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# Review of Ground-Water Monitoring Well Sampling Techniques, the pH "Issue", and the Wells Abandoned and Sealed

Concerned Citizens of Lake Township

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Concerned Citizens of Lake Township (CCLT)
1900 Mt. Pleasant N.E.,
Canton, Ohio 44721

Attn: Chris Borello

Re: Review of ground-water monitoring
well sampling techniques,
the pH "issue", and
the wells abandoned and sealed
summer 2004

Dear Concerned Citizens of Lake Township:

At the request of the Concerned Citizens for Lake Township (CCLT), Bennett & Williams has been asked to again revisit the Uniontown Industrial Excess Landfill (IEL) Superfund site, located in Uniontown, Ohio (Lake Township, Stark County). Bennett & Williams (B&W) first began evaluating this site in the early 1990s, has been involved in three court actions concerning the site, and drafted the Lake Township Comments on the Existing Public Record (1999) which was submitted on behalf of the Township to the US Environmental Protection Agency (US EPA). In addition, a member of our staff participated in teaching The Ohio State University Department of Food, Agricultural, and Biological Engineering's Biological Engineering course for five years, using the site as a field experience and the major group project for the class from 1999 through 2003. This review draws heavily from the information gathered and experience developed during these previous reviews of the site.

The request from CCLT this time is very limited. Bennett & Williams has been asked to review the "Low Flow" sampling techniques undertaken at the site from 1998 through 2001 (period of record of available information provided by CCLT). We originally reviewed the 1998 sampling round as part of the 1999 submittal to US EPA. We were asked to also review the "pH" issue that we first identified in the 1999 report to US EPA to see if it is possible to better understand the significant ranges of field pH measurements that are seen at some of the wells.

Our third assignment was to review the list of wells that were abandoned in the summer of 2004 to determine if the justifications given for the abandonment were valid and to recommend if any of the wells (well nests) need to be replaced.

## Introduction and Background of the Landfill

The Uniontown Industrial Excess Landfill is situated in an abandoned sand and gravel dry extraction pit located on the east flank of a kame that provides the high topography in Uniontown. This kame is part of the largest kame and kettle complex in the state of Ohio, covering parts of Stark, Summit, and Portage counties. The kame and kettle complex has been recreated with each passing glacial ice advance. The Illinoian-age ice sheets first covered this portion of the state. In some areas, the sand and gravel deposits are hundreds of feet thick. In the area of IEL, the glacial deposits approach 200 feet in thickness (Sharp 2003). The base of the sand and gravel dry excavation, the base of the landfill, and the uppermost static water table is controlled by the elevation of the water in Metzger's Ditch to the east of the landfill which also serves as the surface water drain for the Carlisle Muck (peat bog) kettle to the east of the landfill. A more detailed discussion of the physical setting of the landfill and surrounds can be found in the Bennett & Williams report to US EPA (1999).

It is important to remember when reviewing the IEL site that this site is **NOT** a modern landfill. It was simply a hole in the ground. The solid and liquid wastes disposed at IEL were dumped and poured into the old sand and gravel pit. The site covers approximately 30 acres and averages 45 feet in height. There are no liners and/or any type of separation between the wastes and the sands and gravels, which make up the floor and sidewalls of the landfill. The landfill contains a variety of materials. Household sanitary wastes and construction and demolition debris were placed in the landfill. Approximately one-third of the landfill is filled with coal ash from industrial boilers in the Akron/Canton area. This represents approximately 450 acre-feet of coal ash (30 acres x 15 feet). Coal contains heavy metals, many of which are radioactive. Burning the coal concentrates the metals, usually present in a positively charged ionic form. In addition, the fine clay mineral negatively charged particles that were in the coal also remain, providing a clay colloid transport mechanism for heavy metals to move out of the landfill and into the regional surface and ground water in a suspended solid phase (which can be removed by filtering water samples).

