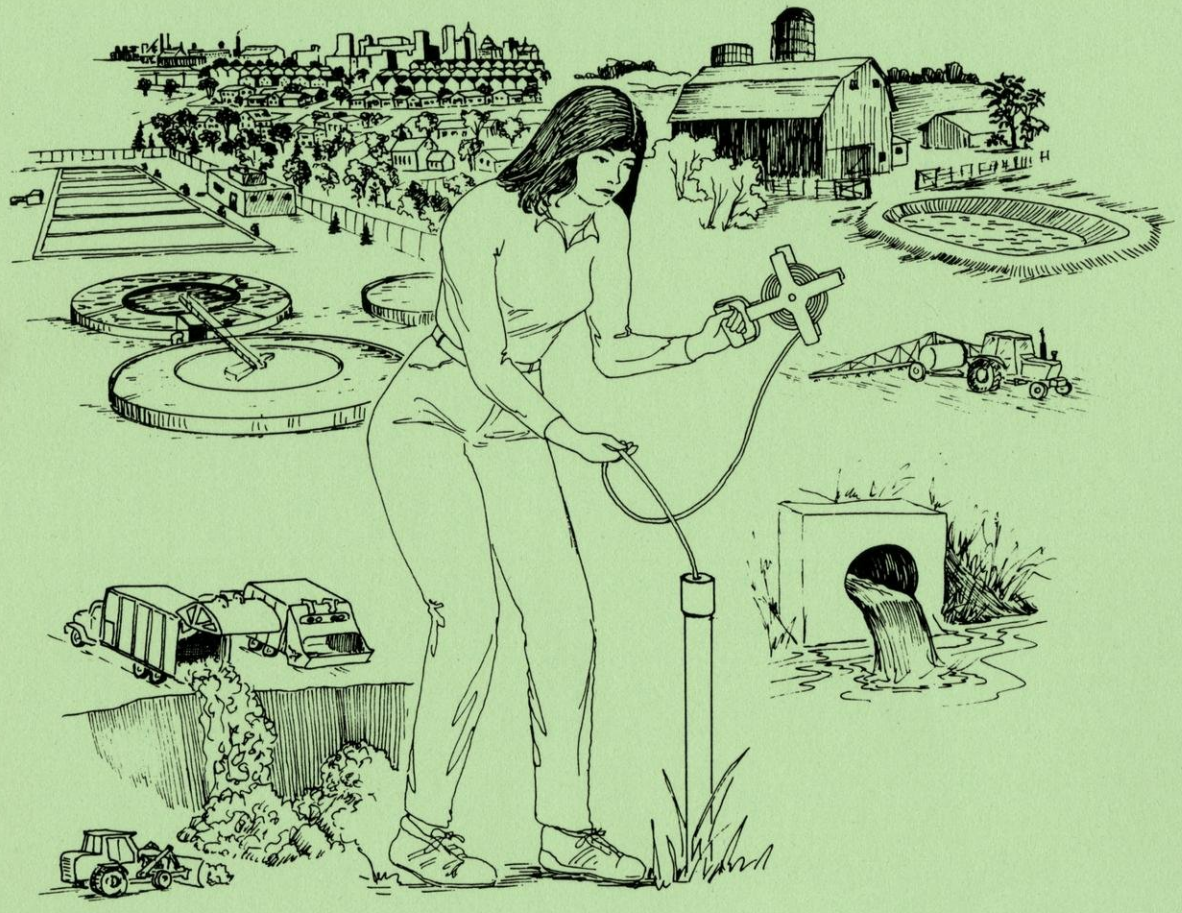
Hydrogeologic investigation and groundwater quality assessment report: Havenwoods State Forest, C.T.H. "G" (Sherman Boulevard) & C.T.H. "S" (Mill Road), Milwaukee, Wisconsin. [DNR-028] 1988

Miller Engineers& Scientists
[Madison, Wisconsin]: [Wisconsin Department of Natural Resources], 1988

Wisconsin Groundwater Management Practice Monitoring Project No. 28



GROUNDWATER
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Wisconsin Department of Natural Resources

