedrock?)

Water table at 9 feet.
Well 1 screened from 17 to 20 feet.
Well 2 screened from 37 to 40 feet.

Well 3

Depth (ft)	Material
0-6	Medium sand
6-10	Sandy silt, pebbles
10-15	Silty, gravelly sand
15-18	Silt, sand, clay
18-21	Gravel, cobbles
21	Refusal (boulder?)

Water table at 4 feet.
Well screened from 10 to 12 feet.

Well B1

Depth (ft)	Material
0-8	Medium to coarse sand
8-16	Fine to medium sand
16-22	Silty clay

Water table at 6 feet.
Well screened from 9 to 21 feet.

Well B2

Depth (ft)	Material
0-19	Medium sand, gravel
19-28	Coarse sand, gravel, cobbles, boulders
28-37	Fine to medium sand, gravel

Water table at 21 feet.
Well screened from 23 to 35 feet.

Well B3

Depth (ft)	Material
0-14	Medium to coarse sand, gravel layers
14-23	Coarse sand, gravel, cobbles
23-42	Fine to medium sand, gravel

Water table at 16 feet.
Well screened from 22 to 42 feet.

Well B4

Depth (ft)	Material
0-10	Very coarse sand, gravel, cobbles
10-13	Silty, sandy clay
13-28	Fine to medium sand, gravel
28-43	Fine to coarse sand, gravel
43-52	Sand, fine gravel

Water table at 29 feet.
Well screened from 26 to 51 feet.
Strong leachate odor below 28 feet.

Well B5

Depth (ft)	Material
0-8	Medium to coarse sand
8-17	Fine to medium sand, silt
17-26	Silty clay
26-30	Medium to coarse sand, gravel
30-38	Silty coarse gravel, boulders
38-42	Medium to coarse sand

Water table at 14 feet.
Well screened from 21 to 41 feet.

Table 10. KENNEBUNK SOLID WASTE FACILITY MONITORING WELL CHEMISTRY.

Part A. Samples analysed by DEP- June, 1983.

Parameter	Units	W 1	W 2	W 3	Seep	Sludge
Temperature	°C	18	13	16	35.5	-
Conductivity	umhos/cm	538	968	182	1780	-
Chloride	mg/l	40	97	8.5	130	60
Nitrate	mg/l	0.12	0.50	0.52	0.33	0.11
Sulfate	mg/l	7.7	5.6	9.2	-	-
Ammonia	mg/l	0.05	0.02	0.04	0.05	-
Sodium	mg/l	37	37	9.2	76	80
Potassium	mg/l	4.0	5.3	-	9.0	11
Calcium	mg/l	66	96	7.1	380	57
Magnesium	mg/l	22	26	5.6	78	9.1
Iron	mg/l	0.34	0.08	5.9	48	40
Manganese	mg/l	1.4	0.11	0.94	62	0.84
Cadmium	mg/l	<0.004	<0.004	0.008	0.009	0.005
Chromium	mg/l	<0.01	<0.01	0.01	<0.01	0.04
Total Organic Carbon (TOC)	mg/l	9	12	21	740	370
Dimethyl Sulfide	ug/l	<1	<1	<1	J2	J5
Toluene	ug/l	<1	<1	<1	<1	18
Xylenes	ug/l	<9	<1	<1	J20	J10
Tetrahydrofuran*	ug/l	J90	J200	J100	<1	<1
1,1,-dichloro-ethylene	ug/l	J5	J9	<1	<1	<1
1,1,1-trichloro-ethane	ug/l	J1	13	<1	<1	<1
Ethylbenzene	ug/l	<1	<1	<1	8	<1
Other volatile organic pollutants	ug/l	<1	<1	<1	<1	<1

Part B. Samples collected by DuBois and King- June, 1984.

Parameter	Units	W 3	B 1	B 2	B 3	B 4	B 5
Conductivity	umhos/cm	270	590	410	160	4200	3400
pH	-	7.4	6.4	6.2	6.0	6.8	6.0
Chloride	mg/l	9.0	120	6.5	16	300	450
Sodium	mg/l	5.3	120	7.5	9.2	240	280
Calcium	mg/l	21	7.4	48	8.0	380	200
Magnesium	mg/l	3.3	3.0	8.6	2.5	69	30
Iron	mg/l	0.29	8.8	1.3	0.97	160	2.0
Total Organic Carbon (TOC)	mg/l	<5	6	<5	7	320	12
Chemical Oxygen Demand (COD)	mg/l	<5	6	<5	7	320	12

* Present due to leaching of PVC cement used in test well installation.
J=approximately

Two adjacent wells northwest of the landfill (B1 and B5) have very high conductivity, chloride and sodium levels. The wells are west of the unlined, uncovered sand-salt pile, and may receive much of their impact from this source. The deeper well (B5) is affected to a greater degree than the shallow well (Table 10).

Wells W3 and B2 have lower concentrations of most constituents than the other five wells, but have above background conductivities, primarily due to high calcium and magnesium levels. Well B3 appears to have water quality similar to that of the project background water quality wells.

The sludge which has been dumped into the gravel pit near the landfill has high chloride, sodium, calcium, and iron concentrations. This sludge is similar in composition to a ground water seep which is present in the northeastern corner of the gravel pit (Table 10). Both the seep and the sludge contain trace levels of dimethyl sulfide and xylene. The sludge also contains toluene, while the seep has trace ethylbenzene concentrations.

All of the wells sampled along the Heath Road, except for the D. Brown and F. Cole wells, have excellent water quality (Table 11, Figure 7). The D. Brown well has apparently been affected by road salting along Route 35; it has a high sodium concentration and slightly elevated chloride level. The F. Cole well has a nitrate concentration exceeding the Department of Human Services Recommended Limit. The high nitrate level in this well may be caused by a leaking nearby septic tank or fertilizers. The landfill does not appear to be causing any degradation of the water quality in the Heath Road wells at this time.

Summary of Sites Impact on Ground-Water Quality

The Kennebunk Landfill is contaminating ground water in a broad area between the site and the Mousam River to its west. The contamination is not affecting the water quality of domestic wells along the Heath Road, east of the landfill.

Dumping of municipal treatment plant sludge into a gravel pit adjoining the landfill, and the storage of road salt in an unlined, uncovered pile are adding to ground water problems at this site. The site is in a very poor location for any of these activities due to the very permeable nature of the geologic substrate in the area.

Reference

DuBois and King, Inc., 1984a, Letter to the Kennebunk Board of Selectmen dated July 17, 1984.

-------, 1984b, Solid waste management assistance report draft for the Town of Kennebunk, Maine.

Table 11. KENNEBUNK SOLID WASTE FACILITY HOMEOWNER WELL SAMPLES- HEATH ROAD

Parameter	Units	F.Cole	R.Plante	R.Brown	T.Lazinsky
Date Sampled	-	7-8-83	7-8-83	7-8-83	7-8-83
Temperature	°C	18	17	15	15
Conductivity	umhos/cm	171	69	98	135
Chloride	mg/l	17	5.0	9.5	12
Nitrate-N	mg/l	12	0.35	1.6	0.05
Sodium	mg/l	13	5.3	10	6.8
Potassium	mg/l	2.8	2.8	2.4	3.1
Calcium	mg/l	11	4.1	5.2	20
Magnesium	mg/l	3.6	0.56	0.76	3.5
Iron	mg/l	0.16	0.16	0.05	0.82
Manganese	mg/l	0.10	0.08	0.01	0.09
Total Organic Carbon	mg/l	<1	<1	<1	<1
Volatile Organic Pollutants	ug/l	<1	<1	<1	<1

		B.Brown	D.Brown	L.Welch	W.Jackson
Date Sampled	-	7-8-83	7-8-83	7-8-83	7-8-83
Temperature	°C	17	16	17	16
Conductivity	umhos/cm	151	336	161	144
Chloride	mg/l	8	17	8.5	5.5
Nitrate-N	mg/l	0.05	0.30	0.76	0.04
Sodium	mg/l	6.4	29	--	6.7
Potassium	mg/l	3.1	3.8	--	3.6
Calcium	mg/l	19	30	--	17
Magnesium	mg/l	2.7	8.5	--	2.7
Iron	mg/l	0.28	0.12	--	<0.03
Manganese	mg/l	<0.01	0.10	--	0.06
Total Organic Carbon	mg/l	<1	<1	<1	<1
Volatile Organic Pollutants	ug/l	<1	<1	<1	<1

LIMERICK - DOT SALT STORAGE AREA

Operational History

The DOT stores salt in an enclosed shed and in an uncovered, unlined sand-salt pile at this location. The site is adjacent to a newly constructed sewage treatment plant, and 1500 feet west of the town dump and salt storage area.

Site Geology

The site is underlain by sandy artificial fill which overlies ice contact sand and gravel. The natural sand and gravel deposit is 17 feet thick. The log of a test well installed on-site for this project is shown below:

Depth (feet)	Material
0-6	Sandy fill, cobbles
6-11	Sand with interbedded cobbles
11-16	Medium sand with pebbles
16-23	Coarse sand, fine gravel
23-25	Till
25	Bedrock

Project Investigation

Conductivities of Brown Brook were measured up and downstream of the site, in August 1981 and again in August, 1983 (Figure 8). The conductivities increased dramatically immediately west of the sand-salt pile, but quickly returned to background levels. Chloride levels in 1981 were 14 mg/L at the Brown Brook Bridge on the East Range Road; this is about 3 times as high as in most Maine surface waters.

The project well was sampled on December 9, 1981, and found to have elevated sodium (36 mg/L) and chloride (38 mg/L) levels. This well is upgradient of the sand-salt pile, and is probably influenced by a ground water mounding effect which the artificial fill and sand-salt pile have had on the local water table.

Summary of Sites Impact on Ground-Water Quality

This site is contaminating ground and surface water in a small area west of the maintenance lot. Contamination from a sewage treatment plant, the town dump, and the town salt pile, all of which are located up-gradient of the Limerick DOT site, may also be degrading water quality in the aquifer underlying this site.

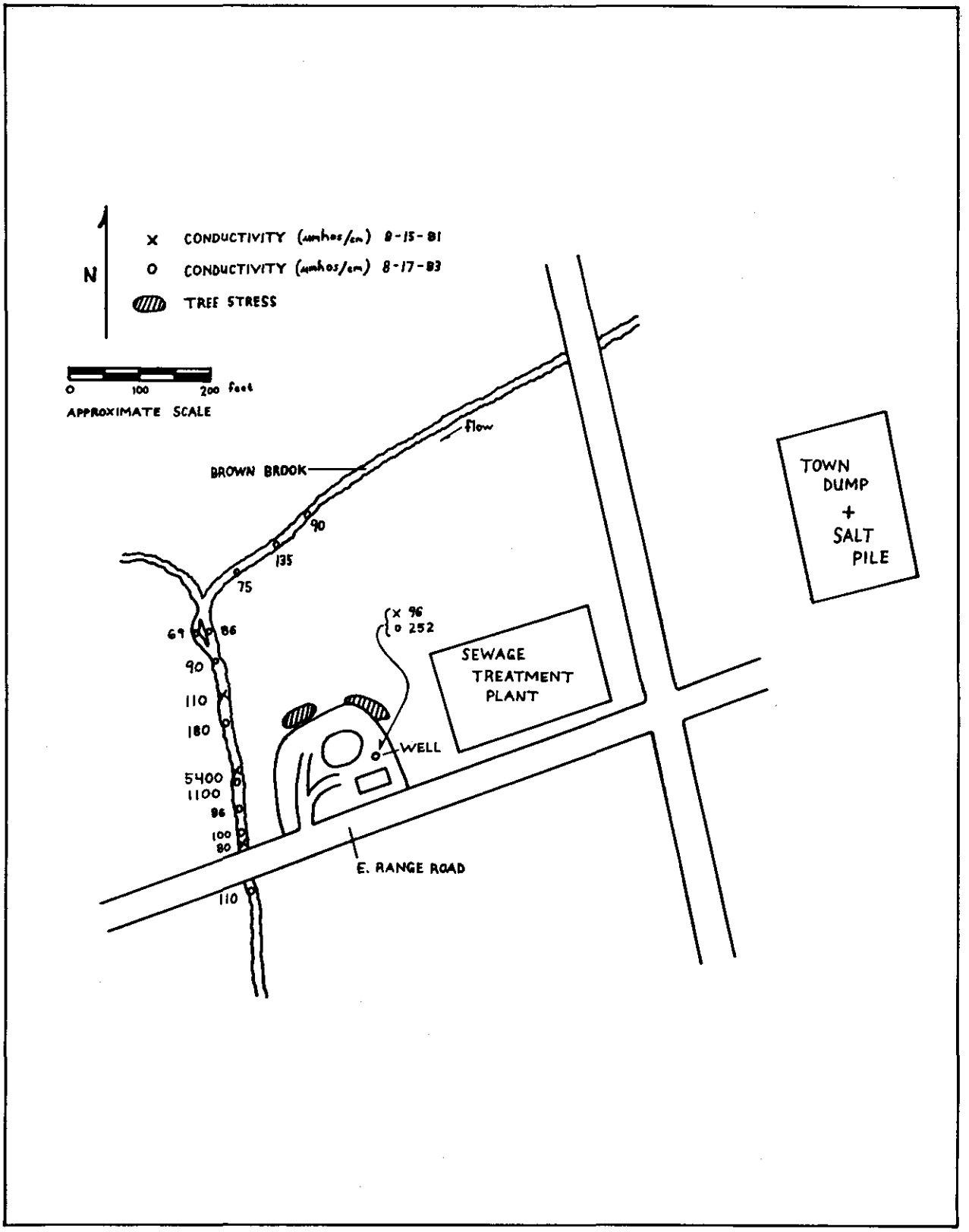

Figure 8. Limerick DOT Salt Storage Area: Specific conductance of Brown Brook.

LIMERICK DUMP

Operational History

The Limerick Dump is located on the New Dam Road in Limerick. The facility is generally operated as an open, burning dump, although cover is occasionally applied. Approximately 157 cubic yards of waste material per year is brought to the dump, including commercial waste from Limerick Footware, Inc. An unlined, uncovered sand-salt pile is stored on the western bank of the landfill/dump area.

Site Geology and Hydrogeology

The dump is located on a kame deposit which is composed of very clean sand and gravel. The nearest body of surface water is Brown Brook, located approximately 1,500 feet west of the landfill. There are a series of ground-water seeps several hundred feet west of the site.

