



GOLDBERG • ZOINO & ASSOCIATES, INC.  
 GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

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 Selectmen's Office

JUL 12 1985

Westford, Mass.

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 STANLEY M. BEMBIN

July 9, 1985  
 File No. A-3249.1,C,PC

Board of Selectmen  
 Town Hall  
 Westford, Massachusetts 01886

Attention: Mr. Paul F. Alphen, Executive Secretary

Re: Chemical Characterization of  
 Landfill Leachate

Gentlemen:

Goldberg-Zoino & Associates, Inc. (GZA) has initiated a study (proposal of June 6, 1985) to investigate whether the landfill adjacent to the Forge Village Road Wellfield would have an impact on water pumped under conditions favoring the migration of leachate toward the wellfield; a seasonally depressed water table and high pumping rates. GZA has undertaken the first task which was to characterize leachate from the landfill.

Sampling of surface water in the wetlands adjacent to Forge Village Road Wellfield and the town landfill occurred on May 16, 1985. A GZA water quality scientist examined the wetlands and landfill area for evidence of leachate and collected samples at five locations. Three samples (LS-1, LS-4, and LS-5) were collected from leachate breakouts in the wetlands adjacent to the landfill. LS-1 was collected at the toe of the wetland area nearest Forge Village Road Wellfield. LS-4 and LS-5 were collected from further north in the wetland opposite the section of the landfill that was then active. Sample LS-2 was collected from an area of the wetlands that appeared to be leachate-free and sample LS-3 was collected from a ditch inside the landfill area. Water samples were tested in the field for temperature, pH, and specific conductance (Table 1) and samples were collected in 500 ml polypropylene bottles and in triplicate in 40 ml septum-capped vials for volatile organic analysis. All samples

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1985

were preserved on ice and transported to GZA's water quality laboratory. Screening for volatile organic compounds was done on a Century Systems 128 organic vapor analyzer/gas chromatograph. Volatile organic compounds were detected in the sample from LS-1. On the basis of the conductivity and volatile screening data, two samples (LS-1 and LS-5) were sent according to chain-of-custody procedures to ERCO (a division of ENSECO, Inc.) in Cambridge, Massachusetts for analysis for volatile organic compounds (US E.P.A. gas chromatographic/mass spectrometric method 624 extended to include ketones) and sodium, chloride, total dissolved solids and alkalinity. Analytical chemical results are attached.

#### DISCUSSION

Measured pH values were all slightly acidic from 6.4 to 6.6. Specific conductances were elevated (from 791 to 1037 umho/cm) compared to typical values for fresh water from the same area (up to 200 umho/cm), except for sample LS-3 taken from the ditch. This sampling location had the reddish-brown appearance of leachate but had low specific conductance because the ditch was shallow and leachate could be diluted with runoff and rainwater. It rained lightly on the morning sampling occurred. Of the inorganic parameters analyzed by ERCO, the sodium concentrations of 23 mg/l and 69 mg/l and chloride concentrations of 97 mg/l and 75 mg/l at LS-1 and LS-5, respectively, can be attributed to road salt finding its way into the wetlands area. The concentration of total dissolved solids, 596 mg/l at LS-1 and 633 mg/l at LS-5 and alkalinity at 260 and 460 mg/l as CaCO<sub>3</sub> for LS-1 and LS-5, respectively are indicative of dissolved landfill constituents as are the elevated specific conductances.

The following volatile organic compounds were detected in the sample from location LS-1: acetone, 2-butanone, 1,1,1-trichloroethane, toluene. Acetone and 2-butanone are possible degradation products of either landfill refuse or naturally occurring organic matter in the wetlands, while the presence of 1,1,1-trichloroethane and toluene is more likely from solvents disposed in the landfill.

Of the constituents analyzed, those that can best serve as indicators of landfill leachate are elevated values of total dissolved solids, alkalinity, and specific conductance. Volatile organic compounds can indicate the presence of landfill leachate as well.