HYDROGEOLOGIC INVESTIGATION AND GROUNDWATER QUALITY ASSESSMENT REPORT

HAVENWOODS STATE FOREST

C.T.H. "G" (Sherman Boulevard)
& C.T.H. "S" (Mill Road)
Milwaukee, Wisconsin

Wisconsin Department of Administration
Project #8607-33, Contract #9247

Miller Engineers Job #8817-86

PREPARED FOR:

State of Wisconsin
Department of Administration
Division of State Facilities Management
101 South Webster Street
Madison, WI 53702

PREPARED BY:

Miller Engineers
5308 South Twelfth Street
Sheboygan, WI 53081

January 7, 1988

I. EXECUTIVE SUMMARY

The Havenwoods study area is triangular-shaped in plan and occupies about 60 acres bounded by Lincoln Creek on the east, the Chicago and Northwestern Railroad trackage on the north and the Chicago, Milwaukee, St. Paul and Pacific Railroad trackage on the southwest.

Thirteen (13) soil borings were drilled in the study area to depths of 25 to 89 feet. Piezometer wells were installed in three of the borings; observation wells in four of the borings.

The borings disclosed native deposits composed of all upper clay-silt till underlain by sand and gravel outwash that overlies either bedrock or an older, clay till. The bedrock encountered is undifferentiated Silurian dolomitic limestone that is part of the Niagara aquifer.

Groundwater occurs at depths of about 15 to 20 feet below site grades. Elevations of the groundwater table vary between about +676 and +680. Horizontal flow directions are to the southeast-south-southwest towards both Lincoln Creek and the U. S. Army Reserve Complex. Vertical flow gradients are occasionally zero but primarily downward indicating recharge to the groundwater table system. For the period of time studied, groundwater levels peaked in April and November with low levels in February-March and July-August.

Fifteen (15) shallow clay cap borings to depths of 1 to 3 feet indicated the soil material used for the cap to be suitable for that purpose. However, these borings and the soil borings indicate that the cap may not be continuous over the refuse fill area, particularly near Lincoln Creek. The cap also appears to be of variable thickness where present. In a number of locations probed, the cap thickness was less than 2 feet.

The refuse fill has an estimated maximum thickness of about 16 feet near Boring B11. The average thickness is about 7 feet. Total estimated refuse fill volume is 200,000 cubic yards. The landfill is estimated to occupy an area of about 16 acres out of the 60 acres of the study area. The fill was

observed to consist of a heterogenous mixture of clay, sand, glass, metal, cinders, bricks, rags, paper and other miscellaneous materials. The refuse fill appears to be continuously underlain by the upper, clay-silt till.

Chemical test results for six sampling rounds indicate generally high heavy metal concentrations in the piezometer wells screened in the dolomitic limestone bedrock and the B7 observation well screened in glacial drift and located adjacent to Lincoln Creek. The concentrations measured in the piezometer wells may have a source in the bedrock itself. The concentrations noted in the B7 well may be coming from either Lincoln Creek during high flow periods or the landfill refuse during low flow periods.

Overall groundwater quality appears to decrease to the southeast-south-southwest in a pattern consistent with estimated groundwater table elevation contours and flow directions. This may indicate that the landfill is having a negative impact on local groundwater quality.

In general, the results of the VOC analysis conducted in the second sampling round are inconclusive. The TLV field values for the soil boring samples indicate an increase in VOCs to the south-southwest towards the Army Reserve Complex.

Non-volatile organics and biological sources of pollution do not appear to have a significant impact on the study area wells.

Additional studies appear warranted to define the lateral and areal extent of the refuse; evaluate and characterize the refuse; evaluate surface water quality; determine the relationship between heavy metal concentrations, the refuse fill and Lincoln Creek; provide additional background groundwater quality data and confirm flow directions and groundwater contours; obtain additional data on heavy metal concentrations in rock cores and glacial drift soils; collect additional data on the elevation of the top of bedrock; and establish a program of periodic groundwater level measurements, sampling and testing, particularly for VOCs.

II. INTRODUCTION

A portion of the present site of the Havenwoods State Forest in Section 26, Township 8 North, Range 21 East, Milwaukee County, had been used as a landfill by the City of Milwaukee until about 1969. There is concern that this abandoned landfill may be having negative impacts on local soils and groundwater.

