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Snohomish County

Public Works
Solid Waste Management
Environmental Services

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December 14, 1998

Department of Ecology
Northwest Regional Office
Attn: Mary O'Herron, WDOE-TCP
3190 - 160th Ave. S.E.
Bellevue, Washington 98008

RE: McCollum Park Annual Report (QM-12), 1998

Mary,

The quarterly samples for QM-12 were collected and analyzed per the Compliance Monitoring Plan (CMP) for the McCollum Park/Emander Landfill (Figure 1). Attached to this report is QM-12's electronic laboratory and field data in tabular form (Excel 5.0 format).

All samples were collected by Snohomish County employees (except the Heatherwood Drive sample collected by a Snohomish Health District employee) without incident from 9/9/98 to 9/10/98 following the procedures listed in the Snohomish County Environmental Monitoring Manual (EMM). After measuring water levels, the wells were purged, field tested, and sampled using properly decontaminated and calibrated equipment. All wells were purged three pore volumes (or dry) before being sampled. Samples were properly preserved, placed on ice, and shipped maintaining proper chain of command procedures.

HYDROLOGY

Water depths were converted to mean sea level (MSL) and plotted by hand on the site maps (see attached). The following is a brief synopsis of each map:

- Shallow Water Table Surface

  The shallow water table surface (Figure 2) appears to indicate a high water table in the vicinity north of the swimming pool near BH-8. Water is flowing in an easterly radial pattern from this location. The flow path curls clockwise towards the south-southwest and flows toward the wetland area near MMW-9.

- Deep Aquifer Potentiometric Surface

  The deep aquifer potentiometric surface (Figure 3) indicates a fairly uniform flow towards the south-southwest. In the southern portion of the landfill the flow pattern turns slightly concave.

Linear horizontal groundwater velocity and direction were also calculated by computer. Groundwater elevations and coordinates were fed into a program designed by In-Situ Inc. (WATER-VEL Version 2.21). The following assumptions were made for the modeling program:

- The upper portion of the aquifer was assumed to have an average isotopic horizontal hydraulic conductivity of 0.47 m/d and an effective porosity of 30.0% (DFRIR Volume 1, Section 5.4.3).
- The lower portion of the aquifer was assumed to have an average isotopic horizontal conductivity of 4.75 m/d and an effective porosity of 30.0% (DFRIR Volume 1, Section 5.4.3).

The shallow (Table 1) and deep (Table 2) aquifer results closely match the hand-drawn maps. The shallow water table surface was calculated to have an average flow rate of 2.06 m/yr at 210.29°. The deep aquifer potentiometric surface was calculated to have an average flow rate of 5.60 m/yr at 203.60°.

GROUNDWATER CHEMICAL DATA QUALITY

Please note the following VOC hits in the QM-12 laboratory results:

1,2,4-Trimethylbenzene	BH-06	0.75	ug/L
1,2-Dichlorobenzene	BH-05	0.44	ug/L
	BH-06	0.60	ug/L
	BH-07	0.78	ug/L
1,4-Dichlorobenzene	BH-05	1.4	ug/L
	BH-06	1.0	ug/L
	BH-07	0.64	ug/L
Benzene	BH-05	1.4	ug/L
	BH-06	12	ug/L
	BH-07	5.9	ug/L
	MMW-17	0.23	ug/L
Chlorobenzene	BH-05	5.1	ug/L
	BH-06	2.0	ug/L
	BH-07	2.2	ug/L
Chloroethane	BH-06	0.49	ug/L
	MMW-09	0.30	ug/L
	MMW-16	1.1	ug/L

	MMW-18	2.6	ug/L
Chloroform	MMW-10	0.40	ug/L
Chloromethane	BH-06	0.24	ug/L
cis-1,2-Dichloroethene	BH-05	0.22	ug/L
	BH-06	0.62	ug/L
	BH-07	0.84	ug/L
	MMW-16	1.7	ug/L
	MMW-17	0.29	ug/L
Dichlorodifluoromethane	BH-06	0.87	ug/L
	BH-07	3.0	ug/L
	MMW-14	0.38	ug/L
	MMW-16	0.40	ug/L
	MMW-18	1.3	ug/L
Ethylbenzene	BH-06	1.2	ug/L
Diethylphthalate	BH-07	2.1	ug/L
Isopropylbenzene	BH-06	3.9	ug/L
	BH-07	0.69	ug/L
m,p-Xylene	BH-06	0.82	ug/L
n-Butylbenzene	BH-06	0.33	ug/L
	BH-07	0.67	ug/L
n-Propylbenzene	BH-06	0.55	ug/L
Naphthalene	BH-06	3.0	ug/L
o-Xylene	BH-06	4.4	ug/L
sec-Butylbenzene	BH-06	1.2	ug/L
	BH-07	3.2	ug/L
tert-Butylbenzene	BH-06	0.27	ug/L
	BH-07	0.70	ug/L
Toluene	BH-06	1.6	ug/L
Trichloroethene	BH-07	0.21	ug/L
Vinyl Chloride	BH-06	0.36	ug/L
	BH-07	1.4	ug/L
	MMW-09	0.28	ug/L
	MMW-16	14	ug/L
	MMW-18	29	ug/L