Project Investigation

Seven resistivity sounding lines were run during the summer of 1981 (Figure 9). Resistivity values exceed 1,000 ohm-feet for profile lines T-2 through T-5. Profiles of T-1, T-1A, and A contain zones of low resistivity, indicating the presence of a contamination plume south-southwest of the site. The resistivity values may be largely influenced by salt leached from the sand-salt pile.

Terrain conductivity values ranged from 0.2 to 2.2 mmhos/m south and east of the site (Figure 9). Along the western edge of the site values ranged from 3.0 to 20 mmhos/m. The values were especially high west of the sand-salt pile.

A seep between the site and New Dam Road (Figure 8) was sampled on July 19, 1984. The analysis of this seep is shown below:

Temperature	22°C	TOC	73 mg/L
Conductivity	3500 umhos/cm	Iron	100 mg/L
Chloride	1300 mg/L	Manganese	290 ug/L
Nitrate-N	50 ug/L	Cadmium	10 ug/L
Sulfate	86 mg/L	Chromium	10 ug/L
Sodium	640 mg/L	Lead	11 ug/L
Calcium	79 mg/L	Zinc	44 ug/L
Magnesium	11 mg/L		

This sample had very high levels of sodium and chloride, due primarily to leaching of the sand-salt pile 150 feet east of the seep. However, sulfate, calcium, magnesium, iron, and manganese were also present at concentrations exceeding those expected for background water quality as determined in Section III of this report (Table 2). This indicates that dump leachate is also present in this seep.

Summary of Sites Impact on Ground-Water Quality

Ground water near this site is being contaminated within a plume which flows west from the dump and sand-salt pile toward Brown Brook. Between the dump and the brook a new sewage treatment plant has recently been built, and an uncovered, unlined sand-salt pile is stored on a Department of Transportation maintenance site. All three sites may have an impact on the area's ground-water quality.

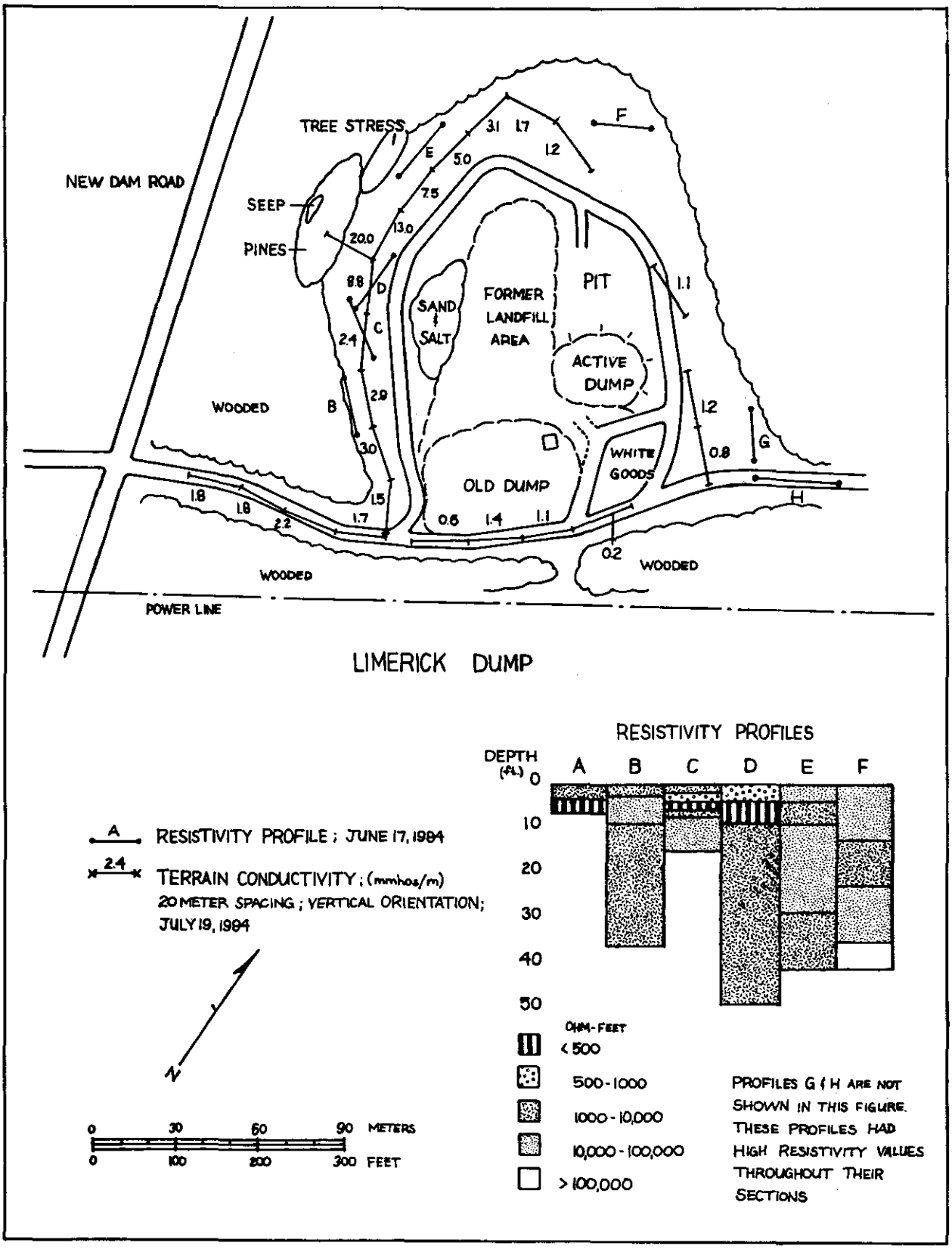

Figure 9. Limerick Dump: Resistivity and terrain conductivity values.

LIMINGTON SALT STORAGE AREA

Operational History

The town of Limington maintains a covered salt shed, an uncovered, unlined sand-salt pile, and a sand and gravel extraction area at this site. The site is located in a sparsely populated area; the nearest house is 1000 feet northeast of the site, and the nearest concentration of population is 1/2 mile northeast of the site, on the opposite side of the Little Ossipee river.

Site Geology

The site is located on the "Hollis Delta", a thick section of sand and gravel. The deposits at the site appear to be outwash; there are interbedded sands and gravels of fluvial origin. A 12-channel seismic line run on the road adjacent to the site indicated a depth to water of 35 feet and a depth to bedrock of 140 feet. Depth to water at the site was more than 25 feet.

Project Investigation

A series of fifteen resistivity soundings were run in a circle around the site. The soundings show an area of low resistivity to the east of the site, towards the Saco River. The contamination appears to extend to some depth (100 feet or more) in the aquifer.

Summary of Sites Impact on Ground-Water Quality

The site has lowered the ground-water quality of an area to the east. No wells or development presently exist in the path of contamination. The town should consider purchasing the area between the site and the Saco River to avoid future problems with contaminated well water. The sand-salt mix could then be stored near the river, where the volume of ground water contaminated by salt would be reduced.

LYMAN DOT SALT STORAGE AREA

Operational History and Geology

Three hundred tons of salt per year are stored at this site in an enclosed building which is in good repair. Fifty two tons of salt per year are stored in an uncovered, unlined sand-salt pile.

The site is underlain by 11 feet of highly permeable deltaic coarse sand, gravel, and cobbles. Fifteen feet of fine sand, 3 feet of till, and granite bedrock underlie this. The water table is less than 10 feet from the land surface.

Project Investigation

Six resistivity lines were run east,south and west of the sand-salt pile (Figure 10). Low resistivity values were encountered in three of the lines (3, 5 and 6) located south of the sand-salt pile.

A test well was installed at the western edge of the maintenance lot. This well had slightly elevated sodium and chloride concentrations, but had background levels of all other analysed elements. The results of this well's analysis are shown below:

Date Sampled	11-20-81
Temperature(^{o}C)	10
Conductivity (umhos/cm)	150
pH	7.2
Alkalinity (mg/L as $CaCO_3$)	4
Chloride (mg/L)	35
Nitrate (mg/L)	0.04
Sulfate (mg/L)	<10
Sodium (mg/L)	26
Potassium (mg/L)	2.3
Calcium (mg/L)	5.1
Magnesium (mg/L)	0.73
Hardness (mg/L as $CaCO_3$)	19
Iron (mg/L)	0.04
Manganese (mg/L)	1.50

A terrain conductivity survey of the area around the maintenance lot was conducted in August, 1983 (Figure 11). This survey delineated a very large plume of contaminated ground water which is flowing southeast of the sand-salt pile. The plume may be as much as 3000 feet long and 2400 feet wide, although it has not been well defined south of Route 5.

The specific conductance of Cooks Brook (109 umhos/cm) is slightly higher than would be expected in uncontaminated surface waters. Water quality in small pond southeast of the maintenance lot does not appear to be affected by the salt contamination.

Summary of Sites Impact on Ground-Water Quality

This site is contaminating ground water in an extensive area between the sand-salt pile and Cooks Brook, approximately one half mile south of the site. No water supplies are known to be impacted, but a large area of land overlying a sand and gravel aquifer may have been rendered unsuitable for development because potable water is not available.