To evaluate the potential negative impacts, the Wisconsin Department of Administration (DOA) acting in cooperation with the Wisconsin Department of Natural Resources (DNR) retained Miller Engineers in August of 1986, to evaluate subsurface conditions at the Havenwoods site.

The purpose of our study was to provide an assessment of any groundwater degradation, determine the horizontal and vertical boundaries of the landfill, and evaluate the hydrogeologic conditions at the site.

Miller Engineers' scope of work was to include:

1. The drilling and sampling of 13 soil borings and the installation of 4 monitoring wells and 3 piezometers in 7 of the soil borings.

2. Establishing coordinates (horizontal control) and elevations (vertical control) at the soil boring and well locations.

3. Conducting a geophysical study to determine the areal extent and depth of refuse fill and the depth to bedrock in areas away from the boring locations.

4. Completing rock coring at the three piezometer installations.

5. Developing the monitor wells and piezometers and estimating in situ field permeabilities.

6. Performing laboratory testing including Atterberg limits, grain size analysis and classification of site soils in accordance with the Unified Soil Classification System.

7. Using an organic vapor analyzer to determine background air quality and quantify the presence of organic vapor in the soil samples.

8. Purging the monitor wells and piezometers and collecting samples for chemical parameter testing. Six such sampling rounds were planned. In the second sampling round, a volatile organic compound (VOC) scan was to be completed.

9. Testing the groundwater samples to provide data on the following parameters: water temperature, pH, conductivity, COD, BOD, dissolved iron, hardness, alkalinity, nitrogen as nitrite, nitrogren as nitrate, nitrogen as ammonia, barium, chloride, sulfate, chromium, mercury, lead, cadmium and arsenic.

10. Completing soil borings and laboratory testing to evaluate the thickness and suitability of the soils used for the landfill cap.

11. Completing a hydrogeologic report that summarizes the findings of the investigation. Included with this report would be an estimate of the plan area of the landfill, geologic profiles and cross-sections through the landfill, a topographic map, a groundwater contour map with flow directions, an assessment of groundwater degradation and recommendations for additional remedial investigation and remedial action (if necessary). Also to be included with the report were the boring logs, well installation sketches, well development data and the safety and health protocol used on the project.

During the course of the soil borings in the fall of 1986, it became apparent that bedrock was deeper than anticipated. The scope of work was altered to accommodate anticipated additional soil drilling footage, soil sampling and well casing. The scope of work was also slightly altered in the fall of 1987 to accommodate a heavy metal and sulfate analysis of the section of the rock core obtained from the B1 observation well.

X. CONCLUSIONS

An analysis of the data obtained from this study allows us to conclude the following:

1. Geologically, the study area is comprised of glacial drift overburden underlain by Silurian Age dolomitic limestone bedrock. The drift deposits are composed of an upper layer of clay-silt till that extends from the ground surface or the base of the refuse fill to depths in the range of 10 to 20 feet. It appears that the refuse fill area is capped with and continuously underlain by this deposit which is moderately impervious to impervious. The clay-silt till is underlain by a deposit of outwash of variable thickness. The outwash is composed of gravels, sands, sands with trace to some silt, and silty sands. This deposit is moderately to highly permeable and appears to increase substantially in thickness to the south and west. However, it does not appear that the refuse fill has any direct hydraulic connection with this deposit. The outwash does appear to have direct contact with the underlying dolomitic limestone bedrock in the south-westerly portions of the study area. In other areas, the outwash is underlain by a very stiff to hard deposit of older clay till that increases in thickness to the north and east. It is expected that this deposit is impervious to very impervious. The dolomitic limestone bedrock appears to be slightly to moderately impervious indicating some hydraulically connected fracturing and joining. The study area bedrock is part of the Niagara aquifer and has a surface that appears to slope towards the north.

2. In the study area, surface water flow is generally to the south and east towards Lincoln Creek. An evaluation of the surface water quality at this site was not a part of this study.

3. The refuse deposit appears to be a relatively long, narrow body of fill with the long direction paralleling Lincoln Creek. The fill deposit necks down near B13 and also tapers down at its south end. The average east-west dimension is on the order of 400 feet with a

maximum north-south dimension of about 2,000 feet. We estimate a total volume of fill on the order of 200,000 cubic yards. The greatest thickness of refuse fill appears to be about 16 feet in area around and to the east of Boring B11 or approximately in the center of the area estimated to contain refuse fill. The average refuse fill thickness is about 7 feet. The borings indicated the refuse fill to be composed of a heterogenous mixture of glass, metal, cinders, paper, rags, wood, rubble and other miscellaneous materials that are also highly variable in both relative density and moisture content.

