Hayward Landfill
Volume I of II

Environmental Contamination Assessment Report

Hayward, Wisconsin

SEH No. HAYWA9503.00

August 1995

August 16, 1995

RE: Hayward Landfill
Environmental Contamination
Assessment Report
City of Hayward
Sawyer County, Wisconsin
WDNR License No. 01751
SEH No. HAYWA9503.00

Mr. Walter Wasko, Area Solid Waste Specialist
Wisconsin Department of Natural Resources
875 S. 4th Avenue
P. O. Box 220
Park Falls, WI 54552

Dear Mr. Wasko:

On behalf of the City of Hayward, Short Elliott Hendrickson Inc. (SEH) hereby submits to the Wisconsin Department of Natural Resources (WDNR) three copies of the Environmental Contamination Assessment (ECA) Report for the abandoned Hayward Landfill in Hayward, Wisconsin. This report is divided into two volumes. Volume I contains the narrative, tables, and figures. Volume II contains the appendices. The drawing set for the report is a separate attachment.

This report satisfies Condition 1 of the February 10, 1994 WDNR Closure Plan Modification for the facility. Section 9.0 of the report contains conclusions and Section 12.0 contains recommendations based on the results of the ECA. Sections 10.0 through 11.0 provide an analysis of potential remedial technologies considered for the site. After the WDNR has reviewed the report, we recommend that a meeting be held amongst the WDNR, the City, and SEH to jointly agree on further actions to be implemented at the site.

In the interim, please contact John Metcalf (715) 634-4612 or myself at (715) 720-6230 if you have any questions. The City and SEH look forward to working cooperatively with the WDNR to resolve issues related to the Hayward Landfill.

Sincerely,

Glenn P. Bruxvoort

Glenn P. Bruxvoort, P.E.
Senior Project Manager

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Distribution List

No. of Copies	Sent to
2	Walter Wasko, Area Solid Waste Specialist Wisconsin Department of Natural Resources 875 S. 4th Avenue P. O. Box 220 Park Falls, WI 54552
3	John Metcalf, Director of Public Works City of Hayward P. O. Box 593 Hayward, WI 54843
1	James R. Dunn, District Hydrogeologist Wisconsin Department of Natural Resources Northwest District Headquarters Highway 70 W., P. O. Box 209 Spooner, WI 54801

Volume I of II

Environmental Contamination Assessment Report
Hayward Landfill

City of Hayward
Sawyer County, Wisconsin

Prepared for:
City of Hayward
Hayward, Wisconsin

Prepared by:
Short Elliott Hendrickson Inc.
421 Frenette Drive
Chippewa Falls, WI 54729
(715) 720-6200

I, John E. Guhl, hereby certify that I am a Hydrogeologist meeting the requirements of s. NR 500.03 (64) Wis. Adm. Code and that to the best of my knowledge all information contained in this document is correct.

John E. Guhl (signature) — 08/16/95

John E. Guhl, P.G. — Date
Hydrogeologist

I, Mark J. Broses, hereby certify that I am a scientist as that term is defined in s. NR 712.03 (3), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.

Mark Broses (signature) — 8/16/95

Mark J. Broses, P.E. — Date
Environmental Scientist

I, Glenn P. Bruxvoort, P.E., hereby certify that I am a registered Professional Engineer in the State of Wisconsin in accordance with ch. A-E 4, Wis. Adm. Code and that this report has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code.

Glenn P Bruxvoort (signature) — 27408

Glenn P. Bruxvoort, P.E. — P. E. Number
Project Manager

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Environmental Contamination Assessment Report

Hayward Landfill

Prepared for City of Hayward

1.0 Introduction

This Environmental Contamination Assessment (ECA) Report and associated Drawing Nos. 1/8 through 8/8 were prepared by Short Elliott Hendrickson Inc. (SEH) on behalf of the City of Hayward (City). Submission of the ECA Report complies with Condition 1 of the Hayward Landfill Closure Plan Modification – Conditional Approval issued to the City by the Wisconsin Department of Natural Resources (WDNR) on February 10, 1994. A copy of the WDNR Closure Plan Modification is presented in Appendix A, "Correspondence" (Appendix A1, "Closure Plan Modification").

Work on the facility ECA was begun by Growth Environmental Services, Inc. (Growth) in 1994. An initial landfill investigation was submitted to WDNR by Growth on August 23, 1994. Upon review of the initial investigation, the WDNR required further investigation of the site to assess off-site groundwater impacts. Consequently, Growth prepared a revised Work Plan for the site (Appendix A2, "Revised Work Plan") which was approved by WDNR on February 1, 1995. SEH performed the ECA in general accordance with Growth's revised Work Plan for the site.

1.1 Location

The Hayward Landfill site is located on the north side of State Highway (STH) 63 approximately one mile west of the City of Hayward, Wisconsin. The location of the Hayward Landfill is depicted on Figure 1, "Site Location Map."

1.2 Purpose

The general purpose of the ECA was to investigate the conditions of the Hayward Landfill to determine if the facility poses a potential hazard to public health, safety, welfare, or the environment. An assessment of potential remedial options for the site was also performed based upon the results of this investigation.

The specific purposes of this ECA are as follows:

1. To provide background information on the site, including: general facility information, facility history, land use information, and regional geotechnical information.
2. To present the results of field investigation of the site, including: soil boring log information, water table well and piezometer installation, monitoring and sampling; groundwater analysis; hydraulic conductivity analysis; and geotechnical data analysis.
3. To present geologic, hydrogeologic, and contaminant migration data on a set of drawings.
4. Present remedial action options to return the facility to compliance with requirements of ss NR 504.04(4), Wisconsin Administrative Code (Wis. Adm. Code).

1.3 Scope of Work

The primary scope of work for the investigation and subsequent preparation of this report is summarized on Conditions 1 and 3 of the facility Closure Plan Modification (Appendix A1). The site specific work plan for the Hayward Landfill ECA was outlined in Growth's January 1995 revised Work Plan (Appendix A2). The revised work plan was modified by SEH to provide additional refuse borings and water level monitoring points within the area of refuse disposal. In summary, the scope of work consisted of the following:

- Installation of five groundwater monitoring wells; six shallow, and six deep nested piezometers to monitor groundwater quality and evaluate hydrogeologic conditions both within and outside the facility design management zone (DMZ).
- Installation of six temporary groundwater monitoring points within the area of refuse disposal to evaluate hydrogeologic characteristics in this area.
- Measurement of groundwater elevations to determine hydraulic gradients and seasonal groundwater fluctuations.
- Performance of two rounds of groundwater sampling on five existing monitoring wells, five new monitoring wells, six shallow piezometers, and six deep piezometers. Samples were analyzed for volatile organic compounds (VOCs), public health and welfare standards (ss NR 508.14, Table 2, Wis. Adm. Code), and indicator parameters (ss NR 508.10, Table 1, Wis. Adm. Code).
- Drilling of six refuse borings to determine horizontal and vertical extent of buried refuse.
- Performance of in-situ hydraulic conductivity testing on the new monitoring wells, shallow piezometers, and deep piezometers.
- Performance of geotechnical analysis of soil samples collected during the investigation.
- Preparation of this ECA Report with conclusions and recommendations based on the results of the investigation.

2.0 General Facility Information

The following general information is presented pertaining to the Hayward Landfill:

Project Title:
Hayward Landfill, City of Hayward, Wisconsin (WDNR License No. 01751)

Project Contacts:
Mr. John Metcalf
Director of Public Works
City of Hayward
P.O. Box 593
Hayward, WI 54843
(715) 634-4612

Mr. Walter Wasko, Area Solid Waste Specialist
Wisconsin Department of Natural Resources
Area Headquarters
875 S. 4th Avenue
P.O. Box 220
Park Falls, WI 54552
(715) 762-3204

Mr. James R. Dunn, District Hydrogeologist
Wisconsin Department of Natural Resources
Northwest District Headquarters
Highway 70 W., P.O. Box 309
Spooner, WI 54801
(715) 635-4049

Mr. Glenn P. Bruxvoort, P.E., Senior Project Manager
Short Elliott Hendrickson Inc.
421 Frenette Drive
Chippewa Falls, WI 54729
(715) 720-6230

Property Owner:
City of Hayward
110 Main Street
Hayward, WI 54843
(715) 634-2311

General Location Description:
Hayward Landfill, located northeast of the intersection of STH 63 and Stress Road, Section 28, T41N, R9W, City of Hayward, Sawyer County, Wisconsin (Drawing No. 1/8, "Title Sheet").

Existing Limits and Thickness of Waste:
Approximately 9.6 acres, thickness ranging from 0 to approximately 17 feet (Drawing No. 2/8, "Existing Conditions").

Total Size of Property:
20 licensed acres

Location of Water Supply Wells Within 1/2 Mile of Facility:
34 private wells (Drawing No. 3/8, "Existing Water Supply Well Locations").

Owners of Private Wells Within 1,200 Feet of Limits of Refuse Disposal Area:

8 private wells (See Table 1, "Owners of Private Wells Within 1,200 Feet of Refuse Disposal Area" for well ownership information, Appendix B, "Water Supply Well Logs").

Active Fill Areas:

None

3.0 Facility History

An overview of facility history is presented in the Finding of Fact section of the facility Closure Plan Modification (Appendix A1). SEH has also reviewed WDNR files, Growth file documents, City files, site photographs, and aerial photographs to develop a more complete site history. The following subsections describe historical activities that have occurred at the Hayward Landfill.

3.1 Historical Documents

A review of historical documents pertaining to operations at the Hayward Landfill was performed by SEH. Documents on file at the WDNR Park Falls office, the City of Hayward, and provided by Growth were included in the review. The document review was used to provide historical information pertaining to the facility.

3.2 Dates of Operation

Landfilling activities began at the Hayward Landfill in the mid-1960's as an open dump. It was operated as a "trench and fill" system for approximately the last ten years of operation. The facility ceased to accept waste and was closed in 1985.

3.3 Waste Materials

A variety of waste materials were disposed at the Hayward Landfill during operation of the facility. WDNR file records and SEH field investigation results were used to identify waste materials disposed at the facility. Actual observation of refuse materials was limited to samples and cuttings generated during the soil boring program at the facility. A detailed description of the waste materials disposed at the facility is provided in Section 7.6 of this report.

3.4 Facility Operations

The Hayward Landfill facility consisted of 20 licensed acres (WDNR License No. 01751) located west of Hayward on the north side of Highway 63. Prior to beginning landfilling operations, the site consisted of vacant land and sand and gravel borrow pits. The site received waste from the mid-1960's until 1985. Burning of refuse at the site reportedly occurred during the early years of operation. A total of 9.6 acres of the 20 licensed acres ultimately received refuse materials. The refuse disposal limits were determined by review of existing site documents as well as by the results of the field investigation. The size of the refuse disposal area was determined by digitizing the area using AutoCAD. The limits of refuse disposal are depicted on Drawing No. 2/8.

Limited use of engineering controls occurred at the facility during landfilling operations. No liner or leachate collection system was installed in the area of refuse disposal. Daily covering of refuse with on-site sand and gravel soils occurred during at least a portion of the life of the facility.

3.5 Landfill Closure

Abandonment of the Hayward Landfill was performed by the City in 1985 in accordance with the March 28, 1985 Conditional Closure Plan for the facility. A Facility Construction Documentation Approval and Closure Plan Modification, dated October 10, 1988, was issued by the WDNR for the closed facility. Abandonment included construction of a topsoil-covered compacted clay cap over the area of refuse disposal. A granular drainage layer was constructed between the refuse and the clay cap. Five groundwater monitoring wells and three gas probes were installed around the perimeter of the refuse disposal area.