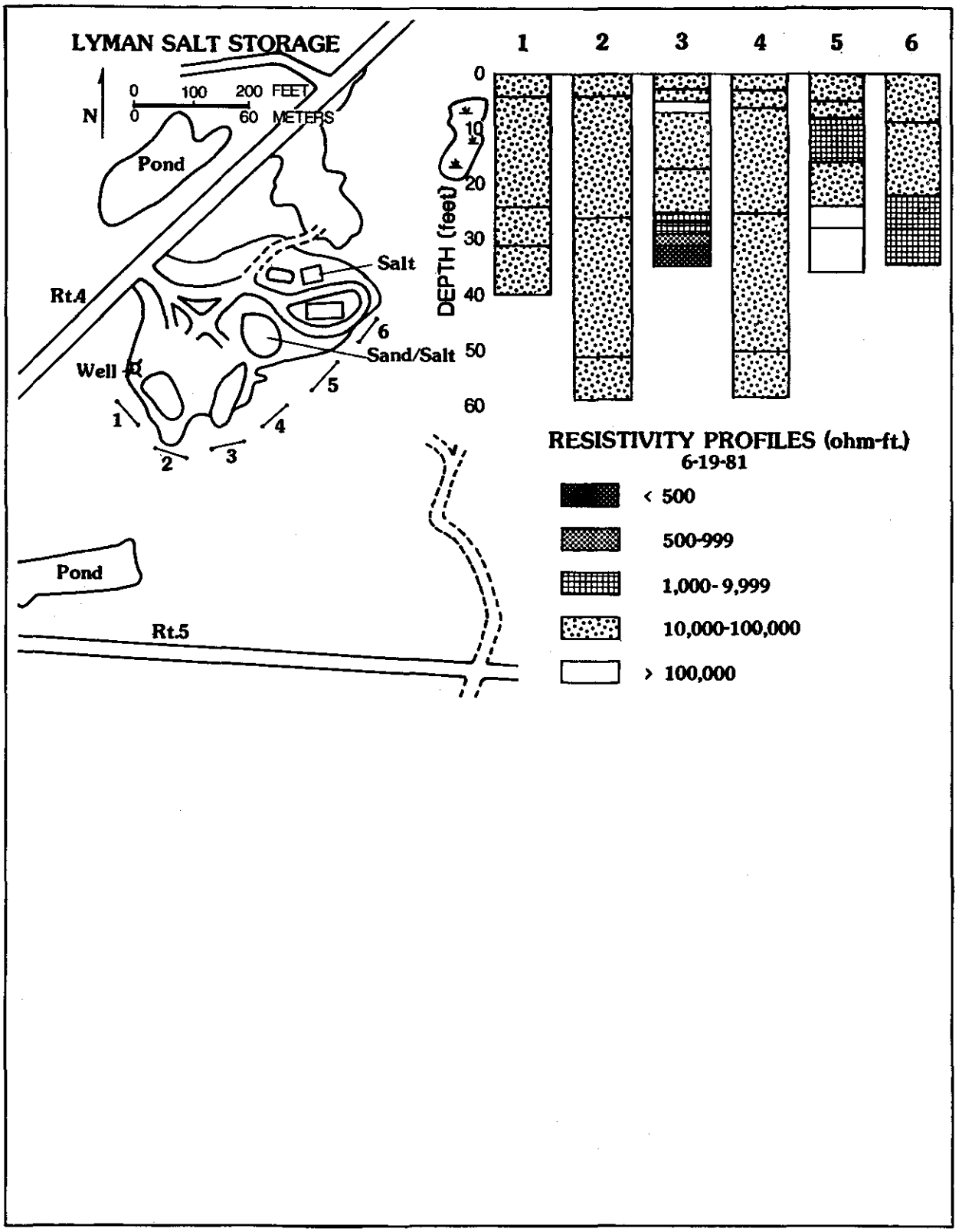

Figure 10. Lyman DOT Salt Storage Area: Resistivity profiles

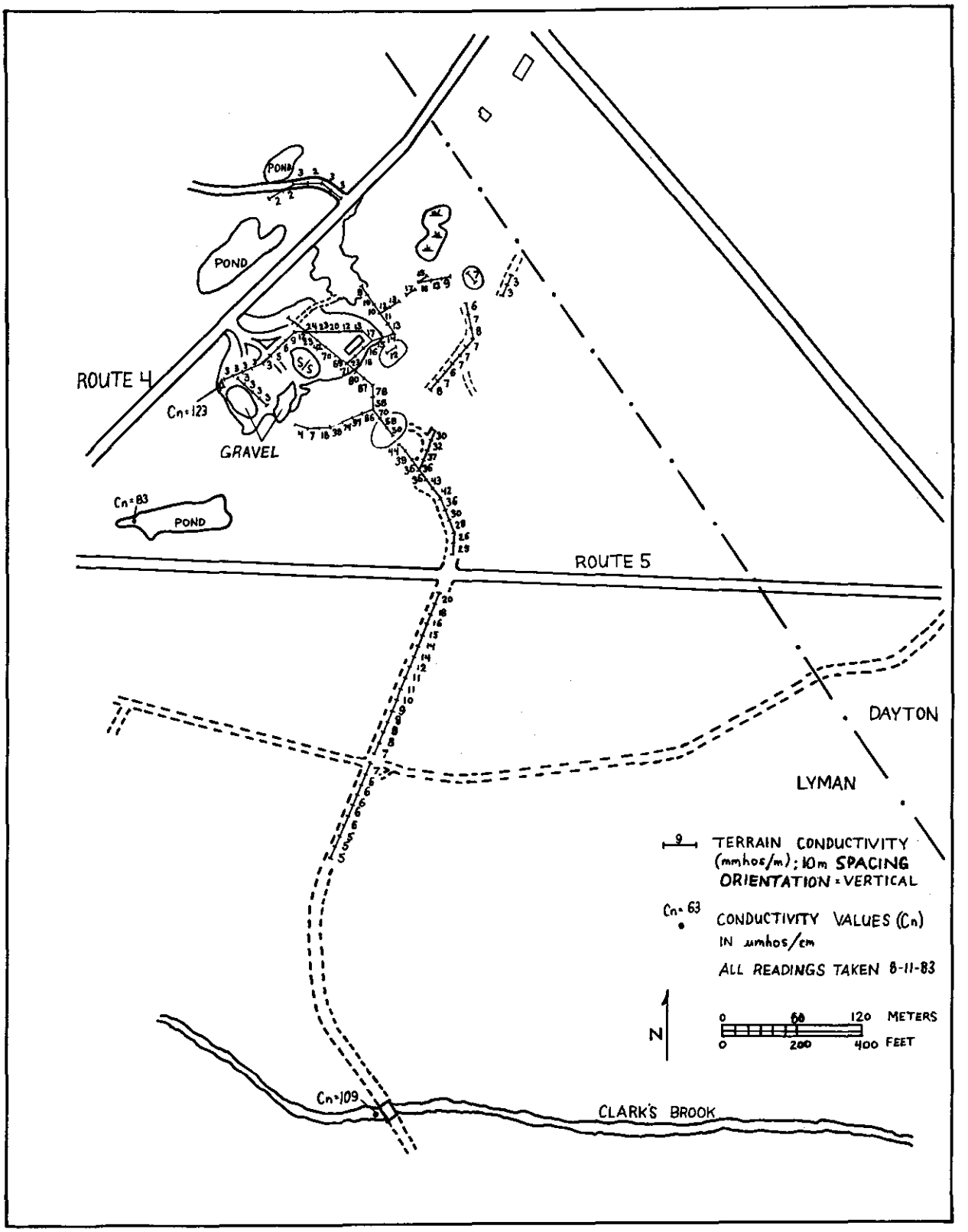

Figure 11. Lyman DOT Salt Storage Area: Specific conductance, terrain conductivity values.

SACO LANDFILL

Operational History

The Saco Landfill consists of three areas; an old dump site which has been closed and covered, an active municipal refuse site, and an industrial waste site (Figure 12). The old dump site was closed in 1974, after several nearby residential wells became contaminated. Municipal water was run to the affected homeowners, and in 1976 the old dump was capped.

In 1980 the Associated Press reported that millions of gallons of hazardous wastes had been dumped at this site, much of it from out-of-state "midnight dumpers" (Portland Evening Express, Biddeford Journal Tribune, May 15, 1980). Subsequent investigations showed that while some hazardous waste had been disposed of at the landfill, the quantities were far less than that reported by the AP (Krueger, 1980).

This site is presently used for the disposal of 170 tons of waste per week from residential, commercial, and industrial sources. The largest single source of waste is the Nike shoe company, which generates 650 cubic yards of waste per week (Dubois and King, 1984). The site is currently under consideration as a hazardous waste "Superfund" site. The Maine Board of Environmental Protection has ordered the City of Saco to close the landfill by November 15, 1985.

Previous Studies

The DEP began to study this site in 1974, after the initial complaints of well contamination were received. This initial study was followed by three reports by the Jordan Gorrill Consulting Firm (Atwell, 1975a, 1975b; Bragdon, 1975). In 1980 the DEP conducted two further investigations (Farrell, 1980; Krueger, 1980) following the reports of illegal hazardous waste dumping at the landfill. Later the site was studied simultaneously by Ecology and Environment, Inc., (1982) to rank the site for the Superfund program, and by Edward Bradley, who studied the site under contract for the Sand and Gravel Aquifer Mapping Program. Most recently, Dubois & King, Inc. (1984) studied the site to develop a closure plan. This report incorporates information from all of these studies.

Site Hydrogeology

The site geology is predominately sand over marine clay, which is underlain by more sand, till or bedrock. The sand varies in thickness from 10 to 25 feet, and in composition from fine to coarse and gravelly. The coarse gravelly deposits are part of a system of morainal deposits, while the finer sands are outwash and ice-contact deposits. At the western end of the site bedrock is exposed (strike slightly east of north, dip S80°E). Five to 10 feet of clay outcrops on the eastern rim of a gravel pit to the southeast of the active dump. The clay deposit apparently dips northeast. The clay is not continuous; in some locations sand directly overlies bedrock.

The water table lies 0 to 20 feet below the land surface. Ground-water flow is toward Sandy Brook in the surficial materials; the direction of flow in the bedrock aquifer is unknown. The site is immediately southwest of a mapped sand and gravel aquifer (plate 1).

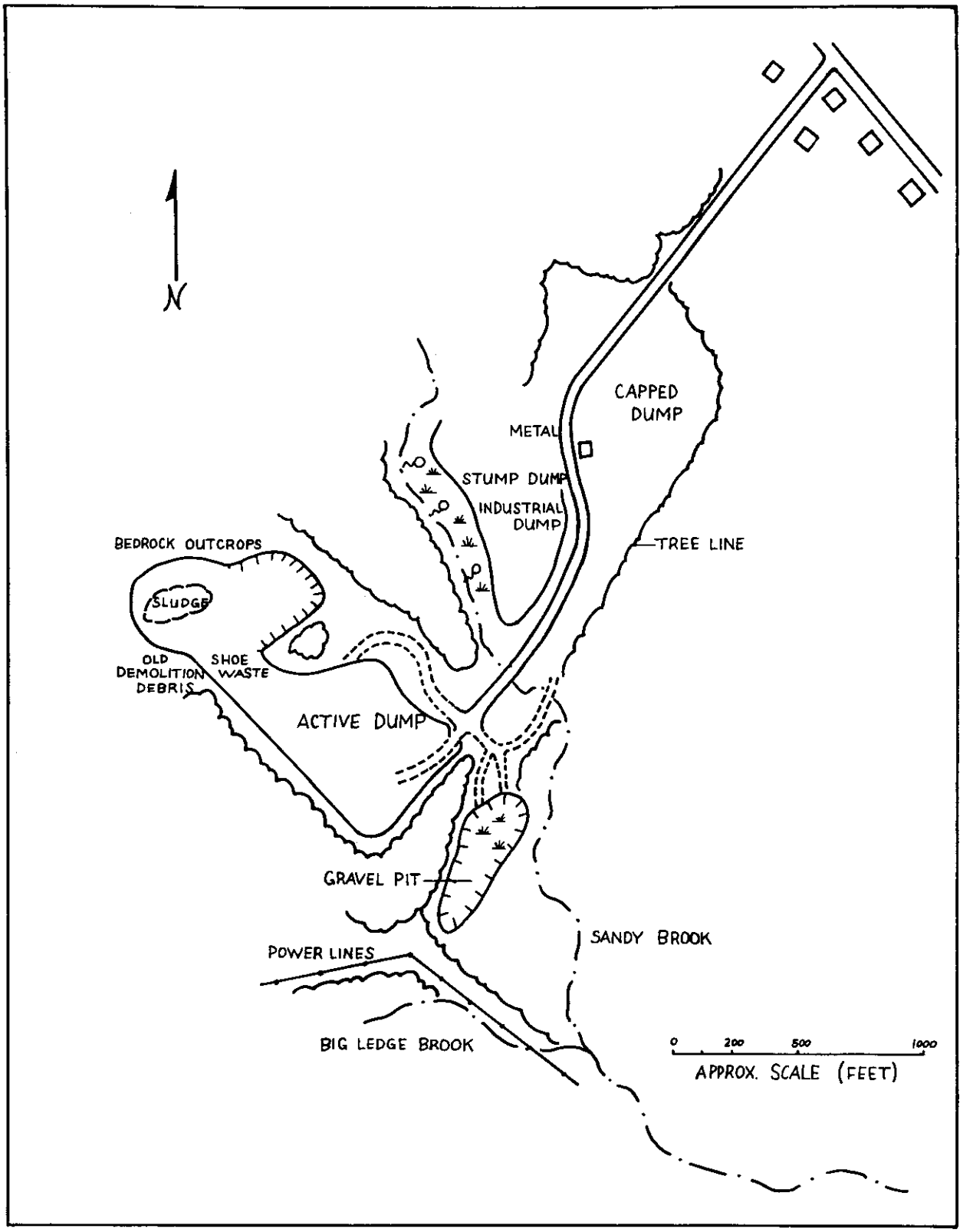

Figure 12. Saco Landfill sketch map.

Summary of Sites Impact on Ground-Water Quality

Leachate is generated from the active dumping area at the Saco Landfill, and moves in a generally east-southeast direction toward Sandy Brook. The leachate surfaces in springs and seeps in an adjacent gravel pit. The springs in the gravel pit are characterized by oily, reddish to rusty brown scum and have a strong odor and high conductivity. Toluene and numerous semi-volatile organic compounds have been found in these springs in concentrations of up to 2300 ug/L (Krueger, 1980).

Contaminants generated by the industrial waste site and closed dump site also travel toward Sandy Brook, but because these sites are east of the brook the plume flows in a west-south westerly direction. Numerous volatile and semi-volatile organic compounds have been detected in test pits and leachate below the industrial waste dump. Thirteen volatile organic compounds, with concentrations to 190,000 ug/L (for methyl ethyl ketone) were found in one leachate sample (Krueger, 1980).

Sandy Brook is contaminated in the immediate vicinity of the landfill, primarily with compounds resistant to biological breakdown, such as phalates, dioctyladipate, and oil by-products. Neighboring wells are not threatened, due to the installation of a municipal water line in the mid-1970's.

A new threat to ground water is posed by the dumping of tannery sludge and other semi-solid wastes at the northwestern edge of the active dump, where bedrock is at or near the surface. Contamination entering bedrock fractures could travel great distances from the site, and move in unpredicted directions to more distal areas.

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SACO-MAREMONT CORPORATION LANDFILL AND LAGOON

Previous Studies

In accordance with the requirements of the Resource Conservation and Recovery Act (RCRA), the Maremont Corporation has implemented a ground-water monitoring program at this site. Three hydrogeologic studies have been produced through this program; Roy F. Weston Inc., 1982a, Roy F. Weston Inc., 1982b, and Roy F. Weston Inc., 1983. This report is a compilation of information from these 3 studies and information available in the DEP Oily and Hazardous Waste Bureau Files.

Operational History

Since the early 1960's, SACO Defense Systems, a division of Maremont Corporation in Saco, Maine, has been manufacturing various auto machine parts, machine guns, and cannon barrels through contracts with the U.S. Government. Halogenated solvents, plating wastes, and oily grinding sludges are generated from the manufacturing process (Roy F. Weston, Inc., 1983) .

Until 1980 waste oils and solvent bearing sludges were dumped into an oily waste lagoon on the northwest portion of Maremont's property. Dewatered metal hydroxide sludges from the plating waste treatment plant were landfilled around the oily waste impoundment area. These sludges, along with grinding sludges or residue continued to be landfilled up to January 1983 (Roy F. Weston, Inc., 1983). In addition to disposal around the lagoon area, contents of drummed wastes were emptied into small backhoe excavated pits throughout the property (Roy F. Weston, Inc., 1982a). Currently, treatment plant sludges are accumulated in a holding tank for off-site disposal in an approved New York landfill. Highly corrosive wastes, solvents and oils are also stored in an on-site licensed hazardous waste storage area, awaiting eventual disposal (Roy F. Weston, Inc., 1983).

Site Hydrogeology

Based on boring logs, depth to bedrock is between 25 to 40 feet beneath the site. Bedrock is covered by 15 to 25 feet of glacial outwash deposits. These deposits consist of fine to medium sands, mixed with silts in the western portion of the site, and with gravels in the northeast. Five to 7 feet of fine lacustrine sediments overlie the outwash deposits. These less permeable sediments consist of interbedded silts, clayey silts and silt clays with occasional sand lenses. A thin layer of recent alluvial sand lies over the fine grained deposits (Roy F. Weston, Inc., 1982a).

Based on monitoring well water level measurements, ground water under the site flows in a generally easterly direction. The ground water gradient is less than one percent. The ground water table is between 8 and 15 feet below the surface (Roy F. Weston, Inc., 1982a). Based on monitoring well slug tests, the average hydraulic conductivity of the screened zones of lower outwash deposits is approximately 432 ft/day (Roy F. Weston, Inc., August 1982).

Ground-Water Chemistry

Seven monitoring wells have been installed around the site, all on Maremont property, and have been analysed quarterly since 1981. All 7 wells have had detectable levels of volatile organic chemicals. Four of the wells have had oil and grease levels greater than 1 mg/L. The two downgradient wells nearest to the oily waste lagoon have had methylene chloride, 1,1-dichloroethane, 1,2-dichloroethylene, 1,1,1-trichloroethane, trichloroethylene, carbon tetrachloride, and chlorodibromomethane concentrations exceeding 1000 ug/L, with high concentrations of many other hazardous chemicals. Wells on the eastern edge of the site, more than 1000 feet away from the lagoon, have also been severely contaminated, with trichloroethylene concentrations of as high as 5200 ug/L. Chromium, iron, barium, manganese, and sodium have also been found in these wells in concentrations exceeding the DHS limits for drinking water.

Summary of Sites Impact on Ground-Water Quality

Various waste disposal practices at this site have resulted in extensive and serious contamination of ground water underneath the site property. While it is unknown whether the contaminants have moved off of the property boundary, it is likely that this has happened (Roy F. Weston, Inc., 1982b).

The Maremont Corporation proposes to close the oily waste lagoon by dewatering liquids from the lagoon, removing highly contaminated sludge and soils, and then backfilling the impoundment. The former sludge disposal area along with the closed impoundment will be capped with an impermeable material and then final cover material. Additional monitoring wells will be installed and regular monitoring of the site will continue (Roy F. Weston, Inc., 1983).