4. The shallow clay cap borings indicated that the material used for the cap is generally suitable for this purpose. The cap material can be characterized as a relatively impervious clay of low to moderate plasticity. However, the borings also indicated that the clay cap may not cover all areas of the refuse fill and in a number of areas is less than 2 feet in thickness. In addition, it appears that the surface of the clay cap is not adequately sloped to efficiently shed surface water.

5. Groundwater flows both southeast towards Lincoln Creek and south to southwest towards the U. S. Army Reserve Complex. These flow directions appear to be primarily a reflection of the natural surface water drainage patterns in the study area as the regional trend of groundwater flow is easterly towards Lake Michigan. Horizontal gradients appear to be greatest in the spring and fall and the slightest in the winter and summer months. Vertical gradients are occasionally zero but primarily downward, indicating recharge to the water table system. However, the quantity of recharge moving vertically through the clay tills is expected to be small. Groundwater elevations are generally highest on the northern part of the site and decrease to the south. Groundwater flow in the dolomitic limestone bedrock, based on the piezometer well observations, appears to follow a southerly flow trend similar to that observed for the observation wells.

6. Overall, groundwater quality appears to follow the same general trend as the groundwater contours with groundwater quality decreasing southeasterly towards Lincoln Creek and south-southwesterly towards the U. S. Army Reserve Complex. This appears to be an indication that the landfill in the study area may be having a negative impact on local groundwater quality.

7. Heavy metals appear to periodically occur in concentrations of concern in the piezometer wells and in the vicinity of the B7 observation well. It is possible, based on the B1 rock core chemical analysis, that the concentrations of heavy metals in the piezometer wells are related to natural mineralization in the dolomitic limestone bedrock. The trend of the heavy metal concentrations in the observation wells is generally the reverse of that observed for overall groundwater quality and flow directions. The relatively high and persistent heavy metal concentrations measured in the B7 observation well decrease to the south and west. This seems to indicate that the source of the heavy metals is in the immediate vicinity of the B7 well. It is possible that during high water levels, Lincoln Creek is discharging heavy metals from a source upstream to the B7 observation well. Alternatively, the heavy metals could be coming from the refuse fill during periods of low stream flow.

8. A component of groundwater flow does pass southeasterly through the landfill site towards Lincoln Creek. The borings indicate that the native clay-silt till layer beneath the landfill is laterally and vertically continuous. If this is indeed the case, we would not expect that potential contaminants are migrating vertically out of the bottom of the refuse and through the clay-silt till. However, it is possible that local defects in the clay-silt till exist that would facilitate vertical contaminant migration. It is also possible that insufficient lateral barriers to contaminant migration exist between the refuse fill and Lincoln Creek. This would allow potential contaminants to discharge directly to Lincoln Creek during periods of falling water levels and/or low flow.

9. Three volatile organic compounds were detected in concentrations above enforcement standard levels in three different wells during sampling round 2. Because the VOCs were analyzed for only a single sampling round, it is difficult to reach any conclusions regarding the impact that the landfill may be having on the VOCs detected. In addition, many of the VOCs analyzed had detection limits above the ES and PAL so that that the data provided is of limited interpretive value. The TLV analysis indicates a trend for VOCs to increase to the south-southwest towards the U. S. Army Reserve Complex.

10. Non-volatile organics and biological sources of pollution do not seem to be of significant impact at this site and do not show any strong correlation with the presence of the refuse fill. There may be periodic increases in concentrations of these types of materials during rising water levels and high flow conditions along Lincoln Creek as evidenced by test results in the B7 observation well.

11. Site groundwater pH appears to be naturally buffered by the dolomitic limestone bedrock underlying the study area and an abundance of this rock-type present in the overlying glacial drift.