3.6 Landfill Monitoring

The five original monitoring wells were used to monitor groundwater quality within the facility DMZ. In addition, several nearby private wells were historically sampled by WDNR and Growth to assess potential off-site movement of landfill contaminants. Historical monitoring data indicated groundwater impacts were occurring both within the facility DMZ and in some private wells located in the vicinity of the landfill. Elevated concentrations of iron and manganese were identified within the facility DMZ and in some private wells. In addition, elevated concentrations of VOCs were identified in monitoring well MW-4 (within the facility DMZ). No primary drinking water standard exceedances were identified in the historical samples analyzed from nearby private wells. However, some VOCs and inorganic constituents were identified below primary drinking water standards in some private well samples. It should be noted the detection limit used by Growth for vinyl chloride analysis of private well samples was above the existing regulatory standard. Two rounds of sampling data provided by Growth on the existing monitoring wells are included in Tables 5 through 8.

3.7 Potential for Gas Generation

Landfill gas (primarily methane) is a by-product of anaerobic decomposition of buried organic waste in landfills. Historical information indicates a variety of organic wastes were disposed at the Hayward Landfill. Consequently, the potential exists for methane generation and migration at the facility.

4.0 Land Use Information

Present and former land uses of the Hayward Landfill and the surrounding areas (approximately a one-mile radius) are presented in the following subsections.

4.1 Past and Present Land Uses

Prior to the mid-1960's a portion of the site was used as a sand and gravel borrow pit. The remainder of the site was undeveloped prior to the onset of landfilling activities.

Prior to the onset of landfilling activities, the surrounding vicinity consisted largely of marsh land and woodlands. Some isolated residential and commercial development was present in the vicinity prior to landfilling. Landfilling activities occurred at the site from the mid-1960's through 1985, when the landfill was closed. The site has since been capped and vegetated, and is currently vacant.

Present surrounding land use in the vicinity of the facility includes marsh areas to the west; woodlands to the north; vacant land and small business development to the east; and State Highway 63, a rail line, a

State nursery, and residential and commercial development to the south. The site lies outside the City of Hayward limits of incorporation, which are located approximately 1/4 mile northeast of the site.

No specific sources of groundwater or surface water contamination were identified in the area adjacent to the site.

Existing water supply well logs obtained from the Wisconsin Geological and Natural History Survey (WGNHS) were reviewed to identify water supply wells located within a one-half mile radius of the site. In addition, visual observation of properties within a one-half mile radius of the site was performed by SEH to identify wells not included in the well logs provided by WGNHS. The approximate well locations are depicted on Drawing No. 3/8. A one-half mile radius was extended around the facility property line, and a 1,200 foot radius was plotted around the limits of refuse disposal to identify existing water supply wells present within these areas. Available logs for water supply wells located within 1,200 feet of the facility are presented in Appendix B (well logs were not provided by WGNHS for some of the wells in this area). Current ownership information for identified water supply wells located within 1,200 feet of the facility is summarized on Table 1.

4.2 Adjacent Property Ownership

The current (1995) City of Hayward tax records were reviewed to obtain the names and addresses of property owners immediately adjacent to the site. Adjacent land ownership information is presented on Drawing No. 4/8, "Adjacent Property Owners."

4.3 Recreational Areas

Recreational areas in the vicinity of the site include the Namekagon River (located approximately 0.3 mile south of the site), Hayward Lake (approximately two miles east of the site), National Fresh Water Fishing Hall of Fame (approximately two miles east of the site), Kissick Swamp State Wildlife Area (approximately two miles northwest of the site), and a public wilderness walk (approximately 1.5 miles south of the site). Several City parks and recreational facilities are located within the Hayward City limits.

4.4 Historical and Archaeologically Significant Areas

The Wisconsin State Historical Society (WSHS) was contacted regarding historical and archaeologically significant sites in the vicinity of the Hayward Landfill. No historically or archaeologically significant sites were identified by WSHS in the vicinity of the site. A copy of the WSHS review letter is provided in Appendix A3, "Wisconsin State Historical Society Letter."

4.5 Environmentally Sensitive Areas

The Northwest Regional Planning Commission and the City of Hayward Planning Department were contacted regarding environmentally sensitive areas located within a one-mile radius of the site. The Namekagon River was identified as a National Wild and Scenic River. Two wetland areas within a one-mile radius of the site were identified on a Wisconsin Wetland Inventory Map of the area. A wetland area just west of the site is characterized as a scrub and shrub, broad-leaved evergreen, standing water palustrine wetland. A wetland just north of the site is characterized as a forested, needle leafed, ridge and swale complex. Several isolated wetland areas of less than one acre in size were also identified in the vicinity of the site.

4.6 Endangered Resources

The WDNR Bureau of Endangered Resources (BER) was contacted and asked to address the known presence of any endangered or threatened species, critical habitat, or natural or scientific areas located within a one-mile radius of the site. One rare species, Clemmys insculpta (wood turtle) was identified as occurring in the vicinity of the site. The exact location of this occurrence cannot be released in publicly disseminated documents. Consequently, the section numbers where this species occurs have been erased from the BER letter (Appendix A4, "Bureau of Endangered Resources Letter").

4.7 Transportation Routes

Waste materials are no longer transported to the site. Current access to Hayward Landfill is provided by a secured access road extending north from STH 63.

5.0 Regional Geotechnical Information

Regional geotechnical information from within approximately five miles of the Hayward Landfill is presented in the following subsections.

5.1 Topography

The site is located in an area of undulating topography on the north side of the Namekagon River Valley. The area is characterized by hilly topography interspersed with wetlands in the low areas. The area adjacent to the Namekagon River is relatively flat. Land surface elevations in the area generally range from approximately 1,150 feet to 1,400 feet mean sea level (MSL) datum.

5.2 Surface Water

There are several primary surface water bodies and numerous smaller water bodies located within a five mile radius of the site. Lakes within a five mile radius of the site include Smith Lake, Hayward Lake, Nelson Lake, Phipps Flowage, Loon Lake, Beaver Lake, Bean Lake, Mud Lake, Colbroth Lake, King Lake, Little Spring Lake, Chippanazie Lake, and the Chippanazie Flowage. Streams include the Namekagon River, Elm Creek, Chippanazie Creek, Smith Lake Creek, Mosquito Brook, Spring Lake Creek, Flat Creek, and Bean Brook. Numerous smaller water bodies, including wetlands, small unnamed lakes, and small streams and tributaries are also present in the area.

Existing surface water quality data is not available in the immediate vicinity of the site. The closest surface water quality data available is for the Lake Chetac (approximately 20 miles south of the site) which is analyzed annually for a variety of indicator parameters (Holmstrom, 1993). In addition, the Namekagon River near Trego, Wisconsin was analyzed for indicator parameters in 1966 (Young, 1973).

5.3 Surficial Soils

According to the soil survey for Sawyer County surficial soils in the vicinity of the site consist largely of Vilas Loamy Sands and Sarona-Pence Sandy Loams (upland areas), and of Loxley, Beseman, and Dawson Peats (lowland areas). Vilas Loamy Sands are characterized as passively drained soils formed in sandy deposits. These soils are typically not erodible and have slopes ranging from 0 to 6 percent.

The Sarona-Pence Sandy Loams are characterized as well drained soils formed in loamy deposits. These soils are potentially highly erodible, have slopes of 6 to 15 percent, and may have hydric inclusions.

The Loxley, Beseman, and Dawson Peats consist of poorly drained soil formed in basins and depressions. These soils are typically hydric and not highly erodible.

5.4 Regional Geology

A relatively thick sequence of unconsolidated Pleistocene deposits largely of glacial origin overly Cambrian age sandstone bedrock in the vicinity of the site and ranges from approximately 100 to 150 feet thick (Young, 1973). The thickness of unconsolidated deposits is controlled by bedrock topography and surface topography.

The unconsolidated deposits in the vicinity are comprised largely of Pleistocene pitted outwash deposits and end moraine deposits. These deposits appear to be contiguous with the Copper Falls Formation found in Douglas, Bayfield, Ashland, and Iron Counties, although this has not been clearly defined due to lack of detailed studies in this area (Mickelson, 1984). The Copper Falls Formation typically consists of fluvial sands and gravels, and till. Soils typically consist of 35 to 80 percent sand, 15 to 50 percent silt, 2 to 15 percent clay, and a few percent pebbles, cobbles, and boulders. (Mickelson, 1984).

The uppermost bedrock unit in the vicinity of the site consists of Cambrian sandstones of the Elk Mound group (Ostrom, 1966). The sandstones generally consist of light yellow to light gray, fine to coarse grained sand grains with some silt in places. Thickness of the Cambrian sandstone in the vicinity of the site has not been determined. The contact with the underlying Precambrian rocks units are located within approximately five miles to the north of the site.

5.5 Regional Hydrogeology

There are two principle aquifers in the vicinity of the site: the sand and gravel aquifer and the sandstone aquifer. The sand and gravel aquifer occurs within buried sand and gravel till and outwash deposits in the vicinity. Yields from high-capacity wells screened from the sand and gravel aquifer average 245 gallons per minute (gpm).

The sandstone aquifer occurs in areas where Cambrian sandstone bedrock is present. Average yields of high-capacity wells producing from the sandstone aquifer are 490 gpm. Yields diminish in locations where the thickness of the sandstone unit decreases (Young, 1973)

Regional direction of groundwater flow is generally to the west. The water table locally generally mimics the surface topography and thus generally flows from topographic highs to low areas (e.g., the Namekagon River).

5.6 Site Geology

Boring log information obtained during SEH's investigation of the Hayward Landfill was used to assess site geologic conditions to 106 feet below ground surface (the deepest penetration during soil borings). Bedrock was not encountered during the investigation. Geologic cross-sections depicting site stratigraphy are presented on Drawing No. 5/8, "Geologic Cross Sections."

The surface of the site within the area of refuse disposal is covered with a topsoil covered clay cap. The clay cap is underlain by 0 to 17 feet of refuse. Refuse was placed directly onto sand and gravel outwash soils. The sand and outwash gravel soils typically contain numerous cobbles and boulders below approximately 35 feet below ground surface (bgs). A dense gray silty sand till with numerous cobbles and boulders was encountered approximately 47 to 90 feet bgs and extended to the maximum depth penetrated (106 feet bgs).

5.7 Site Hydrogeology

A total of five rounds of groundwater elevations were recorded on five existing monitoring wells, five new monitoring wells, six new shallow piezometers, six new deep piezometers, and six temporary wells installed through refuse. The results of the groundwater elevation measurements are summarized on Table 2, "Summary of Groundwater Elevation Data."

Based on the groundwater elevation data, it appears the water table is approximately 7 to 16 feet below the bottom of refuse in the refuse disposal area. No evidence of saturated refuse was identified during the investigation.

Groundwater at the site and immediate vicinity flows generally to the south toward the Namekagon River as shown on Drawing No. 6/8, "Groundwater Contours." Horizontal hydraulic gradients at the site range from approximately 0.015 to 0.005 ft/ft.

A range of hydraulic conductivities of the sand and gravel unit and the underlying silty sand till unit was compiled based on the results of in-situ hydraulic conductivity analysis of monitoring wells and piezometers. The hydraulic conductivity test results are presented on Table 3, "Summary of Hydraulic Conductivity Test Results." The sand and gravel outwash unit has hydraulic conductivity values between $2x10^{-02}$ and $1x10^{-03}$ cm/sec. The silty sand till unit hydraulic conductivities were measured at between $2x10^{-01}$ and $3x10^{-05}$ cm/sec.

The difference between groundwater elevations in shallow groundwater monitoring wells and associated nested piezometers was used to assess vertical hydraulic gradients in the vicinity of the site. There appears to be a general downward vertical gradient at each of the nested well locations except for the MW-10 well nest (near the Namekagon River), where there is an upward gradient. This would indicate the facility lies within a groundwater recharge area, with a groundwater discharge area likely to be present in the vicinity of the Namekagon River.