References

Roy F. Weston, Inc., 1982a, Hydrogeologic investigation and ground-water monitoring plan for Maremont Corporation, Saco, Maine.

Roy F. Weston, Inc., 1982b, Interim ground-water quality assessment report, Maremont Corporation.

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SANFORD SOLID WASTE FACILITY

Operational History

The Town of Sanford's solid waste facility is located adjacent to the Mousam River, on Ruston Street in Sanford. For a number of years the site was located on 15 acres of marshland on the northwest side of Ruston Street, and was operated as an open, burning dump. In 1969 the dump was closed and a gravel pit on the southeast side of Ruston Street was turned into a landfill. The landfill area occupies approximately 14 acres and is also closed. The site is currently operated as a transfer station, with only brush and demolition debris disposed of in the landfill area.

Both the dump and landfill contain municipal and industrial refuse. Approximately 17 industries, including plastics, cement, and textile manufacturers, have deposited refuse at these landfills. American Cyanamid of Sanford transported organics and plastic products to the landfill from 1963 to 1968 (Ecology and Environment, Inc., 1982). The dump and the landfill areas have been capped with clay/sand and loam layers and seeded with native cover.

Previous Studies

The Maine Department of Environmental Protection (DEP) installed seven monitoring wells and analyzed ground-water samples obtained from these wells in 1978. In addition the DEP analysed surface water samples from five locations adjacent to the landfill. In a separate sampling effort, surface water samples were analysed for volatile organic compounds (MDEP, 1981). In August of 1982 the Sanford landfill was evaluated for the Environmental Protection Agency by Ecology and Environment, Inc.'s field investigation team. This preliminary assessment determined the landfill's potential ranking as a hazardous waste site (Ecology and Environment, Inc. 1982).

Site Geology

Surficial materials at this site consist of highly permeable ice contact sand and gravel (Smith, 1977). The water table is shallow, varying from 0 to 8 feet in depth. Two small tributaries flow through the dump sites and discharge to the southeasterly flowing Mousam River. Ground water probably flows westerly through the site and discharges to the Mousam River. The face of the old dump at its closest proximity is approximately 50 feet east of the Mousam.

The sites are located adjacent to a mapped sand and gravel aquifer capable of yielding 10 to 50 gallons per minute (plate 1). The Sanford Water District obtains their water supply from the same aquifer, but their wells are approximately 2 to 3 miles north of the Sanford Dump.

Water Chemistry

Maine DHS Drinking Water Standards were exceeded for iron, manganese and lead in samples taken from the seven monitoring wells on December 12, 1978 (Maine DEP, 1979). Lead was detected at levels up to 0.37 mg/L, seven times the drinking water standard of 0.05 mg/L. Surface water samples were taken in June, July, September and October, 1978, at 5 sampling locations (Mower, 1978). Upgradient of the landfill specific

conductivities in the Mousam River averaged 69 umhos/cm. In contrast, conductivities exceeded 1000 umhos/cm in tributaries flowing through the landfill. Downgradient of the landfill conductivities in the Mousam averaged 88 umhos/cm. Although lower than tributary conductivities, the downgradient conductivities show that the landfill is having a measureable impact on water quality in the Mousam River.

On April 10, 1981 the DEP ran volatile organic analyses on samples taken from the tributary flowing through the southeasterly portion of the landfill. Nine volatile organics were detected, all in concentrations at or above 50 ug/L. These samples contained 1150 ug/L 1,1 dicholorethane and 800 ug/L toluene. While there is no current EPA Health Advisory Limit for dichloroethane, the long term SNARL (Suggested No Adverse Response Level) for toluene in drinking water is 340 ug/L (Table 3, Section IV). Methylene chloride, trans 1-2 dichloroethane, 1, 1, 1 trichloroethane, trichloroethylene, tetrachloroethylene, ethyl benzene and xylene were also detected in the surface water samples (Maine Department of Environmental Protection, 1981).

On July 27, 1982, Ecology and Environment's field investigation team evaluated the site. They identified chlorinated hydrocarbons in ground and surface water in concentrations ranging from 120 to 1000 ug/L. Specific constituents identified include 1,1,1 trichloroethane, trichloroethylene, and toluene. The landfill was given a hazardous ranking system score of 78.2 out of 100 (Ecology and Environment, 1982) due to the relatively high levels of toxic chemicals present and the proximity of the site to a major population center.

Summary of Sites Impact on Ground-Water Quality

The landfill and dump are closed, covered and seeded, but continue to produce leachate and contaminate surface and ground water. The contamination plume apparently flows westerly toward the Mousam River, which is adjacent to the old dump. While there has been concern that the solid waste facility could contaminate Sanford's municipal water supply, this possibility appears to be very unlikely because the site is in a ground water discharge area and is over 2 miles north of the municipal wells.

References

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SANFORD SEWAGE LAGOONS

Operational History

The Sanford Sewage District has been operating a sewage treatment plant at this site since 1962. The facility consists of 4 unlined stabilization ponds which were constucted in 1962-1966, and 2 lined lagoons constructed in 1981. The lagoons provided secondary treatment for domestic sewage and woolen mill wastes, and discharge their effluent to the adjacent Mousam River.

Previous Studies

Environmental Engineers, Inc. (1980) conducted a hydrogeologic study of the site in preparation for the 1981 expansion. Numerous test holes were drilled for this study, providing detailed information on the sites geologic characteristics. The DEP also collected information on the site in 1979 for the Surface Impoundment Assessment Study.

Site Geology

The site is underlain by fine to coarse sand, with some fine to coarse gravel and cobbles. This deposit is generally 10 to 20 feet thick, with moderate to high permeability. The sand and gravel overlies a thick silty clay deposit, although in some locations it first grades to a silty sand. The silty clay deposit ranges from 3 to 40 feet thick. Till is present underneath the clay in most locations, and ranges from 0 to 20 feet in thickness. Bedrock is usually from 20 to 40 feet below land surface, but is 93 feet below land surface in one location. The water table is located from 0 to 10 feet below the land surface.

Project Investigation

Sixteen resistivity profiles were run around the perimeter of the site (Figure 13). Every profile contained layers of low resistivity, indicating that contaminants were flowing radially out from the unlined lagoons toward the Mousam River.

The conductivity of numerous seeps around the perimeter of the site was also determined (Figure 13). Most had high conductivity values . The conductivity of the Mousam River was also elevated in many locations.

Samples were collected in 12 locations for phosphorus analyses. Phosphorus levels were high only in those samples collected north and east of the site. Fecal coliform levels were determined in 6 areas. All six samples contained high concentrations of fecal coliform bacteria.

Summary of Sites Impact on Ground-Water Quality

The lagoons at this site are leaking in many areas, causing contamination of numerous springs and seeps around the site and the Mousam River. Because the Mousam River surrounds the site, the lagoon's have only impacted ground-water quality in a very limited area.

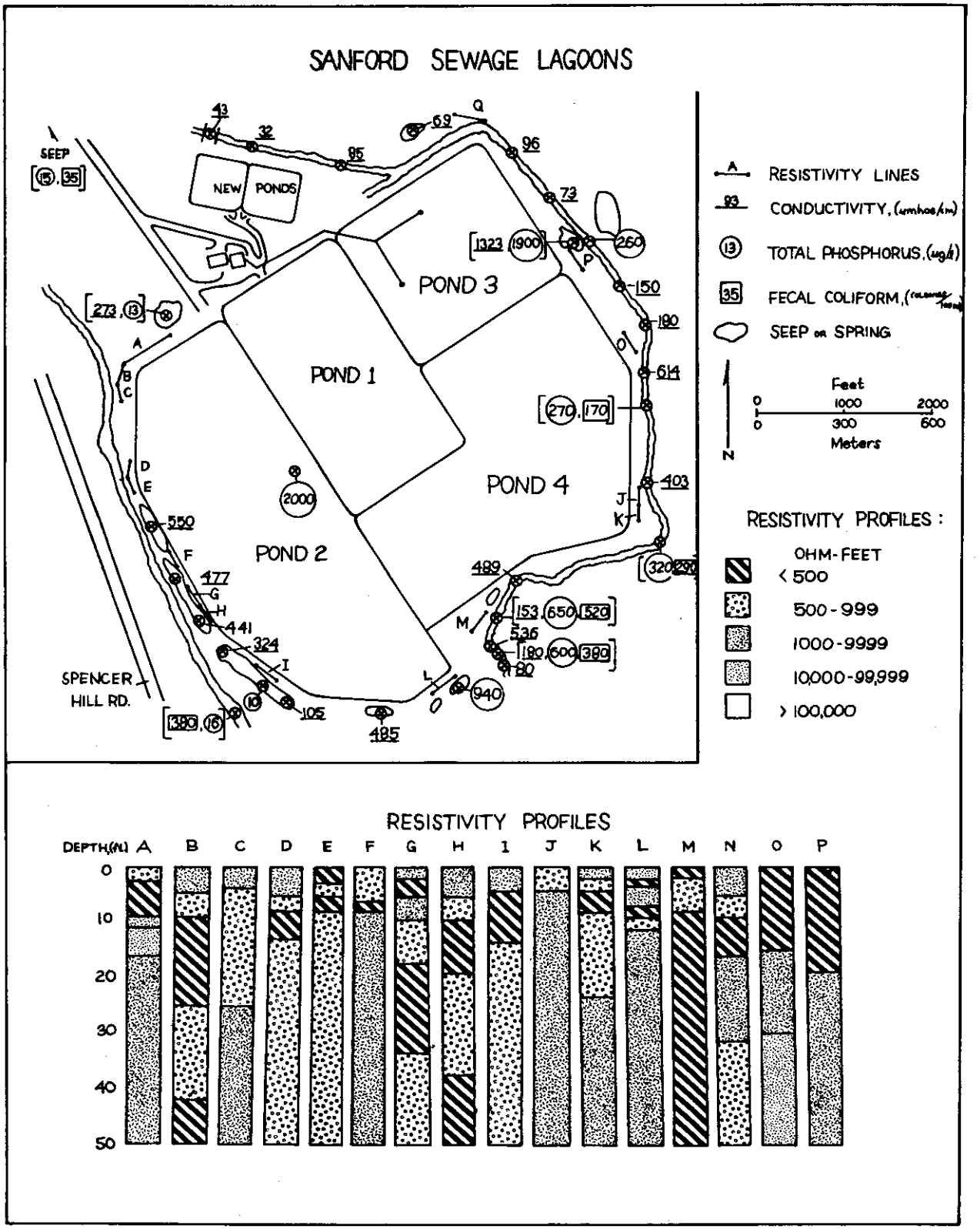


Figure 13. Sanford Sewage Lagoons: Resistivity profiles, water chemistry.

SANFORD CYRO INDUSTRIES

Operational History

CYRO Industries, a partnership of Cyanamid Plastics, Inc. and Rohacryl, Inc., manufactures acrylic sheets and molding compounds. In the process, methyl methacrylate (MMA), a hazardous waste, is generated. Water containing recoverable MMA is stored for recycling in one of two 10,000 gallon underground storage tanks. From 1977 to 1981 solutions containing non-recoverable MMA were stored on site in 55 gallon drums, awaiting eventual disposal.

As a licensed interim hazardous waste storage facility, CYRO was inspected for R.C.R.A. (Resource Conservation and Recovery Act) compliance on February 11, 1981 by inspectors from the Environmental Protection Agency and the Maine Department of Environmental Protection. At this time CYRO had between 500 and 1,000 55-gallon drums of methyl methacrylate waste stored on site. Many of these containers were improperly labeled, rusted, ruptured from expansion of freezing water, or leaking (Haynes and others 1981).

In compliance with the terms of a consent agreement by CYRO Industries and the State of Maine Board of Environmental Protection (1981), CYRO Industries now pumps its non-recoverable MMA into a diked 6,000 gallon steel separation tank. The top reusable layer is transferred to the underground storage tanks. The middle layer of contaminated water is pumped off, transported and recycled. The bottom layer of sludge is collected and solidified into a non-hazardous waste (Gleason and Eufemia, 1982). The contents of the drums stored on site were disposed of in the above described manner.

Summary of Sites Impact on Ground-Water Quality

Both toluene and methyl methacrylate have been detected in low concentrations (up to 3.8 ug/L) in samples collected in two on-site monitoring wells. The site is approximately 2500 feet upgradient of Sanford Water District wells (Whitman and Howard, Inc., 1981). With concentrations of volatile organics quite low in the on-site monitoring wells, it is unlikely that the site is having any effect on the municipal water supply.

References

Gleason, D. and Eufemia, S. (Maine DEP) 1982, RCRA site inspection, Site ID MED040249096, dated 9/10/82.

Haynes, P. (EPA), Demkowicz, R. and Kreuger, J. (Maine DEP), 1981 RCRA inspection, Site ID ME040249096, dated 2/11/81.

State of Maine Board of Environmental Protection, 1981, Consent agreement with Cyanamid Plastics, Inc. and Rohacryl, Inc.

Whitman and Howard, Inc., 1981, Plan of land in Sanford, Drawing No. M-470.

SANFORD-SPRAGUE ELECTRIC WASTE DISPOSAL LAGOONS

Operational History

Sprague Electric Co. has been manufacturing tantalum semi-conductor capacitors in their Sanford plant since 1967. Liquid wastes from the manufacturing process have been disposed of in two unlined lagoons since that time. The wastewater currently includes manganese nitrate, dilute acids (nitric, acetic, and phosphoric), cooling tower water containing a poly-acrylate and water de-ionizer generating fluids, and trace levels of some organic solvents. Twenty eight thousand gallons/day of waste are disposed of at present (Fontaine, 1984). The amounts and chemistry of wastes disposed of may have varied since 1967.

Previous Studies

This site was included in the Surface Impoundment Study in 1979 (Noble, 1980). In 1984, at the request of DEP, 11 monitoring wells (including 4 pairs of nested deep and shallow wells) were installed by Robert G. Gerber, Inc. These wells were sampled in December, 1984. At the time of publication of this report (February, 1985) Robert G. Gerber, Inc. is expanding the hydrogeologic investigation of this site with the installation of several additional wells.