12. When compared with mean values from leachate collected from 20 municipal solid waste sites, groundwater in the Havenwoods study area is, in general, substantially lower in alkalinity, BOD, COD, calcium, iron, nitrogen as ammonia, chloride, hardness and total dissolved solids (as indicated by specific conductance). The study area groundwater is substantially higher in concentrations of lead and sulfate. The study area pH is also significantly higher.

XI. RECOMMENDATIONS

Based on the information and data obtained for this study, we are of the opinion that additional site studies are warranted to better evaluate and define the following:

1. The lateral and areal extent of the refuse. This should be done with additional borings located on a 100' x 100' grid system based on the boundary of the refuse fill area as estimated in this report. This would result in approximately 50 borings. The borings should extend through the refuse and into the clay-silt till to verify the till's presence but without penetrating the till. The borings would also provide additional information on the thickness and areal extent of the clay cap. It would be of particular interest to know the condition of the cap in the area adjacent to Lincoln Creek. Some of the samples of refuse obtained from the borings should be submitted for chemical parameter testing. The samples should also be subjected to TLV field analysis and the values compared with those noted for this study.

2. Surface water quality. A surface water sampling and testing program should be established for Lincoln Creek. This should include creek locations above and below as well as adjacent to the landfill.

3. High concentrations of heavy metals in B7. Two additional observation wells should be installed in the vicinity of the B8 and B13 borings, adjacent to Lincoln Creek. A sampling and testing program should be established for the groundwater in these wells.

4. Groundwater flow directions and background groundwater quality. An additional observation and piezometer well nest should be located in the northeasterly corner of the study area. It is anticipated that this area will be upgradient from the landfill site. Thus, groundwater chemical parameter data obtained from these two wells would be helpful in verifying our groundwater contour and flow direction analysis and serve as an additional source of background groundwater quality data. The piezometer well could also provide additional information on the elevation of the top of the dolomitic limestone bedrock.

5. Bedrock heavy metal concentrations. Additional sections of rock core from the B1, B3 and B5 borings should be tested for heavy metal concentrations. Consideration can be given to evaluating heavy metal concentrations from the rock core when samples are exposed to various aqueous solutions within the pH range of 6.5 to 8.5 for a specified length of time. In addition, soil and rock samples obtained from any future borings should also be checked for heavy metals. Further investigation is also warranted on the relatively high heavy metal concentrations measured in the B1 rock core and the apparent lack of sulfate. The presence of both heavy metals and sulfate would have been an indicator of sulfide mineralization. Such mineralization is a naturally occurring source of a variety of metallic substances.

6. Fluctuations in chemical parameter concentrations. An ongoing water sampling and testing program should be established for the wells in the study area to continue to build a data base for the evaluation of the impact the landfill is having in this area.

Pending the outcome of the recommended additional studies, remedial action alternatives that can be considered for the refuse fill deposit in the study area include:

1. Stripping the refuse fill area of all vegetation and constructing an additional minimum 2-foot thick clay cap over the entire fill area. The cap should be crowned so as to efficiently shed surface water.

2. Constructing a 5-foot thick containment barrier built with clay around the entire perimeter of the refuse fill area. This clay barrier would be keyed at least 2 feet into the underlying native silt-clay till. The refuse fill would also be provided with an additional minimum 2-foot thick clay cap. Any leachate subsequently generated by the refuse fill would be routed to internal drain pipes for collection in sump. The sump would be periodically pumped for disposal of the leachate at a licensed treatment facility. This alternative should provide a positive contaminant containment system for the entire refuse fill area.

3. All of the existing refuse fill could be excavated and moved to an approved off-site landfill area.

4. The refuse fill could be excavated and relocated to another portion of the Havenwoods site that has been specifically prepared in accordance with currently accepted standards for on-land disposal of municipal refuse.

XII. CLOSURE

This report has been prepared for the exclusive use of our client, the Wisconsin Department of Admistration, for evaluation of the Havenwoods site and for possible future studies and remedial action planning purposes. The recommendations are applicable only to the project as described. This report may contain insufficient information for application other than as herein described. We appreciate participating in this project. We are available to review this report in detail with you and to provide proposals for additional study. Any questions or comments pertaining to the study should be directed to Miller Engineers.

Prepared by,

MILLER ENGINEERS

Anthony R. Pawlosk, P.E.
Chief Geotechnical Engineer

John H. Sigwart, P.E.
Chief Civil Engineer

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