6.0 Specific Facility Investigation

A specific investigation of the Hayward Landfill was performed by SEH from March through August 1995. The investigation was performed in general accordance with the Revised ECA Work Plan prepared for the site by Growth in January 1995. Methods used during field investigation are described in detail in Appendix C, "Field Methodologies." Soil boring logs are presented in Appendix D, "Soil Boring Logs." Well information forms for the new wells and piezometers at the site are presented in Appendix E, "Well Information Forms." Monitoring Well Construction Details and Well Development Forms are presented in Appendix F, "Monitoring Well Construction Details and Well Development Forms."

The purpose of the investigation was to define the topography, subsurface soils, depth to groundwater, groundwater flow directions and gradients, extent and thickness of refuse, background groundwater quality, degree and extent of groundwater contamination, and potential for off-site impacts. The following subsections outline the procedures performed to obtain this information.

6.1 Refuse Borings

A total of six borings were performed by Huntingdon Engineering and Environmental under the direction of SEH to delineate the horizontal and vertical extent of buried refuse at the Hayward Landfill. The borings were subsequently instrumented as temporary wells. The location of the refuse borings/temporary wells are depicted on Drawing No. 2/8.

The refuse borings were preformed under the direction of a SEH geologist in May 1995. Samples were collected using standard penetration test (SPT) methods in order to identify the contact between buried refuse and underlying soils. The refuse borings were terminated approximately five feet below the water table to facilitate installation of the temporary wells. Soil and refuse samples collected from the refuse borings were not retained for further analysis.

6.2 Monitoring Well Installation

6.2.1 Temporary Wells

Six temporary wells were installed in refuse borings B-1 through B-6 to determine depth to groundwater in relation to the bottom of refuse, and to determine direction of shallow groundwater flow. The temporary wells were installed with a five foot section of slotted PVC screen intersecting the water table. PVC riser pipe fitted with locking caps were used to complete the temporary wells. Construction of the temporary wells generally complied with ch. NR 141, Wis. Adm. Code except that protective casings were not installed. The temporary wells were not used to collect groundwater samples for laboratory analysis or to determine hydraulic conductivities of site soils.

6.2.2 Groundwater Monitoring Wells/Piezometers

A total of five new groundwater monitoring wells (MW-6, MW-7, MW-8, MW-9, and MW-10), six new shallow piezometers (PZ-1S, PZ-6S, PZ-7S, PZ-8S, PZ-9S, and PZ-10S), and six new deep piezometers (PZ-1D, PZ-6D, PZ-7D, PZ-8D, PZ-9D, and PZ-10D) were installed in the vicinity of the site. The monitoring wells were installed with ten foot screens positioned to intersect the shallow groundwater surface. Shallow piezometers were installed with five foot slotted screens placed approximately 50 feet below existing ground surface. Deep piezometers were installed with five foot screens placed approximately 100 feet below existing ground surface. The monitoring wells and shallow piezometers were constructed with Schedule 40 PVC components, while the deep piezometers utilized Schedule 80 PVC. Monitoring well and piezometer construction was performed in general accordance with ch. NR 141 Wis. Adm. Code.

6.3 Well Development

After completion of monitoring well and piezometer installation, well development was performed in accordance with ch. NR 141 Wis. Adm. Code. A decontaminated submersible pump and disposable polyethylene tubing were used during well development. A total of ten well volumes of water were removed from each well during development. Well development water was disposed on the ground surface adjacent to each well.

6.4 Water Level Measurements and Hydraulic Conductivity Testing

Static water levels were measured in existing and new monitoring wells, piezometers, and temporary wells on five occasions as summarized on Table 2. Groundwater measurements were obtained using an electronic water-level indicator.

In-situ hydraulic conductivity tests were performed by SEH on July 20 and August 7, 1995. The hydraulic conductivity tests were performed on the new wells and piezometers by instantaneously lowering the static water level at each location with a bailer, and recording the rate of recharge with a transducer connected to an Aquistar Model DL1 data logger. The rate of recharge data was used to compute the hydraulic conductivity of the soil units surrounding the screen at each well location by using the AQTESOLV® computer program. In-situ hydraulic conductivity test results are presented in Appendix G, "Hydraulic Conductivity Test Results," and summarized in Table 3.

6.5 Geotechnical Soil Analysis

A total of 16 soil samples collected during the soil boring program were selected for geotechnical analysis. The soil samples selected were collected from within the screened intervals of the wells and piezometers. The selected samples were analyzed for grain size distribution (ASTM D422). The geotechnical laboratory results are presented in Appendix H, "Geotechnical Laboratory Analytical Results." The geotechnical laboratory results were used to check the lithologic descriptions on the field soil boring logs and to develop the geologic cross-sections presented on Drawing No. 5/8.

6.6 Well Sampling

A total of two rounds of groundwater samples were collected by SEH and analyzed from the existing and new monitoring wells and piezometers during the ECA. The first round of samples was collected in May 1995 and the second round was collected in July 1995. The first round of samples from one well nest (MW-6, PZ-6S, and PZ-6D) was not collected until June 1995 because these wells had not yet been installed during the May sampling round.

The wells were sampled with disposable polyethylene bailers and disposable nylon string. The wells were purged prior to sampling by removing four well casing volumes from each well prior to sampling. Field conductivity and pH results from the three sampling rounds are included on Table 4, "Indicator Parameters."

The groundwater samples were collected, preserved, and filtered as necessary, and placed in laboratory-clean sample bottles. Filtering was performed in the field using a 0.45 micron disposable filter. The sample bottles were labeled identifying sample number, location and date, and maintained at 4°C until delivery to the analytical laboratory.

The groundwater laboratory analysis was performed by Northern Lake Service, Inc. in Crandon, Wisconsin (Wisconsin Laboratory Certification No. 721026460). Standard chain-of-custody documentation was maintained during shipment and receipt of analytical samples.

6.7 Site Survey

A survey of the Hayward Landfill and surrounding vicinity was performed by SEH in May 1995 to establish horizontal and vertical control at the site and to provide a project base map. The ground surface elevation as well as elevations of monitoring well and piezometer casing were surveyed and referenced to MSL datum. Locations of several private water supply wells located in the vicinity of the site were also surveyed and plotted on the facility base map (Drawing No. 2/8).

6.8 Investigative Wastes

Waste materials generated during the routine performance of various field investigation tasks include soil cuttings, drilling mud, well development water, and disposable sampling and personal protective equipment (PPE). The soil cuttings, drilling mud, and development water were disposed on the ground surface adjacent to the well location. Disposable PPE and sampling equipment were disposed as solid waste.

7.0 Results of Specific Facility Investigation

The results of SEH's field observations and investigations were used to define the existing conditions at the Hayward Landfill and surrounding vicinity. The existing conditions identified are described in the following subsections.

7.1 Site Topography

The topography of the site is relatively flat on the east side of the site, sloping down to a wetland area to the west. Topography of the DMZ generally slopes from east to west.

7.2 Site Surface Water

Surface water from the site generally drains from east to west to wetland areas located immediately west of the site. Standing water within this wetland area is the only surface water located immediately adjacent to the site. Sampling and laboratory analysis of surface water adjacent to the site was not included in the scope of this investigation.

No evidence of leachate seeps or discharges were observed around the perimeter of the refuse disposal area during investigation of the site.

7.3 Surficial Soils

Surficial soils within the refuse disposal area consist of topsoil fill overlying approximately 0.5 to 1.5 feet of compacted clay fill cover and a granular drainage layer. Surficial soils within the facility DMZ but outside the refuse disposal area consist of a thin layer of topsoil underlain by sand and gravel outwash deposits.

7.4 Geology

The following major soil/geologic units were identified at the site:

- Earthen Fill Soils
- Refuse
- Sand and Gravel Outwash Unit
- Silty Sand and Gravel Till Unit

Two geologic cross-sections of site stratigraphy were compiled from the geologic data obtained during SEH's field investigation (Drawing No. 5/8). The cross-sections depict the approximate extent and lateral continuity of the units outlined above based on data from the various borings performed on-site.

7.4.1 Earthen Fill Soils

The earthen fill soils consist of a surficial topsoil layer, compacted clay cover, and granular drainage layer over the area of refuse disposal, and of granular soils (where present) outside the refuse disposal area.

7.4.2 Refuse

Approximately 9.6 acres of the site were utilized for disposal of solid waste. A detailed description of the waste types, thickness, and extent of refuse at the site is provided in Section 7.6.

7.4.3 Sand and Gravel Outwash Unit

A thick sequence of dense sand and gravel outwash soils underlies surficial soils in the vicinity of the site. Thickness of the sand and gravel outwash unit ranges from approximately 45 to 90 feet. The upper portion of the unit typically consists of relatively clean sands with some gravel. Numerous cobbles and boulders are present within the unit below approximately 35 feet bgs. Occasional gravel, silty sand, silt, and clay seams or layers are present within the sand and gravel unit. This sand and gravel unit is the result of glacial outwash deposition.

7.4.4 Silty Sand and Gravel Till Unit

The basal soil unit encountered during the investigation is a dense silty sand till unit containing occasional to numerous cobbles and boulders. The silty sand and gravel till unit is encountered approximately 47 to 90 feet bgs and extended to the bottom of each deep piezometer boring performed during the investigation. Thickness of the silty sand and gravel till unit was not determined.

7.5 Hydrogeology

Static water level measurements (Table 2), in-situ hydraulic conductivity test results (Table 3), site stratigraphy, and site topography were used to interpret the hydrogeology of the site. A groundwater contour map was compiled from available data to depict direction of shallow groundwater in the vicinity of the site (Drawing No. 6/8). The water table is located approximately 13 to 34 feet bgs as depicted on the geologic cross-sections (Drawing No. 5/8).

As depicted on Drawing No. 6/8, direction of groundwater flow in the vicinity of the site is to the south, towards the Namekagon River. Horizontal hydraulic gradients at the site range from approximately 0.015 to 0.005 ft/ft.

A range of hydraulic conductivities of the major soil units was compiled based on the results of field analysis. The hydraulic conductivity results are summarized on Table 3.

7.6 Waste Area, Thickness, and Type

The limits of refuse and facility DMZ are depicted on Drawing No. 2/8. The limits of refuse were determined by reviewing historical site documents, observing historical aerial photographs, performing soil borings, and making site observations. The line for estimated refuse limits was digitized into AutoCAD and the area of refuse disposal was calculated. Refuse thickness ranges from approximately 0 to 17 feet. Total refuse volume (excluding the clay cover) is estimated to be 150,000 cubic yards, based on an average thickness of 10 feet.

A variety of wastes were disposed during operation of the Hayward Landfill. Based on a review of documents pertaining to the facility, waste materials reportedly disposed at the Hayward Landfill included:

- Municipal and commercial waste from the City of Hayward
- Demolition materials
- Stumps and brush
- Tires
- Empty pesticide containers from the Hayward State Nursery

Waste materials encountered during the drilling program included metal, plastic, paper, wire, and wood. The waste matrix varied somewhat from boring to boring. Free liquids were not observed within the refuse during the soil boring program.

7.7 Field Screening of Soil Samples

The relative concentrations (instrument units) of VOCs in soil samples collected during the soil boring program were measured with a FID using headspace analytical methods. Headspace analysis was not performed on samples collected from refuse borings. The results of headspace analysis ranged from non-detectable to 300 instrument units of VOCs. The headspace results are presented on the soil boring logs (Appendix D) and summarized on Table 5, "Field Headspace FID Screening Results."