Site Hydrogeology

The site is underlain by fine to coarse sand with gravel and occasional cobbles. The sand and gravel is interfingered with silty sand and clay in places, and is underlain by a thick clay-silt deposit and till. The surficial material ranges in depth to more than 75 feet, with bedrock apparently sloping away from the ground surface to the northeast (Gerber, 1985).

October water levels in the monitoring wells ranged from 3 to 19 feet below land surface. The water table appears to slope gradually to the northeast. The Mousam River is located approximately 400 feet north of the disposal lagoons. The river flows northeasterly.

Ground-Water Chemistry

DEP sampled seven of the monitoring wells in December, 1984. The upgradient well (southwest of the site) contained typical background levels of all cations analysed (sodium, iron, manganese, cadmium, lead and copper), and slightly elevated chloride (29 mg/l) and nitrate (0.93 mg/l) levels. No volatile organic compounds were detected in this well.

The six wells north and east of the site had high levels of sodium, iron and manganese, with the highest values (390, 55 and 5.5 mg/l, respectively) in a well east of the lagoons. Lead levels exceeded drinking water standards in 3 of these 6 wells. Cadmium and copper levels were within acceptable limits in all wells.

Chloride levels were very high (640 and 340 mg/l) in two wells east of the lagoons, perhaps due to salting of the plant's parking lot. The remaining 4 wells had chloride concentrations at or below those of the upgradient well. All 6 downgradient wells had nitrate values below those in the upgradient well.

Very high levels of three volatile organic compounds were found in three deep wells; no volatiles were detected in the shallow wells adjacent to these wells. The well which had the highest cation concentration also had the highest concentration of organic compounds; 260 ug/l methylene chloride, 7300 ug/l dichloroethylene, and 1400 ug/l trichloroethylene.

Summary of Sites Impact on Ground-Water Quality

Preliminary water chemistry data indicates that this site may be causing severe ground water contamination to its north and east. However, dichloroethylene, the most concentrated volatile organic compound detected in the ground water, has never been knowingly used by Sprague Electric. Because of this, and because the extent of the contamination is unknown, a much more detailed study is currently being conducted by Robert G. Gerber, Inc. The results of this study should be available in mid-1985.

References

Fontaine, L. 1984. December 28 memo concerning Sprague Electric Co., Sanford, Maine

Gerber, R.G. Inc., 1985. Unpublished well logs and water quality data.

Noble, W.T., 1980. State of Maine Surface Impoundment Assessment, Final Report; Maine Dept, of Environmental Protection, 151 p. plus appendices.

WATERBORO LANDFILL AND CLOSED LAGOONS

Operational History

The Town of Waterboro is currently operating a transfer station in a gravel pit along the Deering Hill Road in Waterboro (Figure 14). Brush and demolition debris are also disposed in this area.

Approximately 1000 feet northeast of the transfer station are two abandoned, unlined lagoons owned by the Waterboro Patent Company. One lagoon was used for storing oils extracted from leather processing, while the other was used for storing caustic material and dilute acrylic resins left over from a patent leather process. A leak in the caustic waste lagoon in the Fall of 1977 allowed the waste to run approximately 300 feet north, killing all vegetation in its path (Florence Hoar, Maine D.E.P., personal communication, 1984).

Approximately 2000 feet south of the abandoned lagoons is a closed and covered dump, which the Town of Waterboro operated until 1982. An estimated 1000 cubic yards of industrial and municipal wastes were disposed at this site annually until the dump was closed. Toxic and oily wastes from the Waterboro Patent Corporation tannery and the Southern Maine Finishing metal processing plant were also disposed at this dump until 1978.

Previous Studies

D.E.P. Water Bureau personnel investigated this site in 1976-1977, followed by D.E.P. Land Bureau investigations in 1978 and 1979. Robert Gerber (1977) conducted a preliminary hydrogeologic investigation of the area around the present transfer station to determine its feasibility for use as a sanitary landfill. The E.P.A. is currently investigating the closed landfill under the Hazardous Waste "FIT" Program.

Site Geology

The three sites are in a large kame terrace deposit containing clean but poorly stratified sandy gravels (Gerber, 1977). A till ridge flanks the western edge of the closed landfill and lagoons. Marsh deposits are located east of the closed landfill, and northeast of the transfer station, around Bartlett Brook (Figure 14).

Seismic data indicate a depth to water from 4 to 7 feet both at the closed landfill and close to the lagoons and transfer station. Bedrock is 11 to 20 feet below land surface near the closed landfill (Figure 14, lines 1-4), but nearly 50 feet below land surface near the lagoons and transfer station (line 5).

Project Investigation

Ten resistivity profiles were made around the closed landfill and lagoons. Several resistivity profiles to the south of the landfill had layers of low resistance, although the results may have been influenced by buried refuse (Figure 14).

Terrain conductivity values were slightly elevated southwest of the closed landfill and northeast of the lagoons (Figure 15). The high values near the lagoons may have been due to the spillage which occurred in 1977.

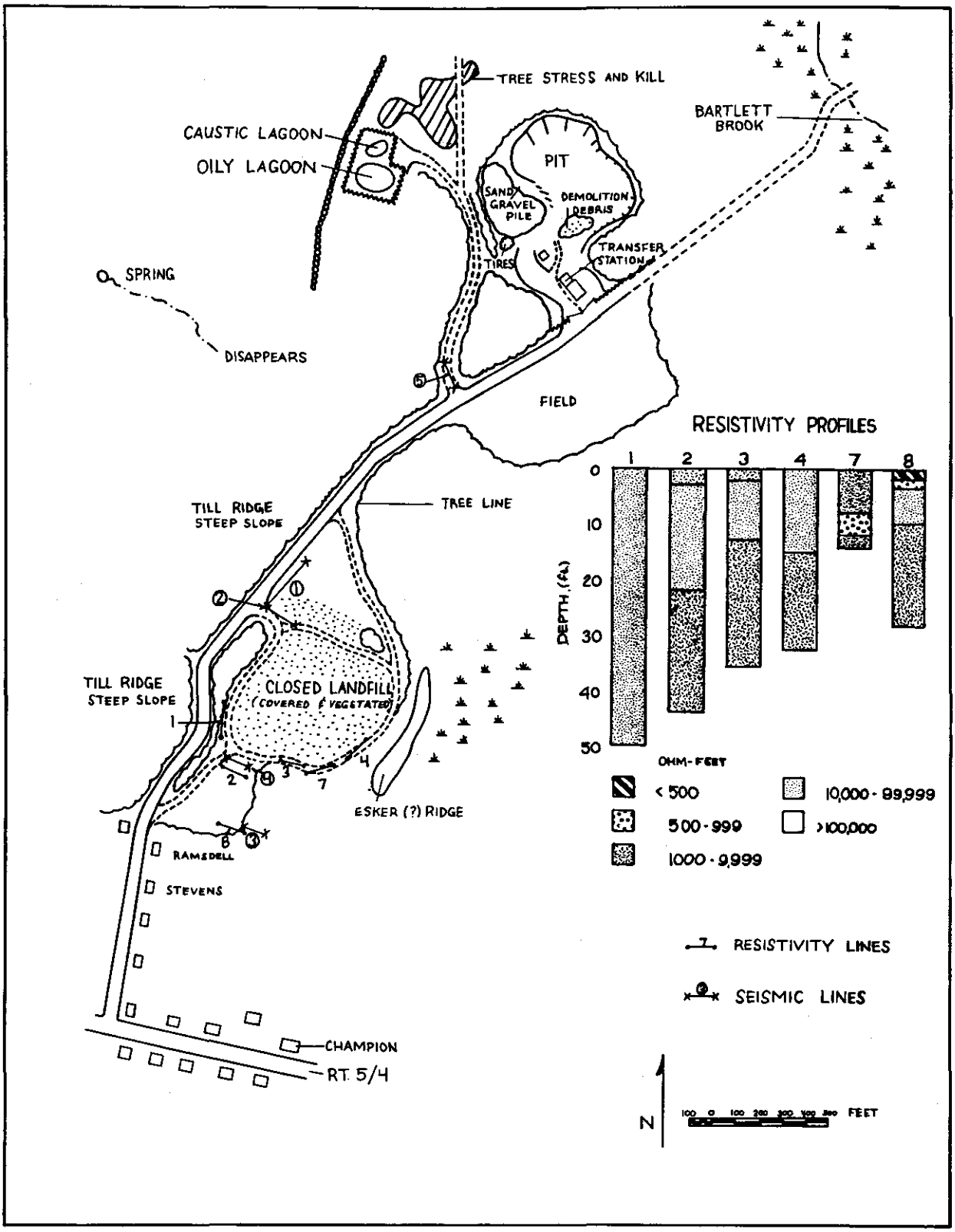


Figure 14. Waterboro Landfill and Lagoons: Seismic and resistivity lines.

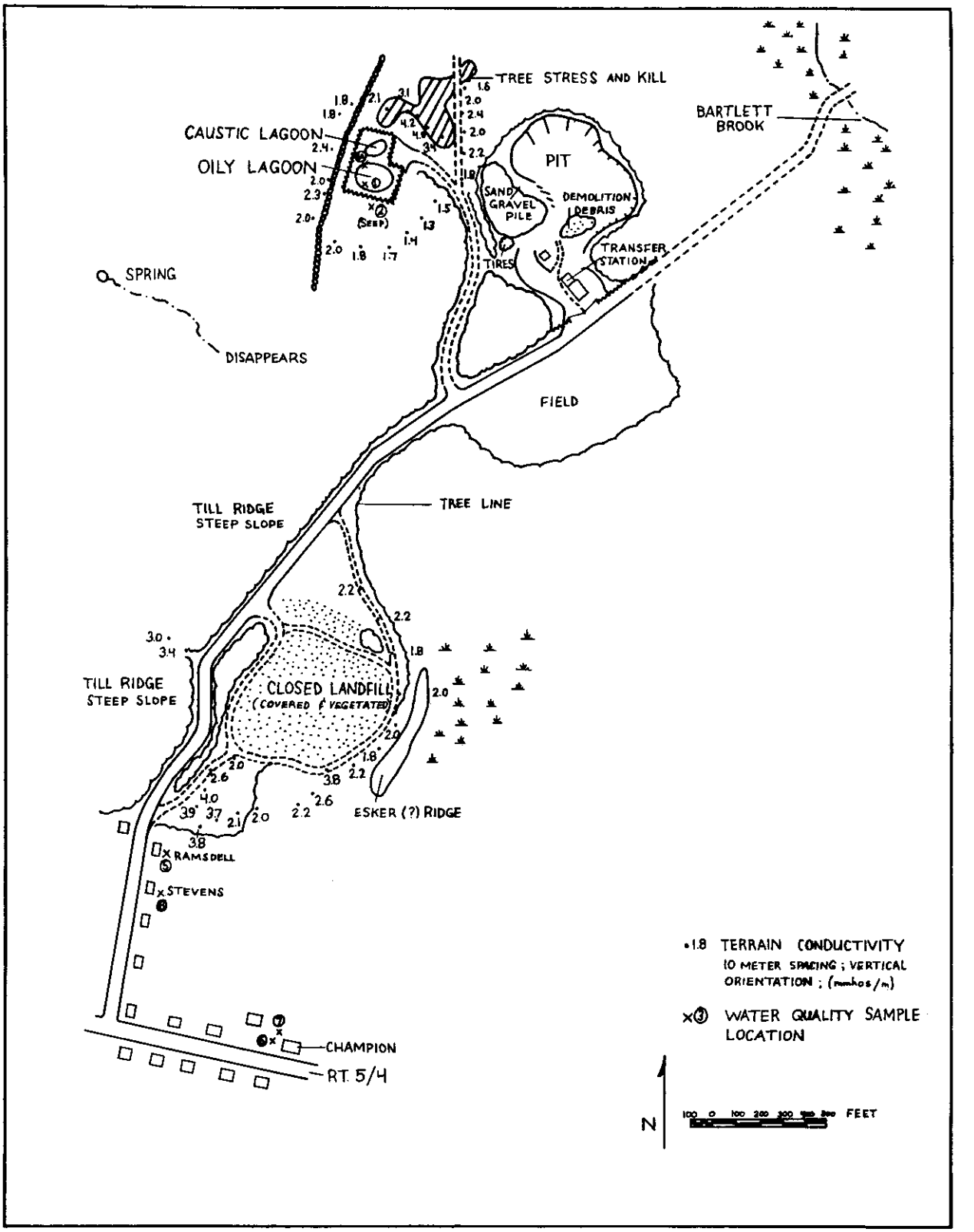


Figure 15. Waterboro Landfill and Lagoons: Terrain conductivity values and water quality sampling locations.

Water Chemistry

Water quality samples were collected at 8 locations (Figure 15). Standing water in the former oily waste lagoon had above background concentrations of sodium, calcium, lead, total organic carbon, and hydrocarbons (Table 12). A seep approximately 100 feet south of the lagoons had a high conductivity, and elevated total organic carbon levels. The Champion dug well had high total organic carbon, perhaps due to leaves and other organic matter falling into the well. None of the other 5 water samples collected showed any signs of contamination.

Summary of Sites Impact on Ground-Water Quality

Resistivity and terrain conductivity readings suggest that leachate from the closed Waterboro landfill is causing some ground-water contamination southwest of the site, and that abandoned waste disposal lagoons adjacent to the present transfer station are contaminating ground-water to their northeast. Standing water in the former oily waste lagoon contains high levels of hydrocarbons, and a ground-water seep south of the lagoons shows some evidence of contamination. No domestic wells have been impacted by either site.

The old landfill appears to have been properly closed and covered. However, the lagoons have been left open. The contaminated material remaining in the lagoons should be removed, and the site should be properly covered and seeded.

References

Gerber, R.G., 1977, Preliminary report on proposed sanitary landfill site, Cudahy Site, Waterboro, Maine.

Maine Department of Human Services, 1983, Rules relating to drinking water.