The next tasks of this study will be performed in August when wells in and near the wellfield will be sampled under conditions likely to favor travel of leachate constituents toward the wellfield.

If you have questions regarding this material, please contact either of the undersigned.

Very truly yours,

GOLDBERG-ZOINO & ASSOCIATES, INC.

*W. Gary Williams*

W. Gary Williams  
Project Manager

*Lawrence Feldman*

Lawrence Feldman  
Associate

WGW/LF:nba  
Attachments

TABLE 1

## CHARACTERIZATION OF LANDFILL LEACHATE

<u>Sampling Location</u>	<u>Temperature (°C)</u>	<u>pH</u>	<u>Specific Conductance at 25°C (µmho/cm)</u>
LS-1	13.1	6.48	836
LS-2	13.2	6.42	791
LS-3	13.4	6.55	235
LS-4	15.0	6.61	866
LS-5	16.1	6.62	1,037

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ERCO

205 Alowite Brook Parkway, Cambridge, Massachusetts 02138 (617) 661-3111 Telex 650-256-7697 AMOT

A DIVISION OF

ENSECO  
INCORPORATED

June 4, 1985

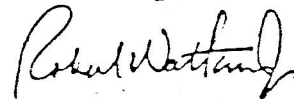
Ms. Katherine Fogarty  
Goldberg-Zoino Associates  
The GEO Building  
320 Needham Street  
Newton Upper Falls, MA 02164

Dear Katherine:

Enclosed are the results for the analyses performed on the two aqueous samples for purchase order number 10183 received on May 20, 1985.

If there are any questions concerning these data, I would be happy to answer them for you. I can be contacted at 661-3111 x56.

Sincerely,



Robert Watkins  
Inorganic Laboratory  
Manager

RW:rb  
Encl.

Regional and international offices:

- Suite 115, Statesman Insurance Building, 3815 Montrose, Houston, Texas 77006 (713) 523-7311
- 525 Central Avenue, Cedarhurst, New York 11516 (516) 295-1162
- c/o Bectech Trading Co., Ltd., P.O. Box 101-41, Taipei, Taiwan (R.O.C.) Tel. 5013908

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Sample Received: 5/20/85  
 Analysis Completed: 5/29/85  
 All Results in: ug/l (ppt)  
 Reported by: JFM  
 Checked by: KS  
 Client: Goldberg-Zoico Associates

ERCC / A Division of ENSECO  
 VOLATILE ORGANICS ANALYSIS

BY EPA METHOD 624

- Data Report -

Page 1 of 2

Compounds	Minimum Reporting Limit	Client ID: ERCC ID:	LS-1 16343	LS-5 16344
Chloromethane	5		ND	ND
Bromomethane	5		ND	ND
Vinyl chloride	5		ND	ND
Chloroethane	5		ND	ND
Methylene chloride	2		ND	ND
Acetone	25		750	ND
Carbon disulfide	2		ND	ND
1,1-dichloroethene	2		ND	ND
1,1-dichloroethane	2		80	ND
Trans-1,2-dichloroethene	2		ND	ND
Chloroform	2		ND	ND
1,2-dichloroethane	2		ND	ND
2-Butanone	10		240	ND
1,1,1-trichloroethane	2		32	ND
Carbon tetrachloride	2		ND	ND
Vinyl acetate	2		ND	ND
Bromodichloromethane	2		ND	ND
1,2-dichloropropane	2		ND	ND
Trans-1,3-dichloropropene	2		ND	ND
Trichloroethene	2		ND	ND
Dibromochloromethane	2		ND	ND
1,1,2-trichloroethane	2		ND	ND
Benzene	2		ND	ND
Cis-1,3-dichloropropene	2		ND	ND
2-Chloroethylvinylether	2		ND	ND
Bromoform	2		ND	ND
2-Hexanone	10		ND	ND
4-Methyl-2-pentanone	10		ND	ND
Tetrachloroethene	2		ND	ND
1,1,2,2-Tetrachloroethane	2		ND	ND
Toluene	2		160	ND
Chlorobenzene	2		ND	ND
Ethylbenzene	2		ND	ND
Styrene	2		ND	ND
Total xylenes	2		ND	ND

ND = Not detected.