7.8 Groundwater Monitoring Results

Two rounds of groundwater samples were collected and analyzed from the existing and new groundwater monitoring wells and piezometers in the vicinity of the site. The temporary wells installed through refuse were not sampled. The samples were analyzed for indicator parameters, VOCs, public welfare standards, and public health standards as specified in the January 1995 revised site work plan. The VOC analysis was performed in accordance with U.S. EPA Method 8260. The indicator parameters analyzed are listed on Table 1 of the ss NR 508.10 Wis. Adm. Code. The test methods and laboratory quantitation limits are listed on the laboratory analytical reports in Appendix I, "Laboratory Analytical Reports." Groundwater analytical results are summarized on Table 4; Table 6, "Public Welfare

Standards;" Table 7, "Public Health Standards;" and Table 8, "Volatile Organic Compounds."

7.8.1 Indicator Parameters

Indicator parameters (Table 4) were analyzed to establish existing water quality at the groundwater sampling points included in the investigation around the facility. For the purposes of this discussion, indicator parameters shall include alkalinity, chemical oxygen demand (COD), conductivity, hardness, pH, and total dissolved solids (TDS).

Alkalinity results ranged from 11 mg/l (MW-3) to 570 mg/l (PZ-7D). The concentrations of alkalinity were highest in the vicinity of MW-4 and the MW-7 well nests. No discernable pattern in alkalinity concentrations was noted vertically or in relation to proximity of refuse disposal.

COD concentrations ranged from non-detectable (PZ-10S and PZ-10D) to 69 mg/l (MW-4). The concentrations of COD are generally somewhat higher in wells and piezometers placed adjacent to the refuse disposal area than in the downgradient wells. Relatively high concentrations of COD were also recorded at PZ-9S. The concentrations of COD appear to be somewhat higher in the shallow wells and decreased with depth. However, this trend was not consistent in all well nests included in the investigation.

Conductivity values ranged from 47 μmhos/cm (MW-3) to 1,005 μmhos/cm (PZ-7D). No discernable pattern of conductivity values was noted either horizontally or vertically in the investigation area.

Concentrations of hardness ranged from 15 mg/l (MW-3) to 510 mg/l (PZ-7D). The concentrations of hardness varied both horizontally and vertically, with no obvious trends in elevated concentrations noted.

Measurements of pH ranged from 5.7 to 8.8. No discernable pattern in pH values was noted at the various sampling points.

Concentrations of TDS ranged from non-detectable to 950 mg/l. The concentrations of TDS appear to remain relatively consistent with depth. Horizontally, the concentrations of TDS vary considerably, with the lowest concentrations generally located in the upgradient or side gradient wells.

7.8.2 Public Welfare Standards

Several parameters were analyzed during each round of groundwater sampling that are regulated by criteria established in ss NR 140.12, Wis. Adm. Code (Public Welfare Standards). These parameters include chloride, iron, manganese, sulfate, and zinc. The analytical results for these parameters are summarized on Table 6.

Concentrations of chloride ranged from non-detectable to 89 mg/l. The concentrations are below the Preventive Action Limit (PAL) and Enforcement Standard (ES) for chloride in the sampling points included in the investigation.

Concentrations of iron exceeding State regulatory criteria were detected in samples collected from wells MW-1, PZ-1S, MW-2, MW-3, MW-4, MW-5, PZ-6S, MW-7, PZ-7S, PZ-7D, and PZ-9D. The highest concentrations of iron were recorded in wells MW-1, PZ-1S, MW-4, and PZ-7S. These wells are located immediately downgradient or adjacent to the area of refuse disposal. This may indicate the elevated iron content in these wells may be due in part to refuse disposal at the site. However, groundwater regulatory exceedances for iron were also measured in upgradient and side gradient wells, so background concentrations of iron appear to be elevated in the vicinity.

Elevated manganese concentrations were identified in groundwater samples collected from numerous sampling points included in the facility investigation. Concentrations of manganese exceeding State regulatory criteria were identified in each well except PZ-8S, PS-8D, PZ-9D, MW-10, PZ-10S, and PZ-10D. The widespread elevated concentrations of manganese, including upgradient and sidegradient sampling locations, appears to indicate the elevated concentrations of manganese are due, at least in part, to background concentrations of this substance.

The concentrations of sulfate were below the PAL and ES for this compound in the samples analyzed from the site except one sample collected by Growth from MW-4 during the September 1994 sampling round. The concentration of this one-time exceedance is approximately three orders of magnitude higher than previous and subsequent analytical results for sulfate collected from this sampling point. It appears likely the units for sulfate were inaccurately reported by Growth's analytical laboratory for this sample, resulting in the concentration reported being inaccurate by three orders of magnitude.

The concentrations of zinc detected during the investigation ranged from non-detectable to 350 μg/l. These concentrations are well below the PAL and ES for zinc.

7.8.3 Public Health Standards

A summary of groundwater analytical results for parameters regulated by ss NR 140.10, Wis. Adm. Code, but not included in the VOC scan is presented in Table 7. The Public Health parameters monitored include arsenic, barium, cadmium, chromium, copper, fluoride, lead, mercury, nitrate-nitrite nitrogen, selenium, and silver. Of these, the concentrations of chromium, copper, mercury, selenium, and silver were below existing regulatory criteria for all groundwater samples analyzed. In addition, the groundwater regulatory criteria exceedances for arsenic, barium, and fluoride were limited to samples collected from within the facility DMZ. Point of standards applications do not apply to these sampling points.

Concentrations of cadmium exceeded its respective PAL in thirteen of the facility monitoring points, including six points located outside the facility DMZ. The PAL exceedance concentrations ranged from 0.69 μg/l to 0.94 μg/l. The concentrations of cadmium were below the ES of 5 μg/l for this substance in groundwater samples analyzed during the investigation.

Concentrations of lead meeting or exceeding its respective PAL were measured in seven site groundwater monitoring points. Three of these monitoring points are located outside the facility DMZ. The concentrations of lead exceedances outside the facility DMZ ranged from 1.5 μg/l to 2.7 μg/l. Lead concentrations in groundwater samples analyzed during this investigation were below the ES for lead (15 μg/l).

The PAL for nitrate-nitrite nitrogen was exceeded at eight site sampling points during one or more rounds of groundwater sampling during the investigation. Three of these sampling points are located outside the facility DMZ. The concentrations of nitrate-nitrite nitrogen exceedances outside the facility DMZ ranged from 2.1 mg/l to 2.6 mg/l and were below the ES for these compounds. ES exceedances were recorded in samples collected from two points within the facility DMZ (MW-2 and MW-4).

7.8.4 Volatile Organic Compounds

Several VOCs were detected in groundwater samples collected from facility monitoring wells and piezometers (Table 8). Isoconcentration maps for vinyl chloride (Drawing No. 7/8, "Groundwater Vinyl Chloride Isoconcentration Map") and total VOCs (Drawing No. 8/8, "Groundwater Total VOC Isoconcentration Map") were prepared to depict the extent of contamination in the vicinity of the site. The concentrations of VOCs detected were compared to existing PALs and ESs published in ss NR 140.10 and NR 140.12, Wis. Adm. Code. Exceedances of PALs and/or ESs were measured for one or more VOCs during one or more rounds of sampling in wells MW-1, PZ-1S, MW-2, MW-4, MW-7, PZ-7S, PZ-8S, and PZ-9S. The compounds detected in concentrations exceeding existing State regulatory criteria included benzene, tetrachloroethene, and vinyl chloride.

Benzene was detected in concentrations exceeding its PAL in two of four samples collected from MW-4. The ES for benzene was not exceeded in any groundwater samples analyzed from the site. No PAL or ES exceedances for benzene were measured outside the facility DMZ.

Tetrachloroethene was detected in concentrations exceeding its PAL in one sample collected from well MW-1. No ES exceedances for tetrachloroethene were measured during the facility investigation, and no PAL exceedances for tetrachloroethene were recorded outside of the facility DMZ.

Vinyl chloride was detected in eight monitoring points in concentrations exceeding State regulatory criteria. Four of these monitoring points (MW-7, PZ-7S, PZ-8S, and PZ-9S) are located outside of the facility DMZ. The PAL for vinyl chloride was exceeded in each of the referenced monitoring points in one or more samples. The ES for vinyl chloride was exceeded in samples collected during the July 1995 sampling round from wells PZ-7S and PZ-9S. ES exceedances within the facility DMZ were also detected in samples collected from wells MW-1 and MW-4.

8.0 Water Budget

A water budget was performed for the Hayward Landfill in accordance with ss NR 508.20(9) Wis. Adm. Code. Engineering controls at the Hayward Landfill include an earthen landfill cover, with no liner or leachate extraction system. The bottom of the waste appears to be consistently above the water table in the area of refuse disposal. Therefore, the water budget only takes into account percolation of surface water through the cover.

Existing water infiltration rates were estimated using the Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 2.05. Model parameters were based on landfill cover characteristics defined during cover construction and subsequent observation during the facility investigation. Appendix J, "HELP Model Results" contains the parameters used as well as the output of the HELP model. The following paragraphs describe the parameters and approach used in modeling the expected hydrologic performance of cover materials overlying the buried waste.

The general profile for the existing cover consists of a topsoil layer overlying a lean clay cap. The clay cap is separated from refuse by a layer of sand. An estimated hydraulic conductivity of $5.2x10^{-4}$ cm/sec and an estimated thickness of 4.8 inches were used for the topsoil layer. An estimated hydraulic conductivity of $1.0x10^{-6}$ cm/sec and estimated thickness of 11.4 inches were used for the lean clay layer. An estimated hydraulic conductivity of $5.8x10^{-3}$ cm/sec and an estimated thickness of 12 inches was used for the sand layer. Hydraulic conductivities were chosen from a list of soil types in the model. The hydraulic conductivity of the lean clay cover was estimated due to lack of data on the cover's current condition. Other parameters assigned as input to the model included an evaporative zone depth of 20 inches and a maximum leaf area index of 2.0. Climatological data was input to the model from five years of data collected in Minneapolis, Minnesota.

The topsoil layer, sand layer, and underlying refuse layers were modeled as vertical percolation layers. The lean clay layer was modeled as a barrier soil liner.

The results of the HELP model indicate approximately three inches of precipitation per year percolates through the existing earthen cover. This results in approximately 784,000 gallons of leachate percolation through the landfill annually. The remainder of precipitation is discharged from the site either by surface runoff or evapotranspiration.

9.0 Summary and Conclusions

This ECA Report was prepared to determine if the Hayward Landfill poses a potential hazard to public health, safety or welfare, or the environment. The summary and conclusions of this assessment are as follows:

1. An estimated 150,000 cubic yards of refuse were disposed at the site between approximately the middle 1960's and 1985. The thickness of refuse appears to range from 0 to approximately 17 feet, with an average thickness of approximately 10 feet. The refuse is frequently separated by layers of sand and gravel soil (probable daily cover materials). Refuse materials disposed at the site include municipal and commercial wastes, demolition materials, stumps and brush, tires, and empty pesticide containers. Burning of refuse was conducted at the facility during the earlier years of operation.
2. The Hayward Landfill was not constructed with a clay liner or a leachate collection system. Refuse was placed in trenches excavated in advance of the refuse disposal area. Site soils (sands and gravels) were used during facility operation as daily cover material. A sand layer, clay cover, and topsoil layer was placed over the top of the refuse disposal area upon completion of landfilling activities.
3. The site is underlain by sand and gravel glacial outwash deposits with occasional to numerous cobbles and boulders at depth. Some silty or clayey sand and gravel layers were identified at depth, but the lateral continuity of these layers was not established. Bedrock was not encountered during the investigation. Bedrock in the vicinity likely consists of

Cambrian sandstone and is estimated to occur between 100 and 150 feet bgs.