Table 12. WATER CHEMISTRY AROUND THE WATERBORO CLOSED DUMP AND LAGOONS

Number	Location	Type	Date Sampled	Temp(°C)	Cond (umhos/cm)
1	Oily waste lagoon	Seep	8-15-83	30	414
2	South of lagoons	Seep	8-15-83	18	230
3	Spring SW of lagoons	Spring	8-15-83	18	95
4	Marsh near Bartlett Bk	Seep	8-15-83	19	73
5	Ramsell well	Dug well	8-15-83	12	34
6	Champion well	Dug well	8-15-83	15	87
7	Champion well	223 foot drilled well	8-15-83	18	67
8	Stevens well	230 foot drilled well	9-2-81	NA	NA

Number	Sodium	Calcium	Iron	Manganese	Nitrate-N	Chloride
1	21	52	0.88	0.29	0.10	<0.5
2	1.8	0.6	.63	.37	0.10	7.0
3	3.4	4.8	.04	.11	.08	1.0
4	NA	NA	NA	NA	NA	NA
5	3.2	3.9	<.03	<.005	0.15	3.0
6	6.3	6.6	.31	.052	0.23	6.0
7	4.4	4.0	.05	<.005	0.22	4.5
8	NA	NA	NA	NA	NA	1.5
Limit*	20	None	.3	0.05	10	250
Background**	13	24	8.8	1.6	1.5	12

Number	Chromium	Lead	Cadmium	TOC	Volatile Organics
1	0.01	0.07	0.005	5500	10***
2	.01	.04	<.004	50	<.001
3	<.01	<.03	<.004	5	<.001
4	NA	NA	NA	NA	<.001
5	<.01	<.03	<.004	1	<.001
6	<.01	<.03	<.004	22	<.001
7	<.01	<.03	<.004	1	<.001
8	<.01	NA	NA	<1	<.001
Limit	0.05	0.05	0.01	None	---

NA = Not Analyzed
* = Maine Department of Human Services (1983) Limit
** = Maximum level expected in uncontaminated ground water as determined in Section IV of this report
*** = A hydrocarbon mixture similar to weathered gasoline was present at an estimated concentration of 10 mg/L

WATERBORO-SOUTHERN MAINE FINISHING

Operational History

For approximately 10 years, Southern Maine Finishing of East Waterboro has been discharging treated process wastewater from their metal plating facility into an on site leachfield at an average rate of 26,200 gallons/day. The composition of the effluent has varied from time to time depending on production requirements. The effluent contains iron, copper, chromium, nickel, silver, lead, zinc, tin, aluminum, sulphates, phosphates, chlorides, nitrates and cyanide.

Previous Studies

Robert G. Gerber, Inc. of South Harpswell, Maine conducted two hydrogeologic studies for Southern Maine Finishing (Gerber, 1980; Gerber, 1982). For these studies Gerber installed 3 monitoring wells and conducted a computerized ground-water modeling study.

Gerber's modeling study has traced a contaminant plume flowing southeasterly from the point of discharge. The plume centers somewhere between Route 5 and Cooks Brook, and has migrated at the rate of approximately one foot per day. Gerber states that after 10 years of migration, the plume reached a steady state of contaminant concentration distribution. The discharge has produced relatively high concentrations of contaminants in Cooks Brook and at the southern boundary of the Southern Maine Finishing property.

Site Hydrogeology

The site is located over a sand and gravel aquifer formed in glacial outwash sediments. Gerber's studies indicate that the aquifer averages 50 feet in thickness and has a relatively high transmissivity (on the order of 4000 ft^2/day).

Water Chemistry

Residential wells along Route 202 and Route 5 were sampled by the DEP and tested for chromium, cadmium, nickel, iron, copper, and zinc. These wells are all shallow and either point driven or dug. One shallow dug well has a cadmium level of 0.065 mg/L, approximately 6 times the DHS limit. Seven of 12 wells tested had an iron content exceeding the drinking water standard of 0.3 mg/L, but none were above the maximum level expected in uncontaminated ground water as reported in Section IV.

Summary of Sites Impact on Ground-Water Quality

A plume of contaminated ground water is flowing southeast from this site and discharging into Cooks Brook, more that 2000 feet from the leachfield where the contamination initiates. There has been no impact to domestic wells which are currently in use.

References

Gerber, R.G. Inc., 1982, Evaluation of wastewater discharges for Southern Maine Finishing Corporation.

Gerber, R.G., Inc., 1980, Hydrogeologic evaluation for subsurface effluent disposal for Southern Maine Finishing Corporation. Report submitted under sub-contract to Land Use Consultants, Inc.

WELLS LANDFILL

Operational History

The Wells landfill was opened in September, 1971. It was operated as a burning dump until 1973, when it was converted to an area system landfill. Approximately 70,000 cubic yards of refuse is deposited at this site annually. The refuse is primarily residential and commercial waste, although septic sludge has also been dumped in the landfill in the past.

Previous Studies

Farrell and Day (1980) investigated the Wells landfill in the late 1970's. Eleven monitoring wells were installed around the site; seven of these were sampled repeatedly for that study. Five of the wells were still in place in 1981; four were found in 1983.

Site Geology

The site is located in an abandoned gravel pit in the top of a sandy till ridge. The sandy till is underlain by saturated coarse to medium grained outwash sands which are 5 to 6 feet deep and overlie a cobbly, silty clay till. Marine clay underlies the till (Farrell and Day, 1980).

An 1800 foot seismic line was run along the southwestern margin of the dump. A 260 foot line was run at the southeastern toe of the site (Figures 16 and 17). Depth to bedrock in these locations varies from 21 to 56 feet below land surface, while the depth to water varies from 4 to 10 feet. The water table is apparently perched on clay lenses in places.

Due to the relatively thin section of coarse grained sediments, the area around the site is no longer considered a significant sand and gravel aquifer (plate 1).

Project Investigation

A total of 52 resistivity lines were run around the periphery of the landfill (Figure 18). A conductive zone, interpreted to be leachate, was detected migrating away from the landfill in a radial pattern, possibly due to the development of a ground water mound under the site or to a perched water table. Some resistivity profiles are probably influenced largely by the presence of conductive marine clay at depth (#5 for example).

The resistivity profiles also show an extensive conductive zone along the southwestern margin of the dump face (lines 3A-19A, T1-T4, Figure 18), suggesting that leachate is migrating away from the landfill in that area. A terrain conductivity survey run in this direction showed a wide plume of conductive ground water flowing southwesterly from the landfill, extending at least 1500 feet from the landfill boundary (Figure 19).

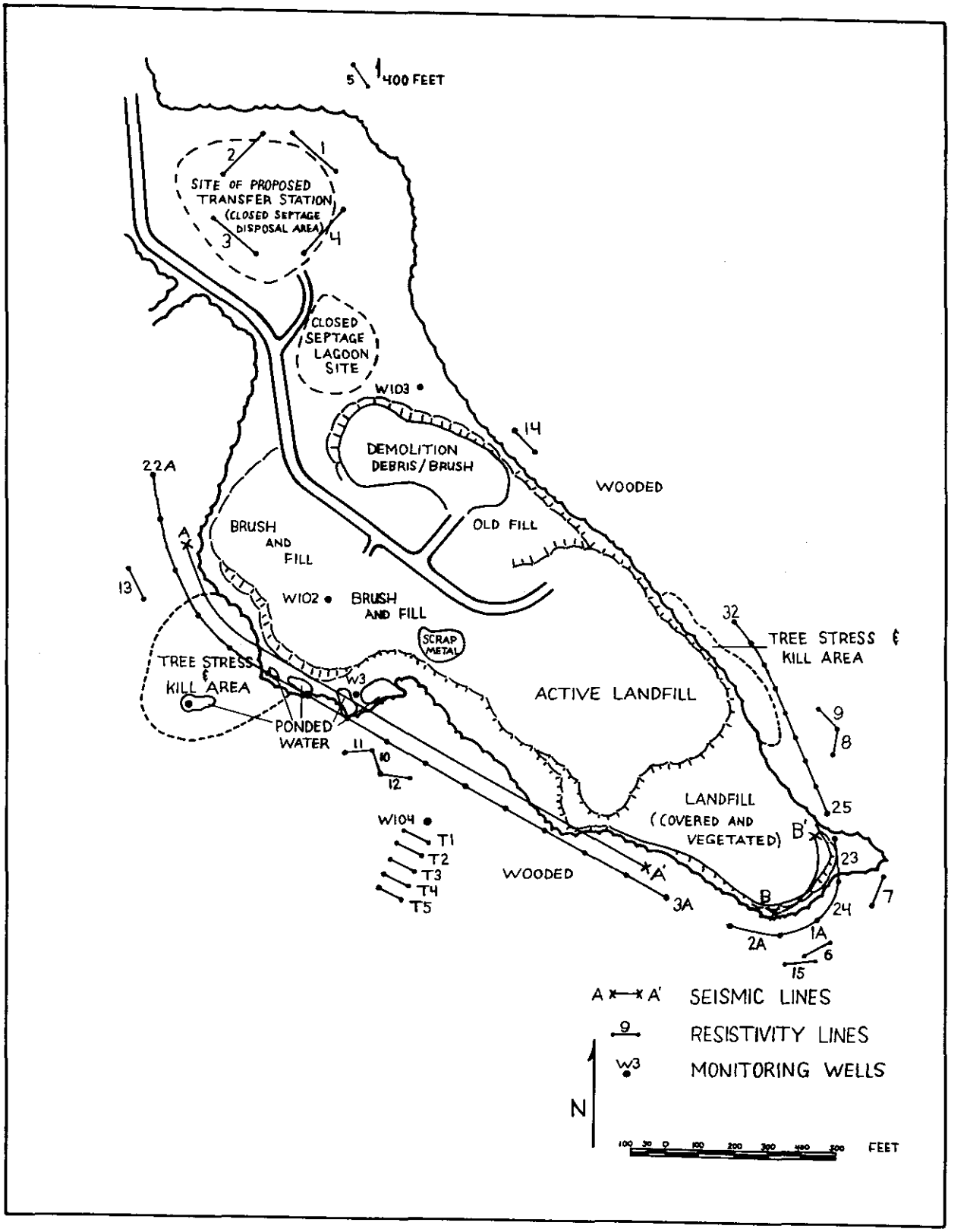
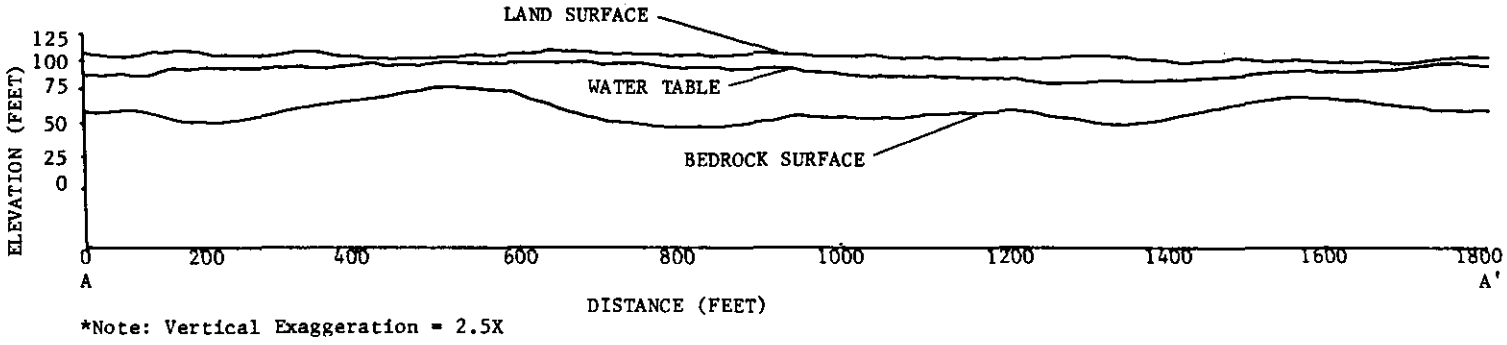
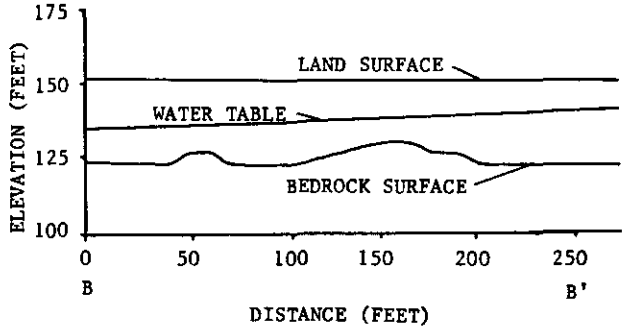


Figure 16. Wells Landfill: Location of seismic and resistivity lines, monitoring wells.



*Note: Vertical Exaggeration = 2.5X



*Note: Vertical Exaggeration = 1.5X

Figure 17. Wells Landfill: Seismic profiles.

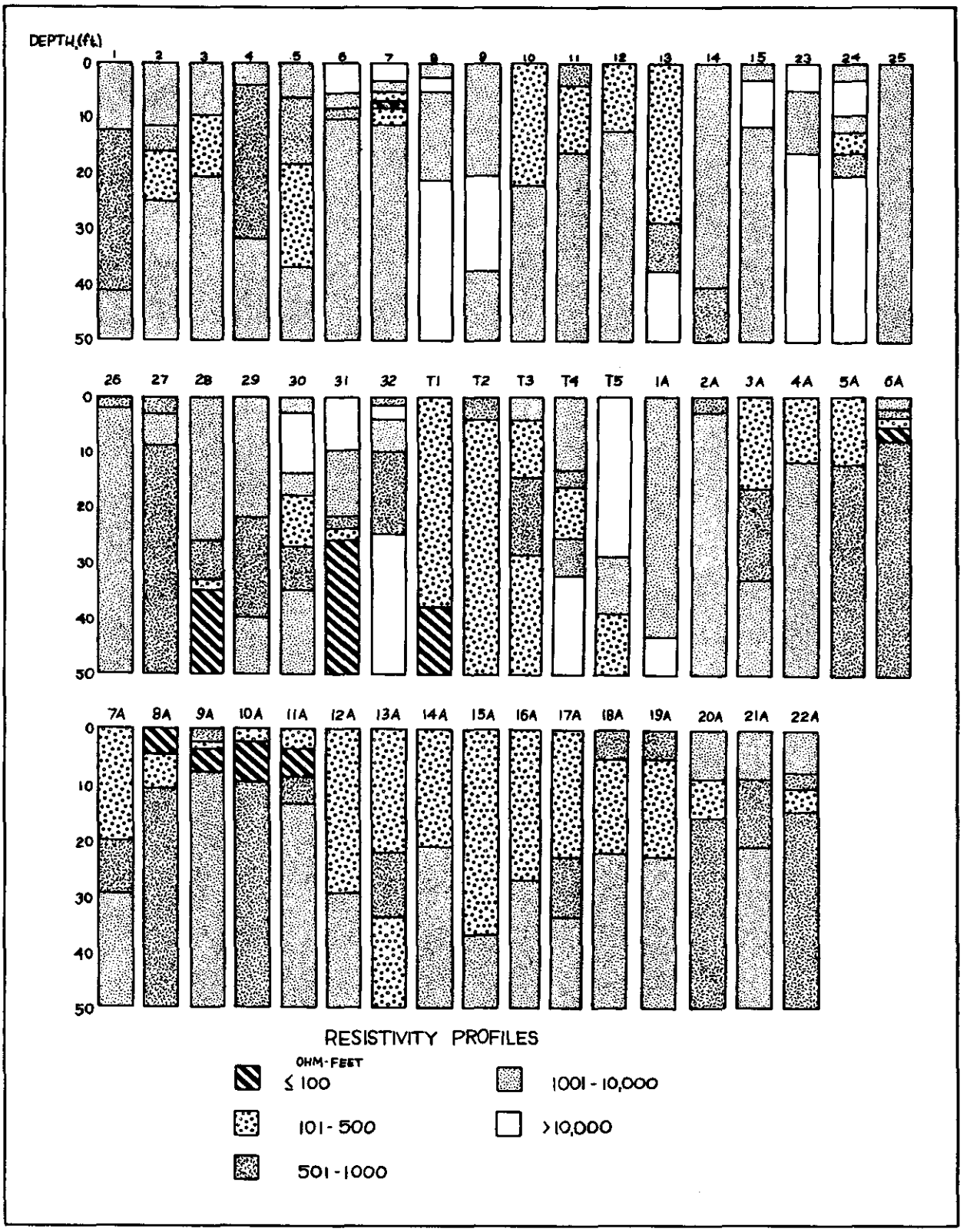


Figure 18. Wells Landfill: Resistivity profiles.