Please note the following general chemistry laboratory results in the QM-12 data:

Alkalinity	BH-05	250	mg/L $CaCO_3$
	BH-06	250	mg/L $CaCO_3$
	BH-07	640	mg/L $CaCO_3$
	MMW-09	270	mg/L $CaCO_3$
	MMW-16	430	mg/L $CaCO_3$
	MMW-18	860	mg/L $CaCO_3$
Ammonia-N	BH-07	60	mg-N/L
Bicarbonate	BH-05	250	mg/L $CaCO_3$
	BH-06	250	mg/L $CaCO_3$
	BH-07	640	mg/L $CaCO_3$
	MMW-09	270	mg/L $CaCO_3$
	MMW-16	430	mg/L $CaCO_3$
	MMW-18	860	mg/L $CaCO_3$
Chloride	BH-07	52	mg/L
	MMW-18	33	mg/L
$N0_3 + NO_2$ - N	MMW-10	4.7	mg-N/L
	MMW-11	3.2	mg-N/L
	MMW-13	3.5	mg-N/L
	MMW-15	2.4	mg-N/L
	HTHWD	2.2	mg-N/L
pH	MMW-11	5.8	SU
Specific Conductance	BH-05	530	umhos/cm
	BH-06	600	umhos/cm
	BH-07	1400	umhos/cm
	MMW-09	500	umhos/cm
	MMW-16	710	umhos/cm
	MMW-18	1400	umhos/cm
Sulfate	BH-05	24	mg/L
	BH-06	72	mg/L
	BH-07	601	mg/L
TDS	BH-05	500	mg/L
	BH-06	310	mg/L
	BH-07	700	mg/L
	MMW-09	320	mg/L
	MMW-12	320	mg/L
	MMW-16	500	mg/L
	MMW-17	400	mg/L
	MMW-18	930	mg/L
	HTHWD	320	mg/L
TOC	BH-07	25	mg/L

Please note the following dissolved metals analyses from the QM-12 sample round:

Arsenic	MMW-16	0.014	mg/L
	MMW-18	0.014	mg/L
Barium	BH-07	0.743	mg/L
Calcium	BH-05	61.8	mg/L
	BH-06	31.5	mg/L
	BH-07	101	mg/L
	MMW-16	69.0	mg/L
	MMW-18	105	mg/L
Copper	HTHWD	0.388	mg/L
Iron	BH-05	0.87	mg/L
	BH-06	3.59	mg/L
Magnesium	MMW-18	114	mg/L
Manganese	BH-03	1.34	mg/L
	BH-05	5.14	mg/L
	BH-06	3.55	mg/L
	BH-07	9.92	mg/L
	MMW-16	3.37	mg/L
	MMW-17	1.98	mg/L
	MMW-18	3.66	mg/L
Potassium	BH-07	48.6	mg/L
Sodium	BH-07	43.6	mg/L
	MMW-18	76.2	mg/L

Please note the general increase in VOC hits and concentrations. Contaminants are being detected in the deep downgradient wells in concentrations comparable (and higher) to those in the upper water table despite the low vertical gradient as reported in the Draft Final Remedial Investigation Report, McCollum Park/Emander Landfill, Snohomish County, Washington, Volume 1, January 1996 (DFRIR). This indicates there *is* a vertical flux of water passing through the Vashon Advance Outwash (Qva) and the Esperance Sand (Qve) directly under the landfill.

STATISTICAL CALCULATIONS

Snohomish County is required to perform statistical analyses of groundwater data using WDOE approved methods. These analyses were not completed using MTCAStat for several reasons:

- It is unclear if our dataset is entirely compatible with MTCAStat. Some translation of data may be required.
- Due to the large number of monitored parameters it is extremely time-consuming to statistically analyze all constituents.
- The MTCAStat program has some apparent "bugs" that may effect performance.