4. Depth to groundwater in the vicinity of the site ranges from approximately 13 to 34 feet bgs. Direction of groundwater flow in the vicinity of the site is generally to the south toward the Namekagon River. Horizontal hydraulic gradients at the site are approximately 0.015 to 0.005 ft/ft.

5. Groundwater quality appears to have been affected downgradient from the landfill outside of the facility DMZ. A low-concentration plume of VOCs extends south from the facility. The concentrations of VOCs outside the facility DMZ are generally higher in the shallow piezometers compared with their associated monitoring wells and deep piezometers. The concentrations of VOCs outside the facility DMZ are also below existing groundwater regulatory criteria except for vinyl chloride, which exceeded its respective PAL and/or ES at four sampling points located downgradient from the facility.

   Concentrations of cadmium, lead, and nitrate-nitrite nitrogen exceeded their respective PALs at two or more monitoring points located downgradient from the facility. ESs for these substances were not exceeded outside the facility DMZ. The concentrations of these substances was generally higher in the monitoring wells and/or shallow piezometers than in the deep piezometers.

   Concentrations of iron and manganese exceeded their respective PALs and ESs at several monitoring points located downgradient from the facility. The concentrations of these substances were generally highest in either the monitoring wells or the shallow piezometers. However, ES exceedances for both iron and manganese did occur in one deep piezometer (PZ-7D) located outside of the facility DMZ. The elevated concentrations of iron and manganese measured in vicinity groundwater may be due in part to naturally occurring concentrations of these substances in area groundwater. Wells and piezometers located outside of the facility DMZ are subject to groundwater point of standards applications. Consequently, remedial measures will likely be required to bring the facility into compliance with ch. NR 140 Wis. Adm. Code regulations.

6. Several private wells were identified within a one-half mile radius of the facility. Several of these wells are located hydraulically downgradient from the facility. Several private wells located downgradient from the facility were sampled and analyzed during Growth's investigation of the facility. Several VOCs and inorganic constituents were detected in the private wells. However, exceedances of existing drinking water standards in samples collected from the private wells were not identified. The laboratory quantitation limits used by Growth during investigation of the private wells were higher than existing regulatory criteria for several parameters, including vinyl chloride. Consequently, it is possible regulatory exceedances in the downgradient private wells exist but were not detected.

7. Concentrations of subsurface gas generation were measured at three existing gas probes located just outside the limits of refuse disposal. No methane was detected in any of the three gas probes.

8. No surficial discharges of leachate were observed around the perimeter of the landfill during the investigation. Thus, leachate is likely draining vertically from the bottom of the landfill to the water table.

9. The refuse within the landfill does not appear to be intersecting the water table based on existing site data.

10.0 Identification and Initial Screening of Remedial Technologies

Refuse disposed at the Hayward Landfill comprises an ongoing source of relatively low concentrations of VOC impacts to local groundwater. Regulatory exceedances for one compound (vinyl chloride) have been identified in groundwater samples collected downgradient from the facility. Consequently, remedial action at the facility may be required. The following subsections describe the objectives of potential remedial action, and potentially applicable technologies to meet those objectives.

10.1 Remedial Action Objectives

The general objective of the remedial action is to provide the immediate and long term protection of public health and the environment from environmental impacts at the Hayward Landfill. As it would not be economically nor technically feasible to remove all contaminants from the groundwater, this study was focussed on those actions which would limit human exposure to the contaminated groundwater, and those actions which would prevent the further contamination and migration of contaminants into the local shallow aquifer by infiltrating leachate from the landfill.

10.2 General Response Actions

General response actions typically utilized to achieve the above objectives are listed below and described in further detail in subsequent sections.

- water supply source modifications
- engineering controls
- hydraulic controls
- groundwater disposal
- groundwater treatment
- in-situ treatment
- excavation and disposal
- institutional controls

10.3 Initial Screening Criteria

Each general response action may have several technologies which may be feasible remedial actions for the landfill. These technologies are briefly discussed. Options were eliminated or retained due to their technical effectiveness or economic feasibility. In those cases where several technologies under the same general response action may be applicable but redundant, one technology is chosen for further evaluation and incorporation into a remedial action option.

10.4 Water Supply Source Modifications

Based on previous water sampling events it is possible that private residential water supply wells are or will be impacted by dissolved contaminants. It should be noted that while VOCs have been historically identified in some private wells, no dissolved contaminant levels in the private well samples have been shown to exceed the Wisconsin drinking water standards for public health.

10.4.1 Commercial Drinking Water Supply

A commercial drinking water supply company could be utilized to provide clean water to those affected residences. Commercially provided water would offer an immediate solution if private wells are impacted, but this option would be very expensive over the long term.

10.4.2 Point of Use Treatment

Treatment systems could be installed at private wells with contaminant levels exceeding the drinking water standards. Systems to remove VOCs would typically utilize air stripping and carbon adsorption. Operations costs of these systems would be high as they require weekly maintenance and monitoring to ensure they are operating properly. Potential long term liability problems could exist if the systems were not maintained properly and did not provide adequate removal for protection of public health.

10.4.3 Deeper Private Water Supply Wells

Most of the private wells located in the area of concern are cased no deeper than 60 feet below grade. Installation of deeper wells into an uncontaminated deeper zone could provide a long term low maintenance solution if the existing private wells are impacted.

10.4.4 Extend Public Water Supply Distribution System

The City of Hayward public water supply system could be extended to reach the affected households. A water main is located within approximately one mile. Capital costs to install this system would be high but would be offset by low operations and maintenance costs and low future liability.

10.4.5 Assessment of Water Supply Source Modification Options

Commercial water supply could be implemented as an immediate solution; however, this option would be cost prohibitive as a long term solution. Deeper water supply wells appear to be the most cost effective long term solution. Extension of the public water supply system should be considered if deeper wells are not feasible due to low yields or the future identification of contamination at depth.

10.5 Engineering Controls

Engineering controls consist of physical barriers that are installed to prevent movement of media in a certain direction. Applicable technologies include horizontal caps and vertical cutoff walls.

10.5.1 Cap Modifications

As discussed earlier in this report, the existing cap allows a considerable volume of water to infiltrate through the landfill as contaminated leachate. Modifications could be made to the existing cap to reduce the hydraulic conductivity such that the future generation of leachate would be reduced. Modifications could include increasing the surface slopes, and thickness of the low permeability cover. Geomembranes and geosynthetic clay liners could also be potentially useful in reducing the quantity of leachate produced.

10.5.2 Cutoff Walls

Typical vertical cutoff walls consist of sheet piling, slurry walls, and auger walls and provide a physical barrier that prevents groundwater and dissolved contaminants from moving horizontally off site. The utility of vertical cutoff walls is limited at this site due to the potential for contaminant depths exceeding 100 feet below the landfill, and the presence of numerous cobbles and boulders which would make installation difficult.

10.5.3 Assessment of Engineering Control Options

Cap modifications will be retained a as a potential remedial technology.

10.6 Hydraulic Control

Groundwater pumping could be implemented to collect some of the dissolved contamination and to control the further migration of contaminants. Hydraulic control technologies generally consist of groundwater pumping from vertical wells, horizontal wells, and cutoff trenches

10.6.1 Vertical Well Groundwater Pumping System

A series of vertical well pumping systems may be effective at capturing the groundwater in the vicinity of the landfill DMZ. A groundwater pumping test and hydrogeologic model should be conducted to determine the optimum well locations and pumping rates.

10.6.2 Horizontal Well Groundwater Pumping System

Horizontal wells can be installed beneath the landfill; however, installation may be difficult at this site due to the existence of numerous cobbles and boulders in the surface. Because the groundwater contamination extends to depths typically not effected by this type of well the use of horizontal wells may not be warranted.

10.6.3 Groundwater Cutoff Trenches

Groundwater cutoff trenches would not be feasible at this site due to the depth of contamination, and geological constraints to installation.

10.6.4 Assessment of Hydraulic Control Options

Vertical pumping wells will be retained as a potential remedial technology.

10.7 Groundwater Disposal

A significant quantity of water may be generated if hydraulic control technologies are utilized. Water disposal options are considered prior to water treatment technologies as they will determine the level of water treatment required prior to discharge. An approximate 200 gpm pumping rate is estimated to be required to control the migration of contaminated groundwater. Water disposal options typically utilized include discharge to sanitary sewers and discharge to surface waters.

10.7.1 Sanitary Discharge

The existing wastewater treatment plant does not have the capacity to accept the estimated continuous flow required from this site.

10.7.2 Discharge to Namekagen River

The Namekagon River is located approximately 0.3 miles from the facility; however it is designated a National Wild and Scenic River and approval to discharge to this outstanding resource would be difficult to obtain.

10.7.3 Discharge to Wetland

Discharge to the adjacent wetland may be a feasible option, if discharged water is treated to surface water standards under a WPDES permit.

10.7.4 Assessment of Water Disposal Options

The option of discharging treated water to the wetland will be retained for further evaluation.

10.8 Groundwater Treatment

A wetland discharge appears to be the most feasible discharge option at this time. The only contaminants that appear to be of concern at levels higher than a typical WPDES permit would allow are vinyl chloride, iron, and manganese.

For the purpose of this evaluation, it will be assumed that aeration can be utilized to volatize the vinyl chloride and to precipitate a portion of the iron and manganese. Suspended solids would be removed prior to discharge to the wetland.

10.9 In-situ Treatment

In-situ treatment options are often employed to address contaminant source reduction without removing the actual media. Technologies which may be employed typically involve enhancement of volatization and biological degradation processes.

10.9.1 Active Gas Extraction

Studies show that active landfill gas extraction systems have served to significantly reduce VOC levels in leachate and groundwater. Typically a flare system would be utilized to treat the off-gases prior to discharge to the atmosphere. This option is potential technically and economically feasible.

10.9.2 Air Sparging the Saturated Zone

Due to thickness of contaminated zone, this techhnology would require several air sparge injection wells spaced both horizontally and vertically to address the contaminants. This system would not likely be economically feasible.

10.9.3 Enhanced Bioremediation

Enhanced bioremediation of the groundwater contamination is not technically feasible due to the depth and area of contamination, as well as the varied mix of contaminants present.

10.9.4 Assessment of In-Situ Treatment Options

Active gas extraction will be retained as a potential remedial action technology for further evaluation.

10.10 Excavation and Disposal to an Engineered Landfill

This option would consist of excavating the solid waste from the landfill and transporting it for disposal to a permitted, engineered municipal solid waste landfill. While technically feasible, this option is not economically feasible. Approximately 150,000 cubic yards of refuse are estimated to exist in the landfill. Assuming a conservative cost of $75/cubic yard to excavate and dispose of the solid waste at a permitted landfill, costs could easily exceed $11,000,000. Therefore, this will option will not be evaluated further.

10.11 Institutional Controls

Institutional controls can be imposed by the regulatory agencies to prevent further potential public health impacts from occurring. Currently a WDNR order is in effect regarding all new water supply wells to be cased to at least 100 feet deep. A stricter institutional control that prohibits the installation of any new wells downgradient of the landfill could be enforced until a remedial action is selected. Other potential institutional controls could include zoning modifications, deed restrictions, and land use planning to prevent future complications and liability issues with future developments.

11.0 Development and Evaluation of Remedial Action Options

This section presents, evaluates, and compares four remedial action options that are potentially feasible to achieve the remedial action objectives. The feasibility of any of the options presented cannot be confirmed until further data is collected and analyzed. Section 12.0 "Recommendations" recommends and describes the data collection and modeling activities that should be performed prior to making a final selection of a remedial action option. Cost projections for each option presented include costs required to collect and analyze the required data.

11.1 Development of Remedial Action Options

The following list of remedial technologies have been assembled as potentially feasible remedial action options for the protection of human health and the environment. The technologies utilized were selected from the previous initial screening.