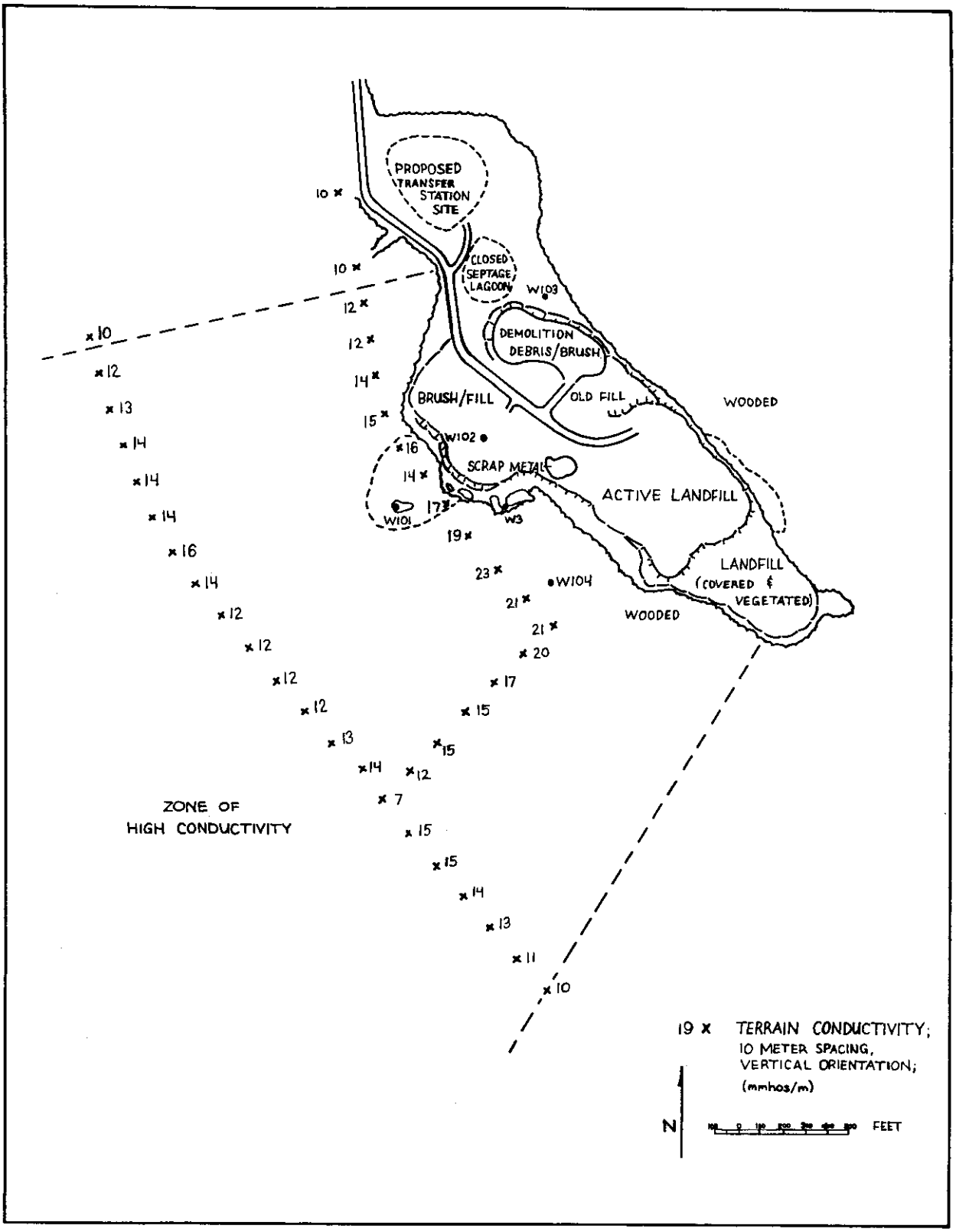


Figure 19. Wells Landfill: Terrain conductivity.

Water Chemistry

Three monitoring wells were sampled in 1981; one well northeast of the landfill (W 103), a second well in the landfill area (W 3), and a third well southeast of the landfill (W 104)(Figure 16). W 103 and 104 were resampled in 1983. Because W3 was destroyed between 1981 and 1983, W 102, another well within the landfill area, was sampled in 1983.

W 104 and W 3 (W 102) are highly contaminated, containing above background levels of almost all elements analyzed (Table 13). In the 1983 analysis W 104 exceeded the DHS recommended limits for chloride, sodium, iron, manganese and lead, and had detectable, although very low, levels of many volatile organic compounds. W 102/W 3 also exceeded the DHS limits for many elements, and had higher volatile organic pollutant levels than W104. W103 had generally low levels of most elements, but in 1981 had lead, iron and chromium concentrations exceeding the DHS limit. In 1983 these elements were not analysed in W103, but high TOC and detectable toluene, trichloroethylene and tetrachloroethylene levels were found.

These results suggest that while contaminated ground water is leaving the site in many directions, most of the contamination is flowing southwest, toward the Webhannet River.

Summary of Sites Impact on Ground-Water Quality

Extensive geophysical surveys, and a more limited well monitoring program have indicated that the Wells Landfill is contaminating ground water in a wide area around the site. The contaminated ground water flows radially from the site, but the contaminants appear to be most concentrated along the site's southwestern periphery. The plume extends at least 1500 feet from the landfill boundary, and probably to the Webhannet River. Fortunately, the Wells Landfill is not on a significant aquifer and is very isolated, so no water supplies should be affected.

Reference

Farrell, R.S. and A.R. Day, 1980, Ground Water Monitoring at selected solid waste disposal sites, Maine Department of Environmental Protection Report, 193 p.

Table 13. CHEMISTRY IN WELLS LANDFILL MONITORING WELLS

	W3/W102*	W 103	W 104	Limit**	Background***
AUGUST 11, 1981					
Conductivity (umhos/cm)	1190	125	2900	None	160
pH	6.35	5.40	6.25	6.5-8.5	---
Chloride (mg/L)	54	6.5	NA	250	12
Nitrate-N (mg/L as N)	0.43	NA	NA	10	1.5
Sodium (mg/L)	36	9.5	NA	20	14
Calcium (mg/L)	140	30	NA	None	25
Iron (mg/L)	120	310	NA	0.3	8.7
Lead (mg/L)	0.11	0.26	NA	0.05	NA
Chromium (mg/L)	0.02	0.31	NA	0.05	NA
Copper (mg/L)	0.01	0.52	NA	1.0	NA
Total Organic Carbon	158	30	NA	None	NA
OCTOBER 25, 1983					
Conductivity (umhos/cm)	1190	66	2000	None	160
Chloride (mg/L)	150	6.0	270	250	12
Nitrate-N (mg/L as N)	0.05	NA	0.06	10	1.5
Sulfate (mg/L)	18	6	NA	250	20
Sodium (mg/L)	NA	NA	180	20	14
Potassium (mg/L)	NA	NA	46	None	5.4
Calcium (mg/L)	NA	NA	230	None	25
Magnesium (mg/L)	NA	NA	82	None	5.2
Iron (mg/L)	NA	NA	50	0.3	8.7
Manganese (mg/L)	NA	NA	7.9	0.05	1.7
Lead (mg/L)	NA	NA	0.10	0.05	NA
Chromium (mg/L)	NA	NA	0.01	0.05	NA
Copper (mg/L)	NA	NA	0.02	1.0	NA
Total Organic Carbon (mg/L)	NA	109	75	None	NA
Benzene (ug/L)	J3	<1	J1	360	<1
Toluene (ug/L)	J7	J1	J1	86	<1
Ethyl-benzene (ug/L)	J8	<1	J1	250	<1
Xylenes (ug/L)	J20	<1	J1	73	<1
Trichloroethylene (ug/L)	<1	J1	J1	75	<1
Tetrachloroethylene (ug/L)	<1	J9	<1	20	<1
Other Volatile Organics (ug/L)	<1	<1	<1	None	<1

* = Well 102 used instead of W 3 in 1983 sampling. Both wells are screened beneath landfill wastes.

** = Limits for organics are EPA long-term (for more than 1 1/2 years) health advisory limits. Other limits are EPA or DHS recommended maximum levels in drinking water.

*** = Maximum level expected in uncontaminated ground water in York County as determined in Section III of this report.

NA = Not analyzed

J = Approximately

YORK SAND-SALT STORAGE AREA

Site History

In 1971 the Town of York built a town garage on the Chase Pond Road. Beginning in 1972, salt was stored at this site in a partially enclosed building over a bituminous pad. Salt was also stored in an unlined, uncovered sand-salt pile. From 1973 through 1979 a small housing development was constructed on Preble Lane, immediately south of the town garage. In 1975 the newly installed residential wells started showing signs of chloride contamination. By June 1976 at least nine residential wells were contaminated by chloride in excess of 250 mg/L. Eighteen wells had chloride levels higher than 12 mg/L, a level which would be expected under natural conditions (Table 2, Section IV).

On July 10, 1980, the York County Superior Court found the Town of York guilty in "the taking without just compensation" of nine homes on Preble Lane as the result of contamination caused by the town's sand-salt pile. The jury awarded $274,000 to the residents as compensation for diminished property values caused by the contamination, and ordered the town to pay an additional $36,000 for legal fees and court costs. The sand-salt pile was moved in 1981, although small amounts of salt and sand still remain on the site.

Previous Work

Ray Woodman (1979) conducted an investigation of this site and concluded that the town sand-salt stockpile was the primary cause of chloride contamination to the affected wells. Gerber and Rand (1979) studied ground water contamination at the site, concluding that ground-water flow from the sand-salt pile was south, toward the contaminated wells. Gerber and Rand constructed a map of the area showing how salt levels had increased in the domestic wells from 1973 to 1979. Florence Hoar (1980) noted that while the soils at this site were not permeable enough to constitue a significant sand and gravel aquifer, some bedrock wells were yielding more than 100 gallons per minute.

Geology and Geochemistry

The salt shed is situated over sandy soils, which are shallow to bedrock. Bedrock outcrops are visible in an adjacent gravel pit. Ground-water flow is to the southwest, roughly parallel to the Chase Road. Gerber and Rand (1979) estimated that after removal of contaminated overburden, 14 years would be needed for good water to be restored to Preble Lane.

Ground water samples taken on June 6, 1979 were analyzed by the Department of Human Services for chloride, sodium, iron and manganese (Table 14). Nine out of 14 wells exceed drinking water standards for chloride and 13 exceed drinking water standards for sodium. The high salt levels in the ground water may be increasing the leaching of other metals from the geologic media, as iron and managanese levels in many wells are also very high.

Table 14. SODIUM, CHLORIDE, IRON AND MANGANESE LEVELS IN DOMESTIC WELLS NEAR THE TOWN OF YORK SALT STORAGE AREA

Owner	Date Sampled	Well Depth Ft.	Chloride	Sodium	Iron	Manganese
York Town Garage	6-6-79	400	63	25	5.6	0.43
Babkirk	6-6-79	U	27	28	0.68	0.10
Chrichet	6-6-79	420	462	89	0.49	0.25
Oulette	6-6-79	240	360	101	11.0	1.0
Biore	6-6-79	185	372	291	0.20	0.03
Rolando	6-6-79	60	1488	408	0.78	0.03
Nolen	6-6-79	525	372	212	<0.2	NA
Sturtevant	6-6-79	210	624	188	.38	1.7
Pasakris	6-6-79	160	169	101	<0.2	NA
Jones	6-6-79	320	1416	821	0.51	0.05
Lapine	6-6-79	175	276	84	<0.2	NA
Buoncristiano	6-6-79	60	43	14	0.71	0.41
Schmigle	6-6-79	60	504	201	33	1.2
Waite	6-6-79	70	118	126	4.1	7.3
Bayres	3-30-79	U	<10	NA	NA	NA
Lawrence	3-30-79	U	21	NA	NA	NA
MacPhail	3-30-79	U	36	NA	NA	NA
Porier	3-30-79	U	51	NA	NA	NA
Trafton	3-30-79	U	96	NA	NA	NA
DHS Limits			250	20	0.3	0.05

All values in mg/L NA = not analyzed U = Unknown

Summary of Sites Impact on Ground-Water Quality

The leaching of salt from the Town of York's uncovered, unlined sand-salt pile has affected ground-water quality in at least 18 drilled wells. Nine of these wells have chloride concentrations in excess of the DHS limit for drinking water. Twelve of 13 wells tested exceed the 20 mg/L DHS sodium standard for individuals on severely restricted sodium diets.