All groundwater chemistry data was statistically analyzed using a scientific program called DUMPStat (Downgradient Upgradient Monitoring Program Statistics). This proprietary program is capable of storing, analyzing, and reporting large amounts of data in an efficient, accurate manner. The program has few user adjustable parameters to reduce the likelihood of possible errors introduced by the data analysis. The following is a brief description of the program.

DUMPStat is an artificial intelligent computer program that, with minimal input regarding the monitoring well network and required monitoring constituents, can provide a complete statistical analysis of all existing site data automatically. The primary advantages to the DUMPStat algorithm are: 1) the user need not configure calculations to provide a statistically rigorous analysis of routine monitoring data; 2) both site-wide false positive and false negative rates are optimally balanced at minimal levels; and 3) site-wide false positive and false negative rates can be directly computed via simulation of 10,000 monitoring events from that facility based on existing site-specific conditions. Most importantly, all statistical methods provided in DUMPStat are permitted under the Subtitle D regulation (i.e., prediction limits and control charts) and are specifically referenced in the U.S. EPA guidance.

POWER CURVE

Each time the DUMPStat program calculates statistics on groundwater data it is also capable of performing a statistical power curve. This power curves represents two tests that: 1) determine the site-wide false positive rate (i.e., the percentage of failures when the background versus current true mean difference equals zero); and 2) determine the false negative rates for effect sizes ranging from 1 to 5 standard deviation units. A power curve will be provided for the latest testing period (Figure 4). The vertical scale (Y-axis) represents two different percentage ranges depending upon the value of the standard deviation (S.D.) unit. When the S.D. is equal to zero, the Y-axis represents the site wide false positive rate. If the S.D. is greater than zero, then the Y-axis represents the false

negative rate. This chart provides a graphical representation of the statistical power provided by the given statistical methods.

All general chemistry data was statistically analyzed using DUMPStat after careful QA/QC procedures. The program performed the following subroutines during analysis:

- Screened data for outliers
- Computed detection frequency
- Detected historical trends
- Selected optimal form of prediction limit

The program reports statistical results via two outputs: 1) tables that summarize the population (N), mean, standard deviation (SD), factor, and intra-well prediction limit; and 2) graphs that summarize data and statistical results. Both of these outputs are included in this report (Appendix A). A summary section that summarizes statistical failures is also included (Appendix B).

Graphs that indicate a failure (i.e., have a stamp marked "FAILURE") can be caused by several conditions. Any type of failure is cause for concern, but these are especially important because they are statistically significant.

- Verified Hit in Results: This type of failure indicates that two consecutive samples were over a prediction limit (when a one of one re-sampling protocol is being used).
- Significant Trend in Background Data: This type of failure indicates that a statistically significant long-term upward trend is indicated. It is considered a failure even if the data is below a prediction limit.
- Nonparametric Limit: This type of failure indicates that a nonparametric prediction limit was exceeded by a sample. This type of failure does not require verification to be considered a failure.

Graphs that include data that have exceeded an intrawell prediction interval but have not been verified are potential candidates for failure (i.e., have a stamp marked "WARNING"). If the subsequent sample result is also above the intrawell prediction interval the location will fail the 1 of 1 verification resampling plan.

WATER CHEMISTRY SUMMARY

The water chemistry results for McCollum Park are difficult to interpret for a number of reasons. First, the site has a complex geology that displays heterogeneity. Second, wells are not evenly distributed across the site and some constituents do not have a sufficient number of samples to statistically analyze. Third, past landfill operations present several possible pollutant sources.

Some of the monitored constituents exceeded the selected cleanup levels (Appendix C) in the CMP, Table 1, February, 1996. In addition, some VOC compounds were detected Appendix D). Following is a summary of statistical failures, cleanup level failures, and VOC hits at the McCollum Park facility grouped by aquifer unit.

SHALLOW WELLS

BH-03 - All parameters in this shallow downgradient well were within acceptable statistical limits. The only MTCA cleanup level failure during the past quarter was dissolved manganese. Dissolved manganese is found in most shallow and deep downgradient wells. This contaminant is commonly associated with landfills and is probably originating as a non-point source from refuse.

BH-05 - All parameters in this shallow downgradient well were within acceptable statistical limits. The only MTCA cleanup level failure during the past quarter were dissolved iron and manganese. These contaminants are commonly associated with landfills and are probably originating as a non-point source from refuse.