- Option 1 – Continued Monitoring/Install Deep Water Supply Wells/Extend Public Water Supply Distribution System
- Option 2 – Continued Monitoring/Install Deep Water Supply Wells/Groundwater Pump and Treat
- Option 3 – Continued Monitoring/Install Deep Water Supply Wells/ Landfill Cap Upgrade
- Option 4 – Continued Monitoring/Install Deep Water Supply Wells/Active Gas Extraction and Flare

11.2 Evaluation Criteria

Remedial action options are evaluated for technical and economic feasibility according to the criteria outlined in ch. NR 722.07(4) Wis. Adm. Code.

11.2.1 Technical Feasibility

The technical feasibility of an option is evaluated according to the following criteria:

- Long Term Effectiveness

- Short Term Effectiveness
- Implementability
- Restoration Time Frame

Each option was assigned a relative rating ranging from low to high, with high being the best rating. The ratings should be considered preliminary as they are based on limited data and may be revised upon completion of further data collection, pilot studies, and computer modeling.

11.2.2 Economic Feasibility

The economic feasibility of an option is evaluated according to the following criteria.

- Capital Costs
- Annual Operations, Maintenance, and Monitoring Costs
- Total Annual Costs
- Potential Future Liability

11.3 Option 1 - Continued Monitoring/Install Deep Water Supply Wells/Extend Public Water Supply Distribution System

This option focusses on removing the private water supply wells which may be impacted by or potentially enhancing the migration of contaminated groundwater from the landfill.

11.3.1 Description and Rationale

Monitoring of the on site and off site monitoring wells would continue to accurately assess the potentially changing characteristics of the contaminated groundwater. Monitoring would determine if contaminant levels are increasing, decreasing or remaining relatively constant over time and allow some measure as to the effectiveness of the remedial action imposed.

The private water supply wells would be resampled and analyzed to determine if drinking water standards are exceeded. If any wells are out of compliance, a commercial water supply company would be contracted to provide an immediate clean drinking water source until new deeper wells could be installed out of the zone of contamination.

The pumping head created by the private water supply wells downgradient of the landfill could be enhancing the migration of contaminants from the landfill into the wells. A potential solution to this would be to abandon all pumping wells between the landfill and the assumed groundwater discharge area, the Namekagon River. The City of Hayward public water supply distribution system could be extended to the parties that are now utilizing wells.

A groundwater contaminant fate and transport model would be constructed to estimate the migration of contaminants from the landfill with and without the private wells pumping.

If the model results indicate that continued pumping may cause potential impacts even to deep wells or that elimination of the pumping heads would stop migration of the contaminants, the proposed remedial action would be to extend the public water distribution system. The distance between the nearest water main and the landfill area is approximately one mile.

No action beyond landfill cap maintenance would be completed at the landfill to remove the source, as source control options could be potentially deleterious to the internal degradation processes ongoing in the landfill.

11.3.2 Evaluation of Technical Feasibility

The long term effectiveness of this option would be high for the protection of human health, safety, and welfare because the contact between humans and the potentially contaminated water supply would be greatly reduced. The long term effectiveness of this option for the protection of environment is difficult to ascertain and rated low until further data collection and modeling is conducted. Therefore, a medium rating is assigned.

The short term effectiveness of this option is rated high because it immediately addresses the protection of human health, safety, and welfare by providing a safe drinking water supply through the proposed interim actions.

The implementability of this option is rated low until further data collection and modeling is conducted. The WDNR may not approve of this action due to the fact that remediation of the groundwater contamination is not addressed. An exemption from the remediation requirement would be required from the WDNR under ss NR 140.28 Wis. Adm. Code, especially if continued monitoring consistently indicates ES exceedances off site. Approval or disapproval of this option would be based upon the results of continued monitoring and the groundwater fate and transport model.

Restoration time frame is also difficult to judge until further information is assembled, regarding the groundwater contaminant transport and attenuation. A relative medium to low rating was assigned because this option does not directly address the groundwater contamination.

11.3.3 Evaluation of Economic Feasibility

The preliminary projection of total initial capital costs for this option is approximately $732,000. The projection includes costs for preliminary data collection and analysis activities such as private water well supply sampling and analysis, landfill leachate collection and analysis, groundwater contaminant fate and transport modeling, risk assessment modeling and preparation of risk assessment. The projection also accounts for an interim water supply remedial action involving short term commercial water supply and new installation of deeper water supply wells and pumps. Capital costs for the extension of the water distribution system include planning, permitting, testing, design, bidding, construction, and oversight.

Annual operations, maintenance, and monitoring (OMM) costs are approximately $78,200. OMM costs include quarterly site monitoring, and maintenance of the landfill cover.

The estimated total annual cost (OMM and amortized capital costs) over a 20 year period is estimated to be $142,000 per year. Capital costs were amortized over 20 years at an interest rate of 6%.

Detailed calculations of the cost projection is included in Appendix K, "Remedial Action Option Cost Summary Tables."

This option is considered to have low potential future liability because the private wells will be abandoned and contact with the low level contamination will be limited.

11.4 Option 2 - Continued Monitoring/Install Deep Water Supply Wells/Groundwater Pump and Treat

This option focussed on preventing the further movement of contaminated groundwater from beyond the DMZ and at capturing any new leachate produced.

11.4.1 Description and Rationale

As discussed previously, monitoring of the on site and off site monitoring wells would continue to accurately assess the potentially changing characteristics of the contaminated groundwater. Monitoring would determine if contaminant levels are increasing, decreasing or remaining relatively constant over time and allow some measure as to the effectiveness of the remedial action imposed.

The private water supply wells would be resampled and analyzed to determine if drinking water standards are exceeded. If any wells are out of compliance, a commercial water supply company would be contracted to provide a clean drinking water source until new deeper wells could be installed out of the zone of contamination.

A groundwater contaminant fate and transport model would be constructed to estimate the migration of contaminants from the landfill. The model would also investigate the effects of a groundwater recovery system installed at the landfill to recover and prevent further migration of contaminants. The model would confirm or reject the assumption that the dissolved contaminants beyond the capture zone of the groundwater recovery system would eventually attenuate to levels below the ch. NR 140 Wis. Adm. Code standards, in an acceptable time frame.

A 200 gallon per minute (gpm) groundwater recovery system is assumed to be sufficient to capture new leachate produced from the landfill and the contaminated groundwater within the DMZ. A 72 hour pumping test would be conducted to provide data to a groundwater pumping computer model to estimate optimum pumping rates.

Extracted groundwater would be aerated for volatization of VOCs and precipitation of some metals, with subsequent solids removal prior to discharging to the adjacent wetland. A settling basin would be constructed on site for settling equalization prior to discharge.

No action beyond cap maintenance would be completed at the landfill to remove the leachate source in the landfill, as source control options could be potentially deleterious to the internal degradation processes ongoing in the landfill.

11.4.2 Evaluation of Technical Feasibility

The long term effectiveness of this option would be rated high for the protection of human health, safety, and welfare because the contact between humans and the potentially contaminated water supply would be greatly reduced. The long term effectiveness of this option for the protection of environment would be medium as it would limit further movement of groundwater contamination to downgradient receptors. Therefore, a medium to high rating was assigned.

The short term effectiveness of this option is rated high because it immediately addresses the protection of human health, safety, and welfare by providing a safe drinking water supply through the proposed interim actions.

The implementability of this option is rated medium. No difficulties are foreseen regarding materials availability, construction, or assessment of effectiveness. Potential difficulties do exist though with regards to the adjacent wetland. An WPDES permit would be required for discharge to the wetland and it is unknown at this time if any sensitive ecological receptors are located in the wetland that would be adversely impacted by a treated effluent inflow.

Restoration time frame is difficult to judge until further information is assembled, regarding the groundwater contaminant transport and attenuation. This option was given a relative medium to high rating because it is the only option that directly removes dissolved contamination existing in the groundwater.

11.4.3 Evaluation of Economic Feasibility

The preliminary projection of total initial capital costs for this option is approximately $1,226,000. The projection includes costs for preliminary data collection and analysis activities such as private water well supply sampling and analysis, landfill leachate collection and analysis, a groundwater pumping test, and groundwater contaminant fate and transport modeling. The projection also accounts for an interim water supply remedial action involving short term commercial water supply and new installation of deeper water supply wells. Capital costs for the groundwater pumping, treatment, and discharge system include planning, permitting, testing, design, bidding, construction, and oversight.

Annual OMM costs are approximately $152,500. OMM costs include the remediation system operations and maintenance costs, system performance monitoring costs, quarterly site monitoring, and maintenance of the landfill cover.

The estimated total annual cost (OMM and amortized capital costs) over a 20 year period is estimated to be $259,000 per year. Capital costs were amortized over 20 years at an interest rate of 6%.

Detailed calculations of the cost projection is included in Appendix K.

This option is considered to have low to medium relatively liability because the potential still exists for the deeper water supply wells to be impacted by contamination in the future.

11.5 Option 3 - Continued Monitoring/Install Deep Water Supply Wells/Landfill Cap Upgrade

This option is aimed at preventing the further production of leachate which has been the likely source of groundwater contamination.

11.5.1 Description and Rationale

As discussed previously, monitoring of the on site and off site monitoring wells would continue to accurately assess the potentially changing characteristics of the contaminated groundwater. Monitoring would determine if contaminant levels are increasing, decreasing or remaining relatively constant over time and allow some measure as to the effectiveness of the remedial action imposed.

The private water supply wells would be resampled and analyzed to determine if drinking water standards are exceeded. If any wells are out of compliance, a commercial water supply company would be contracted to provide a clean drinking water source until new deeper wells could be installed out of the zone of contamination.

A groundwater contaminant fate and transport model would be constructed to estimate the migration of contaminants from the landfill. The model would also investigate the effects of greatly reducing the leachate source of contamination. The model would confirm or reject the assumption that the dissolved contaminants currently existing in the saturated zone would eventually attenuate to levels below the ch. NR 140 Wis. Adm. Code standards in an acceptable time frame.

The existing landfill cover system would be upgraded to create a low permeability cap, in exceedance of current Wisconsin landfill cover design standards. The current site vegetation would be cleared and grubbed, and the topsoil would be stripped and stockpiled. The existing 12 inch clay layer would be regraded and recompacted to provide a greater drainage slope. New clay would be imported and compacted over the existing clay to provide a minimum two foot thick cap. An impermeable geomembrane would be placed directly over the cap to minimize any infiltration. A six inch layer of drainage soils would be placed above the geomembrane. An 18 inch thick rooting zone would then be installed and covered with the salvaged topsoil.

A passive gas extraction system and flare would be installed to prevent the accumulation of gases beneath the impermeable cover system.

A low permeability cap could potentially slow down the degradation of the solid waste in the landfill due to the eventual lack of sufficient moisture.

Further study would be required to define the minimum separation distance between the landfill bottom and the groundwater table.

11.5.2 Evaluation of Technical Feasibility

The long term effectiveness of this option would be rated high for the protection of human health, safety, and welfare because the contact between humans and the potentially contaminated water supply would be greatly reduced. The long term effectiveness of this option for the protection of environment would be medium as it would limit further contamination of groundwater by reducing the leachate source. Potential direct contact between the groundwater and waste would be a source of contamination not addressed by the cap modification. Therefore, this option is rated medium to high.

The short term effectiveness of this option is rated high because it immediately addresses the protection of human health, safety, and welfare by providing a safe drinking water supply through the proposed interim actions.

The implementability of this option is rated high. No difficulties are foreseen regarding materials availability, construction. Cap upgrades are commonly utilized to prevent leachate production and migration from unlined landfills.