The site is not over a significant sand and gravel aquifer, but does overlie thin, sandy soils which recharge a high yield bedrock aquifer.

Nine residents whose wells were contaminated with salt sued the Town of York, and were awarded $274,000 plus court costs as compensation for their diminished property values. These homes still need a source of potable water. It has been estimated that extending the town's public water supply lines to these houses will cost $550,000.

References

Gerber, R.W., and J. Rand, 1979, Salt polluted wells and salt-sand stockpile, York, Maine, map drawn for the Citizens of the Prebble Lane Area, York.

Hoar, F., 1980, York salt-and-sand pile, memo to Dennis Merrill, DEP Water Bureau, January 31, 1980.

Woodman, R.G.. 1979, Chloride contamination of private water wells, Prebble Lane, York, Maine, Report prepared as a gratis service of the Maine Department of Transportation.

YORK LANDFILL

Operational History

Since 1977 the Town of York has operated a landfill in a former gravel pit on the Witchtrot Road, located off Rt. 91. Seventy percent of the town's refuse is commercially collected and hauled to the Pease Air Force Base energy recovery incinerator. The remainder of refuse is disposed of at the landfill (Maine Department of Environmental Protection, 1983).

Establishment of the landfill was approved on June 8, 1977 by the Maine Board of Environmental Protection (MBEP). A five acre landfill with a parameter drainage ditch and sedimentation basin was constructed on the southern portion of the site. The sedimentation basin empties into McIntyre-Junkins Brook.

In December 1983 the MBEP denied the town of York's application for a solid waste landfill license renewal and denied the application to expand the landfill. The renewal was denied partly because landfill disposal resulted in contamination of ground water. As stated in the Board's conclusions "the applicant has not provided evidence of financial capacity and technical ability to meet air and water pollution control standards in that ground water pollution is occurring on the site; polluted ground water is leaving the site at the north; and contaminants are entering McIntyre-Junkins Brook from the sedimentation pond and immediate vicinity" (Maine Department of Environmental Protection, 1983).

Previous Studies

In 1976 Haley & Aldrich, Inc., performed a geologic investigation of the proposed landfill site for the Town of York. For this study 14 monitoring wells were installed and 7 test pits were excavated. The MDEP Land Bureau has closely monitored operations at this landfill since it was opened in 1977. Ground-water levels have been checked regularly and ground-water quality has been monitored quarterly. The chemical analysis of ground-water samples was performed by Peck Environmental Laboratory, Inc., of Kennebunk, Maine. No additional work on this site was done by the Sand and Gravel Aquifer Mapping Project.

Site Geology

The site is located on a kame terrace ridge consisting of fine sand and silty fine sand varying locally to gravelly sand and silt (Haley & Aldrich, 1976). The outwash deposits are sandwiched between two bedrock ridges which are exposed to the east and west of the site. The site was mapped as a sand and gravel aquifer by Caswell (1979). Subsequent information has shown that the aquifer is unlikely to yield more than 10 gallons of water per minute, so it is not included as a significant aquifer in plate 1.

Haley & Aldrich (1976) have shown that a ground-water divide runs east-west through the landfill. North of the divide ground water flows generally northerly, while south of the divide ground water flows southerly toward McIntyre-Junkins Brook.

The site is bounded on the southeast by McIntyre-Junkins Brook. A small brook also flows from the north side of the site.

Ground-Water Chemistry

Since October 1977 six monitoring wells have been sampled quarterly and tested for iron, alkalinity, pH, chemical oxygen demand (COD), nitrate, total kjeldahl nitrogen, specific conductivity, total phosphate, and chlorides. In the November 1978 ground-water analysis, approximately one year after landfill operation commenced, significant increases in iron, alkalinity, conductivity, chloride, COD, and pH were detected in three of the six monitoring wells. Since that time these trends have continued, with the contamination also spreading into the the other 3 monitoring wells (Maine DEP, 1977-1983).

In August 1982 three additional wells were added to the monitoring program. Two of these wells have been impacted by ground-water contamination; the third appears to reflect background chemical conditions.

In addition to ground-water monitoring, McIntyre-Junkins Brook has been monitored both upstream and downstream of the landfill. Alkalinity, pH, specific conductivity and chloride measurements taken downstream of the landfill regularly exceed upstream measurements, reflecting an impact by the landfill to McIntyre-Junkins Brook. (Maine DEP, 1977-1983).

Summary of Sites Impact on Ground-Water Quality

Water chemistry results show that the York Landfill is having an impact on both ground and surface water quality around the site. Contaminated ground water is leaving the site at the north; another leachate plume is migrating across the site toward the southeast boundary. The contaminated ground water discharges to McIntyre-Junkins Brook, lowering its water quality. Both the license renewal and a permit to expand the landfill were recently denied by the Board of Environmenal Protection in 1983. The Town is considering options to close this site.

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SECTION VI

SUMMARY

Nearly 25 percent of York County's land surface is underlain by sand and gravel aquifers. Seven municipalities in York County utilize these aquifers for their municipal water supplies. The largest single user of ground water from sand and gravel aquifers in York County is the Sanford Water District, which uses an average of 2.11 million gallons of water per day. The majority of individual water systems in York County also utilize sand and gravel aquifers. In all, approximately 1/3 of the homes in York County are dependent on water from sand and gravel aquifers for their water supply.

The regional water quality in York County aquifers is excellent. Twenty four background water monitoring wells were installed in York County for this project. None of these wells contained any elements except for iron and manganese which were in excess of the DHS recommended limits for drinking water. However, average iron concentrations in these wells were 4 times higher than the DHS recommended limit, while manganese values averaged 8 times the DHS limit. These two elements are naturally derived from soils. Filtration may be required for many wells in York County to avoid staining and taste problems due to high iron and manganese concentrations.

Twenty four potential contamination sources to sand and gravel aquifers have been studied in some detail. These sites were primarily dumps or landfills, but salt storage lots, septage disposal sites, industrial subsurface waste disposal sites and facilities handling hazardous wastes were also studied.

At most sites a contamination plume was found between the site and the nearest river or stream. Most contamination plumes were small and isolated, although salt contamination was traced from one uncovered, unlined sand-salt pile for nearly 1/2 mile to a stream. In general, sites adjacent to major rivers caused the least ground-water contamination, while those situated on high ground far from any surface water had the most extensive plumes.

No municipal water supplies in sand and gravel aquifers are known to be contaminated in York County. However, the closed Alfred Landfill is adjacent to the Alfred Water Company well, and thus warrants continued monitoring.

Domestic wells have been contaminated at only 2 of the sites which were studied; the Saco Landfill and the Town of York's salt storage lot. Neither of these sites were determined to be on aquifers, but both were situated over sandy, highly permeable soils. The York salt storage lot has caused the most widespread contamination; 18 domestic wells downgradient of the uncovered, unlined sand-salt pile have elevated salt levels.

In addition to the sites mentioned above, widespread contamination plumes, or plumes containing toxic or hazardous substances were found at the following sites: the Biddeford Landfill, Cornish DOT Salt Storage Lot, Kennebunk Dump, Limerick Dump, Limington Salt Storage Lot, Lyman DOT Salt Storage Lot, Maremont Oily Waste Lagoon and Landfill in Saco, the closed Sanford Dump, the Sprague Electric Company waste disposal lagoons in Sanford, Southern Maine Finishing's wastewater disposal leachfield in Waterboro, and the Wells Landfill. Many of these sites are being closed; at other locations site or operational changes are being made to reduce contamination. Unfortunately, despite these improvements, it will be many years before the ground-water quality around these sites can be restored.

SECTION VII
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-----1979a, Sand and gravel aquifers, map 2: Maine Geological Survey, scale 1:50,000.

-----1979c, Sand and gravel aquifers, map 3: Maine Geological Survey, scale 1:50,000.

-----1979d, Sand and gravel aquifers, map 4: Maine Geological Survey, scale 1:50,000.

-----1979e, Sand and gravel aquifers, map 12: Maine Geological Survey, scale 1:50,000.

-----1979f, Sand and gravel aquifers, map 13: Maine Geological Survey, scale 1:50,000.

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SECTION VIII

ACKNOWLEDGEMENTS

Funding for this project was provided primarily by the U.S. Environmental Protection Agency through the Clean Water Program (208), Surface Impoundment Assessment Program, and Underground Injection Control Program. A continuation of funding after the majority of federal funds were discontinued was provided by the state of Maine's 111th Legislature.

Many people assisted in conducting contamination site field investigations, including Dorothy Tepper and Glenn Prescott from the U.S.G.S., Susan Oullette Gammon from the D.E.P., and Edward Bradley, Consulting Geologist. Field assistants included Melanie Lanctot, James Adamik, Denis Hanson, Daniel Pritchard, Lynn Caron, Mimi Boxwell, Robin Doane, and Christine Olson.

Information about the sites was provided by many town officials, Bill Reid of the D.O.T., Florence Hoar, Mark Hyland, Don Kale, Nancy Norman, and Bill Noble of the D.E.P. Land Bureau, Hank Aho, Marcel Moreau, Peter Garrett and David Boulter of the D.E.P. Oil and Hazardous Materials Control Bureau, and Louis Fontaine, Dennis Merrill, Tom Potter, Norm Marcotte and Gary Nault of the D.E.P. Water Bureau.

Most of the cartography for this report was done by Bill Bryant. Cartographic assistance was also provided by Robert Tucker, Ben Wilson, Robert Johnston and John Poisson of the Maine Geological Survey Cartographic Section. Alva Achorn, Al Prysunka, Gary Westerman, Bob Nunan and Frank Fiore of the D.E.P. Planning Section provided much of the initial organization for this project.

Typing of this report was done by Arlene Davis, Ann Ward, and Pat Fish.

CHARACTERISTICS OF SURFICIAL AQUIFERS

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OPEN FILE NO. 85-77

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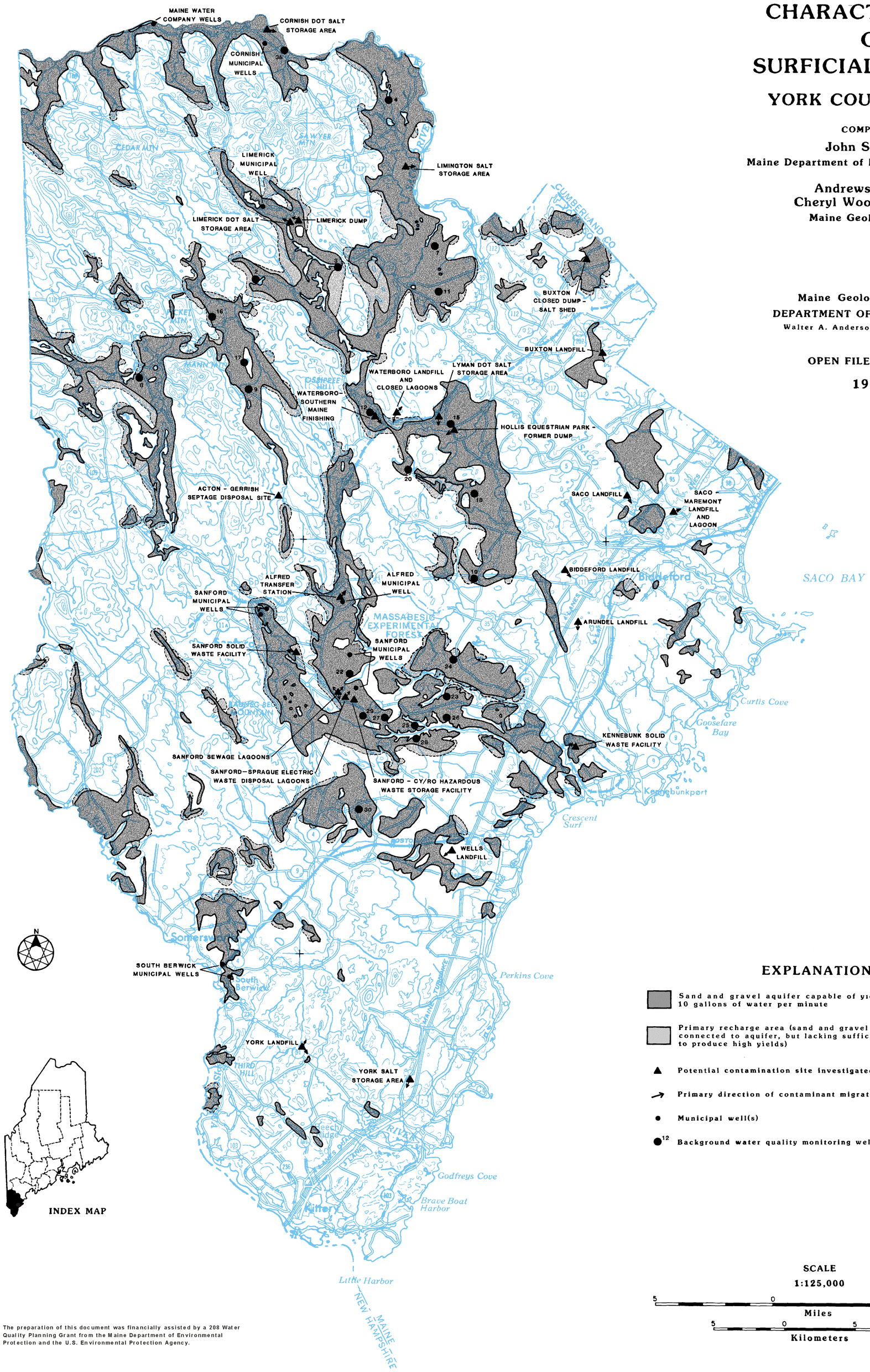

INDEX MAP

EXPLANATION

- Sand and gravel aquifer capable of yielding greater than 10 gallons of water per minute
- Primary recharge area (sand and gravel deposits hydrologically connected to aquifer, but lacking sufficient saturated thickness to produce high yields)
- ▲ Potential contamination site investigated for this report
- → Primary direction of contaminant migration from site
- ● Municipal well(s)
- ●12 Background water quality monitoring well sites

SCALE
1:125,000

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Miles

5 0 5 10
Kilometers

The preparation of this document was financially assisted by a 208 Water Quality Planning Grant from the Maine Department of Environmental Protection and the U.S. Environmental Protection Agency.