BH-06 - All parameters in this shallow downgradient well were within acceptable statistical limits except dissolved iron. This parameter is once again demonstrating a significant trend in background data and has now been a verified hit over a prediction interval. Benzene, dissolved iron, dissolved manganese and vinyl chloride exceeded MTCA cleanup levels during the past quarter. Dissolved iron and manganese are found in most shallow and deep downgradient wells. These contaminants are commonly associated with landfills and are probably originating as a non-point source from refuse. The benzene and vinyl chloride hits probably originated from the sludge and liquid wastes in the landfill that were subsequently solidified. It may take some time for these contaminant levels to decrease as the plume slowly dissipates.

BH-07 - All parameters in this shallow downgradient well were within acceptable statistical limits except dissolved calcium and dissolved sodium. These contaminants are commonly associated with landfills and are probably originating as a non-point source from refuse. The only MTCA cleanup level failures during the past quarter were benzene, dissolved iron, dissolved manganese, specific conductance, and vinyl chloride. The dissolved iron, dissolved manganese, and specific conductance are probably originating from a non-point source as these constituents are common leachate compounds. The benzene and vinyl chloride hits probably originated from the sludge and

liquid wastes in the landfill that were subsequently solidified. It may take some time for these contaminant levels to decrease as the plume slowly dissipates.

BH-08 - All parameters in this shallow upgradient well were within acceptable statistical limits. There were no MTCA cleanup level failures in this well during the past quarter.

MMW-09 - All parameters in this shallow downgradient well were within acceptable statistical limits except dissolved manganese. This parameter is demonstrating a significant trend in background data. The only MTCA cleanup level failures during the past quarter were dissolved manganese and vinyl chloride. Dissolved manganese is found in most shallow and deep downgradient wells. This contaminant is commonly associated with landfills and is probably originating as a non-point source from refuse. The vinyl chloride hit probably originated from the sludge and liquid wastes in the landfill that were subsequently solidified. It may take some time for this contaminant level to decrease as the plume slowly dissipates.

MMW-10 - All parameters in this shallow upgradient well were within acceptable statistical limits. The only MTCA cleanup level failure during the past quarter was nitrate. This contaminant could be originating from any number of upgradient sources.

MMW-11 - All parameters in this shallow downgradient well were within acceptable statistical limits. The only MTCA cleanup level failures during the past quarter was dissolved iron. This constituent is probably originating from a non-point source as it is a common leachate compound.

INTERMEDIATE WELL

MMW-17 - All parameters in this intermediate downgradient well were within acceptable statistical limits. The only MTCA cleanup level failure during the past quarter was dissolved manganese. Dissolved manganese is a common leachate constituent and is probably originating as a non-point source.

DEEP WELLS

MMW-12 - All parameters in this deep downgradient well were within acceptable statistical limits. There were no MTCA cleanup level failures during the past quarter in this well.

MMW-13 - All parameters in this deep upgradient well were within acceptable statistical limits. There were no MTCA cleanup level failures during the past quarter in this well.

MMW-14 - All parameters in this deep upgradient well were within acceptable statistical limits. The only MTCA cleanup level failure during the past quarter was dissolved manganese. This contaminant could be originating from any number of upgradient sources.

MMW-15 - All parameters in this deep downgradient well were within acceptable statistical limits. There were no MTCA cleanup level failures during the past quarter in this well.

MMW-16 - All parameters in this deep downgradient well were within acceptable statistical limits. The only MTCA cleanup level failures during the past quarter were dissolved manganese, specific conductance, and vinyl chloride. Dissolved manganese and specific conductance are commonly associated with landfills and are probably originating as a non-point source from refuse. Once again, the vinyl chloride hit probably originated from the sludge and liquid wastes in the landfill that were subsequently solidified.

MMW-18 - All parameters in this deep downgradient well were within acceptable statistical limits. The only MTCA cleanup level failures during the past quarter were dissolved manganese, specific conductance, and vinyl chloride. Dissolved manganese and specific conductance are common leachate constituents and are probably originating as non-point sources. Once again, the vinyl chloride hit probably originated from the sludge and liquid wastes that were subsequently solidified. It may take some time for this contaminant level to decrease as the plume slowly dissipates.

MMW-19 - All parameters in this deep downgradient well were within acceptable statistical limits. The only MTCA cleanup level failure during the past quarter was dissolved manganese. This contaminant is commonly associated with landfills and is probably originating as a non-point source from refuse.