Originally, the greatest concerns were the tens of thousands of gallons of industrial solvents such as toluene and benzene, which were dumped into coal ash ponds in the landfill. Most of those Volatile Organic Chemicals (VOCs) have long since been washed out of the landfill and into the drinking water of the surrounding community. The occasional high benzene levels detected in some of the monitoring wells, most notably MW-13-S and MW-14-S, probably come from leaking barrels that have deteriorated. Since most of the VOCs were simply poured into the ground as liquids and/or the barrels were crushed to decrease the air space, these detected levels are just a residual of the levels that have washed out of the landfill into the drinking water of the homes in Uniontown in the 1960s, 1970s, 1980s, and early 1990s.

After closure, sands and gravel from the site were spread on top of the wastes, creating a permeable cover that allowed for extensive infiltration of precipitation into the landfill. Water entering the overlying sand and gravel covering is slowed as it leaches down through the landfill, creating a mounding effect in relationship to water levels surrounding the landfill. By 1999, Bennett & Williams estimated that as much as a **billion** gallons of precipitation had washed through the landfill. Since then, approximately 24 to 26 inches of participation a year continues to leach through the landfill cap, washing contaminants into the surrounding area and into the ground-water aquifer which, until the early to mid-1990s, supplied all of the water for all of the homes in Uniontown.

Until the current public water supply system was installed in the community in the early to mid-1990s, all the properties in the Uniontown area were served by private wells. This included homes and businesses, now destroyed, located on the northern border of the landfill and on the east side of Cleveland Ave., directly west of the unlined landfill. Most of these wells pumped for domestic supplies, but given the density of properties, the proximity to the unlined landfill, and the ground-water recharge through the open and then uncapped landfill, contaminants flushed out of the landfill and into the surrounding water supply for more than 30 years while the whole community was on private wells. Over that period of time, all of the "up gradient" wells had lower water levels on various dates than the wells surrounding the landfill, documenting a condition where contaminants from the site flushed into the surrounding kame and kettle deposits. There are no true "up gradient" wells in the area that can be used to determine true background chemistry. All of the surrounding kame materials have been flushed with contaminants from IEL. This condition is discussed in more length in the Bennett & Williams 1999 report to US EPA. The radial flow condition during the pumping of private wells is depicted in Figure 1. It is important to note that all of the important ground-water flow studies for the site were undertaken after the public water supply system was installed, so flow directions measured during those studies did not reflect the flow directions when all of the properties were still on wells.

## Evaluation of the "Low Flow" Sampling Efforts

According to the "Summary Report on the September 1998 Sampling Event, Industrial Excess Landfill, Stark County, Ohio", the ground-water sampling procedures were changed effective with this sampling event in order to incorporate the concept of low-flow sampling. Low flow sampling involves the careful monitoring and control of purge water, purge rate, water level, and water-quality characteristics to obtain analytical results representative of actual aquifer conditions. Instead of the traditional purging of three to five well volumes from a monitoring well prior to sampling, the low-flow method is not reliant on the volume of water removed, but rather relies on sample pump positioning, flow rate, and careful stabilization of ground-water quality parameters. Rather than complete removal of the standing water in the well column (which then allows only aquifer water to re-enter the well), low flow sampling relies on placing a well pump opposite a portion of the well screen and adjusting the flow rate being removed to equal the rate of water entering the well from the aquifer.

In conducting low-flow sampling, flow rate, parameter stabilization, and drawdown in the well are key measurements in order to determine if low flow sampling can be successfully used in a well. In addition, the well must be able to accommodate a pump. Frequently, one advantage of low flow sampling is that turbidity is typically less when compared to sampling methods such as bailing, which tends to agitate water in the well. Low turbidity is an advantage when sampling for inorganic parameters that are preserved with nitric acid in the field in that nitric acid has been documented in some cases to cause total metals concentrations to be artificially elevated. However, not all elevated metals concentrations can be attributed to the addition of nitric acid; colloidal particles with attached metals can be transported in ground water. Low flow sampling does not always reduce turbidity to desired levels of less than 5 NTUs unless extended pumping times are employed.

In order to understand the history of low flow at the site, we have prepared a history of low-flow sampling as it exists in the documents available at the time of this review.