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ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS

BY EPA METHOD 624

- Data Report -

Page 2 of 2

Client: Goldberg-Zoino Associates

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COMPOUNDS	Minimum Reporting Limit	Client ID: ERCO ID:	LS-1 16343	LS-5 16344
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Additional Compounds

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None detected

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Dilution factor:	2	2
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Multiply minimum reporting limit by dilution factor to obtain true minimum limit.

1246-c

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INORGANIC ANALYSIS

- Data Report -

Sample Received: 5/20/85  
Analysis Completed: 6/4/85  
All Results in: mg/l (ppm)  
Reported by: PC/AW  
Checked by: GCW

Client: Goldberg-Zoino Associates

ERCO ID	CLIENT ID	Chloride	Total Dissolved Solids	Alkalinity (as CaCO <sub>3</sub> )
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16343	LS-1	97	596	260
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16344	LS-5	75	633	430
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If customer has any questions regarding analysis, refer to sample in question by its ERCO ID#.

24-0



ERCO / A DIVISION OF ENSECO, INC.

Sample Received: 5/20/85  
Analysis Completed: 5/20/85  
All Results in: ug/ml (ppm)  
Reported by: CAK  
Checked by: LAS

INORGANIC ANALYSIS

- Data Report -

Client: Goldberg-Zoino Associates

ERCO ID	CLIENT ID	Na
16343	LS-1	23
16344	LS-5	69

IF customer has any questions regarding analysis, refer to sample in question by its ERCO ID#.

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GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

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Selectmen's Office

NOV 15 1985

Westford, Mass.

November 13, 1985  
File No. A-3249.1-C,PC

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STANLEY M. BEMBEN

Board of Selectmen  
Westford Town Hall  
Westford, Massachusetts 01886

Attention: Mr. Robert Alpin

Re: Forge Village Wellfield

Gentlemen:

This letter presents an executive summary requested by Robert Alpin for the report "Groundwater Quality at Forge Village Wellfield During Sustained Pumping, August 1985" (Goldberg-Zoino & Associates, Inc., November 1985).

#### 1.00 INTRODUCTION

Goldberg-Zoino & Associates, Inc. (GZA) has performed an evaluation to assess groundwater flow direction, velocities, quantities, and water quality in the vicinity of Forge Village Wellfield while it was being heavily pumped at a time of seasonally low water table. This work was completed according to GZA's proposal dated February 22, 1983, which was accepted by the Town on December 31, 1984. The tasks outlined in GZA's proposal were as follows:

1. Chemical characterization of samples taken from breakouts of landfill leachate.
2. Collection of water samples and measurement of water levels from observation wells at the wellfield after a period of

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sustained pumping by Town wells during a seasonal low water table.

3. Chemical analyses of selected groundwater samples.
4. Analysis of hydrogeology and interpretation of results of the chemical analyses.

## 2.00 FIELD TESTING AND WATER SAMPLING

In May 1985, a GZA water quality scientist observed the wetland area adjacent to the wellfield and the landfill for evidence of leachate. Water was sampled from five locations including three areas in the wetland which appeared to be breakouts of leachate. Testing of those samples indicated constituents which are indicative of landfill leachate. One of these surface water samples contained low levels of common solvents including acetone, 1,1,1-trichloroethane, and toluene.

The next phase of field measurements took place after thirty-four days of sustained pumping of the wellfield in the summer of 1985. Between July 19 and August 6, the wellfield was pumped at an average rate of 150 gallons per minute (gpm) or 216,000 gallons per day (gpd); between August 7 and August 22, 1985, the pumping rate was increased to 200 gpm, equivalent to 288,000 gpd. GZA measured groundwater elevations which were 2 to 3.5 feet lower than those observed in an earlier study. GZA concluded that although a small proportion of the depression of the groundwater surface in the vicinity of the pumping well could be attributed to the cone of depression for the pumping wells, that, indeed, the study had been conducted at a time of seasonal low groundwater table.