Restoration time frame is difficult to judge until further information is assembled, regarding the groundwater contaminant transport and attenuation. This option was rated medium because the source of contamination is addressed.

11.5.3 Evaluation of Economic Feasibility

The preliminary projection of total initial capital costs for this option is approximately $1,664,000. The projection includes costs for preliminary data collection and analysis activities such as private water well supply sampling and analysis, landfill leachate collection and analysis, an analysis of the existing cover, and groundwater contaminant fate and transport modeling. The projection also accounts for an interim water supply remedial action involving short term commercial water supply and new installation of deeper water supply wells. Capital costs for the cap modification and passive flare system include planning, permitting, testing, design, bidding, construction, and oversight.

Annual OMM costs are approximately $103,700. OMM costs include the flare system operations and maintenance costs, quarterly site monitoring, and maintenance of the landfill cover.

The estimated total annual cost (OMM and amortized capital cost) over a 20 year period is estimated to be $247,000 per year. Capital costs were amortized over 20 years at an interest rate of 6%.

Detailed calculations of the cost projection is included in Appendix K.

This option is considered to have low to medium relatively liability because the potential still exists for the deeper water supply wells to be impacted by contamination in the future.

11.6 Option 4 - Continued Monitoring/Install Deep Water Supply Wells/Active Gas Extraction and Flare

This option is aimed at preventing the infiltrating leachate contamination source from further contaminating the groundwater by treating the leachate in-situ.

11.6.1 Description and Rationale

As discussed previously, monitoring of the on site and off site monitoring wells would continue to accurately assess the potentially changing characteristics of the contaminated groundwater. Monitoring would determine if contaminant levels are increasing, decreasing or remaining relatively constant over time and allow some measure as to the effectiveness of the remedial action imposed.

The private water supply wells would be resampled and analyzed to determine if drinking water standards are exceeded. If any wells are out of compliance, a commercial water supply company would be contracted to provide a clean drinking water source until new deeper wells could be installed out of the zone of contamination.

A groundwater contaminant fate and transport model would be constructed to estimate the migration of contaminants from the landfill. The model would also investigate the effects of removing the leachate source of contamination. The model would confirm or reject the assumption that the dissolved contaminants currently existing in the saturated zone would attenuate to levels below the ch. NR 140 Wis. Adm. Code standards in an acceptable time frame.

An active gas extraction system would be utilized to volatize the VOC contamination from the leachate in the vadose zone below the landfill and potentially in the landfill. A study of landfill gas extraction systems at four landfills in Wisconsin indicated that gas extraction systems significantly reduced the magnitude of VOC contamination in the leachate or groundwater.

A flare or thermal treatment system would be required to prevent the discharge of contaminant to the atmosphere at levels beyond those specified in ch. NR 400 Wis. Adm. Code.

An extraction system could potentially slow down the anaerobic degradation of the solid waste in the landfill if oxygen is drawn into the landfill due to active vacuum gas extraction.

11.6.2 Evaluation of Technical Feasibility

The long term effectiveness of this option would be rated high for the protection of human health, safety, and welfare because the contact between humans and the potentially contaminated water supply would be greatly reduced. The long term effectiveness of this option for the protection of environment would be medium as it would prevent further contamination by reducing the contaminated leachate source. This option was rated medium to high.

The short term effectiveness of this option is rated high because it immediately addresses the protection of human health, safety, and welfare by providing a safe drinking water supply through the proposed interim actions.

The implementability of this option is rated medium to high. No difficulties are foreseen regarding materials availability or construction; however, this is not the WDNR's typically preferred method of reducing contaminant source in leachate.

Restoration time frame is difficult to judge until further information is assembled, regarding the groundwater contaminant transport and attenuation. This option was rated medium because the source of contamination is addressed.

11.6.3 Evaluation of Economic Feasibility

The preliminary projection of total initial capital costs for this option is approximately $841,000. The projection includes costs for preliminary data collection and analysis activities such as private water well supply sampling and analysis, landfill leachate collection and analysis, a gas extraction pilot test, and groundwater contaminant fate and transport modeling. The projection also accounts for an interim water supply remedial action involving short term commercial water supply and new installation of deeper water supply wells. Capital costs for the active gas extraction system and flare include planning, permitting, testing, design, bidding, construction, and oversight.

Annual operations, maintenance, and monitoring (OMM) costs are approximately $119,900. OMM costs include the remediation system operations and maintenance costs, system performance monitoring costs, quarterly site monitoring, and maintenance of the landfill cover.

The estimated total annual cost (OMM and amortized capital costs) over a 20 year period is estimated to be $193,000 per year. Capital costs were amortized over 20 years at an interest rate of 6%.

Detailed calculations of the cost projection is included in Appendix K.

This option is considered to have low to medium relatively liability because the potential still exists for the deeper water supply wells to be impacted by contamination in the future.

11.7 Comparison of Remedial Action Options

Table 9, "Preliminary Comparison of Remedial Action Options" summarizes the evaluation of each option and utilizes a numerical scoring for each evaluation criteria. Rating and scoring for each evaluation criteria was based upon the previous discussion for each option. The scoring system provides a balanced system to give equal weight to each evaluation criteria specified in ch. NR 722.07(4) Wis. Adm. Code.

The "long term effectiveness" of Options 2, 3, and 4 were given a "medium to high rating" because those options provide protection of public health and will reduce the volume of contamination over time by source reduction. Option 1 was only given a medium rating, because it does not address the reduction of contamination volume, but does provide protection to the public heath.

All options were rated high for "short term effectiveness" because the potential immediate threat to water supply is addressed by providing commercial water and new wells if necessary.

Option 3 was given a high rating for "implementability" because capping is a commonly applied and accepted response to reduce the production of landfill leachate at the contaminant source. Option 4 was given a medium to high rating, because it is a proven technology but not as commonly applied as capping for leachate contaminant source reduction. Option 2 was given a medium rating because of potential difficulties associated with the groundwater pumping, drawdown effects and/or the potential difficulty in receiving a permit to discharge to the nearby wetland. Option 1 was given a low rating because it may be very difficult to receive WDNR approval for this option because the source of groundwater contamination is not addressed.

Option 2 received a medium to high rating for "restoration time frame" because this option addresses the existing dissolved contamination in the groundwater. Options 3 and 4 only address the source and, therefore, were given a medium rating. Option 1 was given a medium to low rating because it does not address cleanup of the contaminated groundwater zone. Option 1 did not receive a low rating because the actual contaminant level is very low and the quantity of potential receptors is very limited.

Cost information presented in Table 9 is supported by detailed cost information in Appendix K.

Option 1 appears to be the least expensive option, followed by Options 4, 3, and 2 respectively.

Option 1 is considered to have low future liability relative to the other options because the public health is provided the best protection in this scenario. Options 2, 3, and 4 were considered to have low to medium liability because the potential for future contamination of the water supply wells does exist, although it is unlikely.

11.8 Discussion

As a preliminary recommendation, Option 1 appears to be the most favorable remedial action option when all evaluation criteria are considered. It is important to note that this option scored poorly in the area of implementability, as the zone of groundwater contamination would not be remediated. WDNR approval of this option is highly dependant upon the results of further monitoring, data collection, and modeling.

Final selection of a remedial option is not appropriate at this time due to the lack of sufficient data. Completion of the recommended actions in the next section will provide sufficient data for final selection of a remedial action. The recommended actions are applicable to all of the remedial action options described previously.

12.0 Recommendations

This section recommends the additional data collection, pilot studies, and computer modeling that should be conducted prior to final selection of the remedial action.

12.1 Private Water Supply Well Sampling

Resampling and analysis of groundwater from private water supply wells located downgradient of the landfill is recommended. Laboratory analyses would determine if the private water supply quality meets the Wisconsin safe drinking water standards promulgated in ch. NR 809.24 Wis. Adm. Code.

12.2 Interim Water Supply Remedial Action

If the results of the sampling program indicate that the water from the private water supply wells represent an immediate threat to public health, an interim water supply remedial action will go into effect as described below.

12.2.1 Short Term Commercial Water Supply

Water utilized for human consumption will be provided to each affected household, until a long term interim solution can be put into effect. The proposed long term interim solution will be to install deeper wells. Due to potential seasonal delays, the short term commercial water supply period may be as long as 3 months.

12.2.2 New Water Supply Wells Installation

New deeper private water supply wells would be recommended for each affected household. The average depth of the existing private water supply wells is less than 60 feet. The proposed depth of the new well casings will be approximately 110 feet.

Only two off-site monitoring wells (PZ-7S and PS-9S) have shown water quality exceeding the drinking water standards, and these monitoring wells were screened at depths less than 60 feet. The deeper monitoring wells have demonstrated water quality within the drinking water standards and indicate that the deeper water meets the public health criteria. Therefore, the 110 foot depth of the new water supply wells appears to be sufficient.

As discussed previously, variable hydraulic conductivities in the till soils are present at this depth and in some cases drilling may be required in excess of 110 feet depth in order to provide adequate yields.

12.2.3 Institutional Controls

A request will be made to the State of Wisconsin to prohibit the installation of any new water supply wells in the area located between the landfill and the Namekagon River until further data can be collected and a final remedial action is selected as described below.

12.3 Collection of Further Data

Further data acquisition is required prior to making a final selection of a remedial action option. The data will be reviewed and utilized to conduct computer modeling which will demonstrate the effectiveness (or non-effectiveness) and feasibility of the recommended remedial action option.

12.3.1 Continued Groundwater Monitoring

Continued groundwater monitoring should be conducted in accordance with the WDNR requirements. To date, only one sampling event has detected off-site public health ES exceedances and those exceedances were very slight. Results of further monitoring may potentially indicate that the ES exceedances in the off-site piezometers were a one time occurrence.

12.3.2 Landfill Leachate Collection and Analysis

Suction lysimeters are recommended for collection of leachate samples from various points in the landfill. Collected leachate will be analyzed for the ch. NR 140 Wis. Adm. Code public health and welfare criteria. This data will be utilized in concert with the estimated landfill leachate production parameter (HELP model output) as the contaminant source input to the "Fate and Transport" model.

12.3.3 Fate and Transport Field Data Collection

Subsurface soils characterization data including total organic content (TOC), effective porosity, biological degrader populations, etc. are required to prepare a complete "Fate and Transport" model. Field personnel and soil boring/sampling equipment will be deployed to collect this data.

12.4 Groundwater Contaminant Fate and Transport Model

A computer generated "Fate and Transport" model will be set up and run to estimate the adsorption, transport, degradation, and dilution mechanisms acting upon the dissolved contaminants in the subsurface. This data is useful to estimate the long term maximum extent of the dissolved contaminant plume migration and concentration.

The modeling effort will also provide insight as to what effect the pumping heads created by the private wells have upon movement of groundwater from the landfill.

12.5 Apply for ss NR 140.28 Wis. Adm. Code Exemption

It is not technically nor economically feasible to directly remediate the entire zone of groundwater downgradient from the landfill DMZ which may potentially exceed PALs. Therefore, it will be necessary to apply for an exemption to ss NR 140.24 Wis. Adm. Code or ss NR 140.26 Wis. Adm. Code, under ss NR 140.28 Wis. Adm. Code. The granted exemption may include an alternate concentration limit for vinyl chloride, which would make Option 1 potentially feasible.

12.5.1 Agency Meetings

Meetings will be held with the WDNR to determine what actions are required to apply for and receive an exemption to required remediation of the low level contamination outside of the facility DMZ.

12.5.2 Public Health and Ecological Risk Assessment Report

If Option 1 is potentially viable, the WDNR may require a risk assessment be performed to evaluate the potential effects of not directly addressing the source of groundwater contamination.

12.6 Final Selection of Remedial Action

A remedial action option will be selected based upon the results of the above described actions.