MMW-20 - All parameters in this deep downgradient well were within acceptable statistical limits. The only MTCA cleanup level failures were dissolved iron and dissolved manganese. These contaminants are commonly associated with landfills and are probably originating as a non-point source from refuse.

MMW-21 - All parameters in this deep downgradient well were within acceptable statistical limits. The only MTCA cleanup level failures during the past quarter were dissolved iron and dissolved manganese. These contaminants could be originating from any number of upgradient sources.

CONCLUSIONS

The flexible membrane liner (FML) has greatly reduced the amount of precipitation passing through the refuse to form leachate, however, it appears there is a substantial horizontal flow of water passing through the upgradient unlined sides of the landfill even during the dry season. Most of this flow surfaces downgradient of the landfill in the wetland area. Some flow is caught by the vertical component of water movement under the landfill and reaches the lower portion of the Outwash Aquifer in a relatively short horizontal distance. This indicates contaminants are continuing to reach the lower portion of the Outwash Aquifer despite the FML cover system.

The occurrence of VOC's in the deep aquifer have slightly increased during the past quarter. The benzene level in BH-07 has continued its upward trend since March 1995. When benzene is statistically analyzed in this well a significant trend in background data is calculated (Appendix E). It is likely this significant trend is correlated to the recent construction/closure of the site. Based on an average calculated transport time of 9.35 feet per year (DFRIR Volume 1, Section 5.4.3) it is probable this peak will occur sometime in 1999. The benzene levels in BH-05 and MMW-17 have apparently peaked and will hopefully continue to decrease with time.

Vinyl chloride concentrations in wells MMW-09 and MMW-16 appear to have peaked in May 1997. These wells have been trending downward since this apparent peak. Vinyl chloride concentrations in MMW-18 continues to trend slightly upward, but when vinyl chloride is statistically analyzed in this well a significant trend in background data is not found. Please note the vinyl chloride concentration in BH-07 increased substantially this quarter.

The metals and general chemistry concentrations also remained relatively stable over the past quarter. A nitrate concentration exceeding the MTCA cleanup level was detected in an upgradient well indicating an off-site source. Dissolved manganese is being detected in a large number of wells. Many locations are exceeding the cleanup level of 0.02 mg/L including MMW-14 and MMW-21. As these wells are generally outside the downgradient flowpath (based on the landfill footprint) it is likely that the background dissolved manganese levels already exceed cleanup levels. It is apparent, however, that the landfill is leaching dissolved manganese into the shallow, intermediate, and deep aquifers.

RECOMMENDATIONS

Based on the findings of twelve (12) groundwater monitoring rounds it is apparent some contamination of the shallow, intermediate, and deep aquifers has occurred due to contaminants leaching from the McCollum Park Landfill. The extent of this contamination appears to be limited to monitoring wells directly south of the landfill. Snohomish County proposes to focus future sampling efforts on key downgradient wells. By limiting the number of wells being sampled the site-wide false positive rate will be reduced which will provide more power to statistical analyses. Snohomish County proposes the following changes to the current groundwater monitoring program for 1999:

1. The following sample schedule will be followed:

Designation	Date
QM-13	December 1998
QM-14	March 1999
QM-15	June 1999
QM-16	September 1999

2. Groundwater elevations will continue to be collected each quarter.

3. Groundwater samples will be collected quarterly from the following shallow groundwater monitoring wells for the parameters listed in the CMP:

Well	Location
BH-08	Upgradient
BH-05	Downgradient
BH-06	Downgradient
BH-07	Downgradient

4. Groundwater samples will be collected quarterly from the following deep groundwater monitoring wells for the parameters listed in the CMP:

Well	Location
MMW-14	Upgradient
MMW-15	Downgradient
MMW-16	Downgradient
MMW-18	Downgradient

5. A groundwater sample will be collected from the domestic well on Heatherwood Drive during QM-16.

6. Quarterly update reports will be submitted detailing events at the site.

7. Quarterly performance monitoring data analysis reports will be submitted per the CMP.

8. An annual report will be submitted following QM-16 per the CMP.

Please let me know if you have any questions or comments regarding this report. I can be reached at (360) 668-6133 or faxed at (360) 668-3944.

Sincerely,

David Schonhard

David Schonhard
Environmental Monitoring Supervisor

cc: Ken Moser, Snohomish County, Solid Waste Division
Deanna Ritter, Snohomish Health District