On August 22, 1985, GZA personnel measured groundwater levels and sampled groundwater in seven wells including wells in the aquifer directly between the landfill and Forge Village Wellfield. All samples were tested in the field for parameters indicative of landfill leachate and also screened in GZA's Water Quality Laboratory for volatile organics. Field testing and screening indicated water quality potentially indicative of landfill leachate in only one well where the results were suspect because of the age of the well. Based on the results of this testing and screening, selected samples were submitted to an outside laboratory for more definitive testing including U.S. EPA



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methodology for volatile priority pollutants. No volatile organics were detected in the two groundwater samples tested nor were any other unambiguous indications of leachate determined from other chemical data.

### 3.00 SITE GEOLOGY

The geology of the site has been described in an earlier GZA report<sup>1</sup>. The wellfield is located in an area of stratified ice-age deposits consisting primarily of fine sand with minor amounts of silt overlain in places by fine to medium sand. In places, these deposits are 40 to 60 feet thick. Most of the wetland areas are over swamp deposits which are organic silts and fine sands in strata between 7.5 and 10 feet thick.

### 4.00 SITE HYDROGEOLOGY

The 1982 GZA report describes the aquifer in which the wellfield is located at stratified glacial deposits 40 to 60 feet thick, which apparently extend for several thousand feet around the wellfield. The direction of groundwater flow in absence of pumping is toward the northwest. From observations of groundwater surface elevations taken after the wellfield had been pumped for 34 days, GZA concludes that sustained pumping there sufficiently affects the direction of flow to cause groundwater from the landfill to flow toward the wellfield. The transport velocity of groundwater between the edge of the landfill and the wellfield for the pumping conditions observed by GZA was estimated to be 1.5 to 2.5 feet per day. At this speed, groundwater from the edge of the landfill adjacent to the wetland would take approximately four to six months to reach the wellfield.

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<sup>1</sup>Hydrogeologic Study, Westford Wellfield, Westford, Massachusetts. Prepared for the Town of Westford, Massachusetts by Goldberg-Zoino & Associates, Inc., 1982.



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## 5.00 CHEMICAL ANALYSES, RESULTS, AND DISCUSSION

Samples taken from locations suspected of receiving leachate from the landfill contained constituents indicative of leachate. One sample tested contained low concentrations of volatile organic constituents which are common solvents. When samples from observation wells were tested for these same volatile organic constituents after the Forge Village Wellfield was pumped for thirty-four days, none of the compounds were detected.

## 6.00 CONCLUSIONS

Hydrogeologic analysis indicates that leachate from the landfill moves toward the wellfield under conditions of sustained pumping. Constituents from landfill leachate could appear at the wellfield in one hundred-fifty days if the wellfield is pumped for that period of 200 gpm.

## 7.00 RECOMMENDATIONS

Water quality monitoring should be continued with the frequency of testing depending upon the rate of pumping for Forge Village Wellfield. To provide early warning of potential arrival of leachate constituents at the wellfield, monitoring wells between the landfill and the wellfield should be sampled for volatile organic priority pollutants. GZA recommends that existing wells in this area should be augmented with an additional well located close to the landfill in the wetland; this additional well should provide an "early warning" for landfill constituents moving toward the wellfield. Sampling frequency could vary between one to three times per year depending upon the pumping rate of the wellfield.

Because groundwater elevation changes at the gravel pack well located to the west of Forge Village Wellfield and at the landfill may affect groundwater flow between the landfill and Forge Village Wellfield, GZA recommends groundwater elevations at these points to be incorporated in any subsequent hydrogeologic study at the site.

Thank you for the opportunity to be of service to you. If you have any questions or comments, please do not hesitate to contact the undersigned.

Very truly yours,

GOLDBERG-ZOINO & ASSOCIATES, INC.



W. Gary Williams  
Environmental Specialist

WGW:dkr



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