A letter will be sent to the WDNR describing the recommended remedial action. Upon WDNR approval, required design studies will be conducted to collect site specific design parameters and confirm the feasibility of the selected remedial action.

13.0 Schedule

According to the February 1994 Closure Plan Modification, the WDNR will review this ECA and upon approval, provide a schedule for implementation of the approved recommendations. Table 10, "Preliminary Projected Schedule for Implementation of Remedial Action Option" illustrates a conceptual timetable to complete the above recommendations and installation of remedial action options presented in this ECA.

14.0 Standard of Care

The conclusions and recommendations contained in this report were arrived at in accordance with generally accepted professional engineering practice at this time and location. Other than this, no warranty is implied or intended.

15.0 References

Holmstrom, B.L., Kammerer, P.A., Ellefson, B.R., 1993, "Water Resources Data Wisconsin, Water Year 1992," United States Geological Survey Water Data Report WI-92-1.

Mickelson, D.M., et. al., 1984, "Pleistocene Stratigraphic Units of Wisconsin," Geologic and Natural History Survey, University of Wisconsin-Extension, Miscellaneous Paper 84-1.

Ostrom, M.E., 1966, "Cambrian Stratigraphy of Western Wisconsin," University of Wisconsin Geological and Natural History Survey, Information Circular No. 7.

Young, H.L., and Hindall, S.M., 1973, "Water Resources of Wisconsin St. Croix River Basin," Geologic and Natural History Survey, University of Wisconsin-Extension, Hydrologic Investigations Atlas HA-451.

Tables

Table 1
Owners of Public and Private Water Supply Wells Within 1,200 Feet of Facility

Well Designation (Drawing No. 3/8)	Well Owner	Address	Distance and Direction From Limits of Refuse
PW-1	Behive Botanicals Linda Graham	RR8, Box 8257 Hayward, WI 54843	1140 ft. South
PW-4	James D. Lake	N8924 Curve Inn Road Tomahawk, WI 54487	650 ft. Northeast
PW-8	Leonard G. Asp	RR 8, Box 8256 Hayward, WI 54843	750 ft. Southeast
PW-9	B & B Sales Susan L. Brown	RR 1, Box 224 Gordon, WI 54838	280 ft. Southeast
PW-10	Five States Merchandise Richard H. Pfister	RR 8, Box 8226 Hayward, WI 54843	290 ft. Southeast
PW-11	Barko Sales John E. Norlen	P.O. Box 280 Two Harbons, MN 55616	450 ft. East
PW-12	Conway Central Express, Inc.	4880 Venture Avenue Ann Arbor, MI 48108	750 ft. East
PW-13	Hayward Bus Service, Inc.	P.O. Box 1007 Hayward, WI 54843	500 ft. Northeast

Notes:
1. List of well owners within 1,200 foot radius of refuse disposal limits is based on visual observation of wells in this area. Owners names obtained from the City of Hayward tax records.
2. Available well logs for wells located within 1,200 feet of refuse disposal limits are provided in Appendix B.

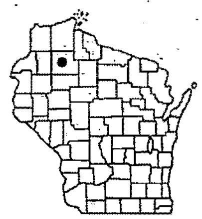
Figures

Figure 1 – Site Location

REPRODUCED FROM

USGS RESERVE, BEAN LAKE, STANBERRY EAST AND HAYWARD QUADRANGLES

WISCONSIN – SAWYER CO. 7.5 MINUTE SERIES



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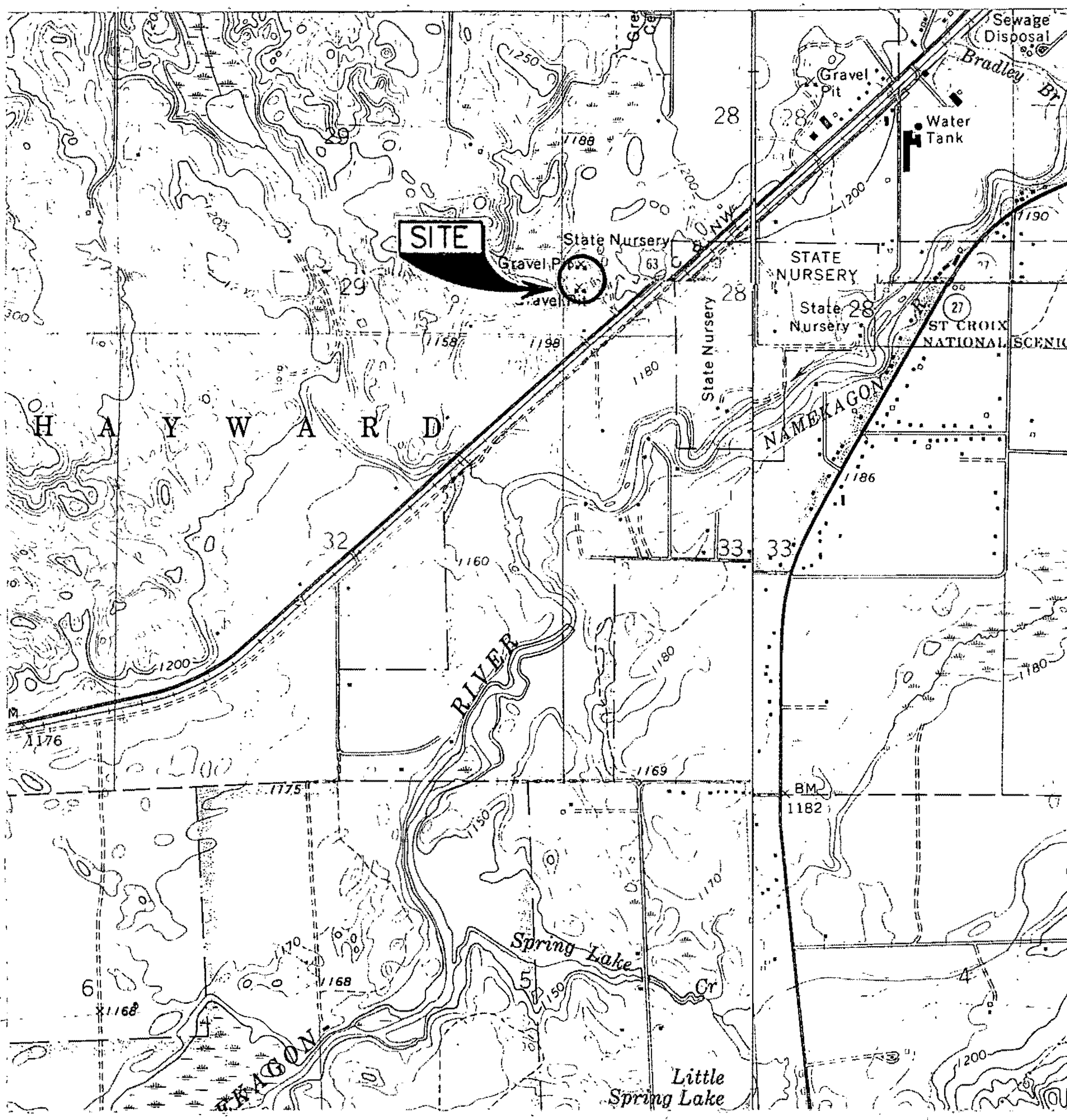

SEH ENGINEERS ■ ARCHITECTS ■ PLANNERS	DRAWN BY: JLE 08/09/95	CITY OF HAYWARD FIGURE 1 SITE LOCATION	FILE NO. HAYW9503
	CHECKED BY: JEG 08/16/95		DRG. NO. 9503FBA2

Table 2
Summary of Groundwater Elevation Data
Hayward Landfill
Hayward, Wisconsin

	MW-1	PZ-1S	PZ-1D	MW-2	MW-3	MW-4	MW-5	MW-6	PZ-6S	PZ-6D	MW-7	PZ-7S	PZ-7D	MW-8	PZ-8S	PZ-8D	MW-9	PZ-9S	PZ-9D	MW-10	PZ-10S	PZ-10D	B-1	B-2	B-3	B-4	B-5	B-6
Top of Casing Elevation, MSL	1187.91	1187.85	1187.93	1199.20	1200.20	1188.88	1181.03	1185.11	1184.70	1184.65	1199.70	1199.67	1199.48	1189.34	1189.27	1189.30	1189.06	1189.25	1189.48	1180.05	1179.92	1179.41	1200.63	1203.03	1200.19	1192.74	1195.98	1192.46
Date	Depth to Groundwater Below Top of Casing (feet)																											
May 22, 1995	20.08	21.48	21.32	31.78	24.40	17.10	10.96				34.90	34.96	35.01	24.39	24.38	24.60	26.85	27.74	28.12	21.84	21.05	21.25						
June 2, 1995	19.94	21.35	21.21	31.64	24.24	17.72	10.65	14.30	14.08	14.65	34.77	34.83	34.76	24.32	24.30	24.67	26.80	27.77	28.07	21.80	21.03	21.26	24.91	27.84	28.08	22.88	26.48	23.29
July 5, 1995	20.04	21.44	21.28	31.87	24.67	17.62	11.57	14.92	14.52	15.00	34.86	34.92	34.87	24.40	24.38	24.74	26.94	27.93	28.28	22.14	21.32	21.52	24.99	27.75	28.07	23.26	26.64	23.54
July 24, 1995	20.22	21.60	21.47	31.83	25.00	17.42	11.89	15.12	14.72	15.12	35.00	35.06	35.02	24.57	24.56	24.84	27.05	28.08	28.35	22.24	21.43	24.57	25.41	28.04	28.24	23.33	26.79	23.72
August 7, 1995	20.32	21.67	21.52	31.91	25.19	17.95	12.10	15.27	14.87	15.25	35.05	35.11	35.05	24.61	24.59	24.95	27.12	28.09	28.41	22.27	21.44	21.59	25.63	28.21	28.37	23.29	26.89	23.82
Date	Groundwater Elevation (MSL)																											
May 22, 1995	1167.83	1166.37	1166.61	1167.42	1175.80	1171.78	1170.07				1164.80	1164.71	1164.47	1164.95	1164.89	1164.70	1162.21	1161.51	1161.36	1158.21	1158.87	1158.16						
June 2, 1995	1167.97	1166.50	1166.72	1167.56	1175.96	1171.16	1170.38	1170.81	1170.62	1170.00	1164.93	1164.78	1164.81	1165.02	1164.97	1164.63	1162.26	1161.48	1161.41	1158.25	1158.89	1158.15	1175.72	1175.19	1172.11	1169.86	1169.50	1169.17
July 5, 1995	1167.87	1166.41	1166.65	1167.33	1175.53	1171.26	1169.46	1170.19	1170.18	1169.65	1164.84	1164.75	1164.61	1164.94	1164.89	1164.56	1162.12	1161.32	1161.20	1157.91	1158.60	1157.89	1175.64	1175.28	1175.12	1169.48	1169.34	1168.92
July 24, 1995	1167.69	1166.25	1166.46	1167.37	1175.20	1171.46	1169.14	1169.99	1169.98	1169.53	1164.70	1164.61	1164.46	1164.77	1164.71	1164.36	1162.01	1161.17	1161.13	1157.81	1158.49	1157.84	1175.22	1174.99	1171.95	1169.41	1169.19	1168.74
August 7, 1995	1167.59	1166.18	1166.41	1167.29	1175.01	1170.93	1168.93	1169.84	1169.83	1169.40	1164.65	1164.56	1164.43	1164.73	1164.68	1164.35	1161.94	1161.16	1161.07	1157.78	1158.48	1157.82	1175.00	1174.82	1171.82	1169.45	1169.09	1168.64

Notes: All elevations recorded in Mean Sea Level (MSL) datum.
All depth measurements recorded in feet.