> According to the September 1998 Summary Sampling Report,
>
> *"SHARP revised/updated the Groundwater Sampling Plan prepared by Earth Sciences Consultants, Inc., dated July 1998. This revised Sampling and Analysis plan was ultimately approved by USEPA.*
>
> *The Earth Sciences Plan was changed as follows:*
>
> - *Low-flow sampling procedures were to be used on some wells: an addition to the plan included decontamination procedures for low-flow equipment;*
> - *The addition to the plan included copies of SHARP'S field documentation forms; and*
> - *The addition to the plan included sampling parameter details and bottle/preservation requirements."*

The September 1998 Summary Sampling Report also indicates that the field sampling plan was revised based on discussions with USEPA to include the following:

- *"Using the EPA-developed Quality Assurance Project Plan (QAPP);*
- *Using CLP protocols for the analysis;*
- *Splitting samples with USEPA at approximately 40% of the wells;*
- *Recognizing that USEPA was sampling/analyzing 5 nearby residential wells;*
- *Collecting data on both filtered and unfiltered samples for metals."*

Then after site discussions with USEPA and Geraghty & Miller, the following additions were also made to the Sampling Plan:

- *"All groundwater samples will have field analysis conducted using HACH test kits for sulfide (Catalog Number 22445-00) and ferrous iron (Catalog Number 1037-69).*
- *All manufacturer recommended equipment calibration and quality assurance protocols will be followed and recorded in the daily log.*
- *All groundwater samples collected using the low-flow technique will have volumes collected for both total (unfiltered) and dissolved (filtered) Target Analyte List (TAL) inorganics analyses. An inline .45 micron filter manufactured by QED will be used to collect the filtered sample from each monitoring well.*
- *All groundwater samples collected for dissolved gas analytes will be analyzed by Microseeps, Inc. located in Pittsburgh, Pennsylvania."*

According to the 1998 Summary Sampling Report, *"Where possible, all of the wells were sampled with a low flow pump. In addition, five wells were sampled with a bailer (as in the past) as well as with the low flow pump."*

The Groundwater Sampling Plan dated July 1998 is included in the 1998 Summary Sampling Report as Appendix C. The Sampling Plan does not include criteria for stabilization of parameters prior to collecting a ground-water sample. However, the Sampling Plan does state that *"The low-flow techniques followed will be substantially similar to those procedures recommended in the procedural documents recently produced by USEPA Region I and USEPA Region 3, or the procedures recommended in "Low Flow (Minimal Drawdown) Ground-Water Sampling Procedures (Puls and Barcelona, 1996)."* The Sampling Plan also states that

*"Field parameters will consist of the following:*

- *Turbidity*
- *Dissolved oxygen*
- *Specific conductance*
- *Temperature*
- *pH*
- *Oxidation reduction potential*

Although the Sampling Plan does not contain parameters for stabilization, both Puls and Barcelona (1996) and the USEPA Region 1 document indicate that stabilization is reached when three successive reading three to five minutes apart show that the three successive readings are *"within ± 0.1 for pH, ±3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO."* If these are the criteria that were to be used, then the majority of the wells sampled never reached stabilization prior to sampling. Turbidity was the most frequent parameter that did not stabilize, but conductivity and DO also were not stabilized in some wells prior to sampling. Also, frequently readings were taken at intervals as small as one minute apart, thereby not allowing the parameters adequate time to stabilize.

Similarly, the Sampling Plan does not include criteria for determining an acceptable level of drawdown in the well. If the criteria in the USEPA Region 1 document were used, then the target drawdown should be less than 0.3 feet. This document also indicates that *"If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, continue purging until indicator field parameters stabilize"*. Once again, if the criteria are applied, then some wells had drawdown that exceeded the stated criteria. In one instance (MW-2D), parameters were measured every minute in order to "demonstrate" stability because in the 11 minutes that the well was pumped, the drawdown just began to exceed 0.3 feet.

By the November 2000 sampling event, SHARP had installed 26 QED P-1101 low flow sampling pumps and installed these dedicated pumps in 26 wells. In addition, *"SHARP purchased a non-dedicated low-flow sample pump (QED Sample Pro) and used it for low-flow sampling of all the other wells"*. The November 2000 Sampling Report Summary indicates that *"During purging and sampling, SHARP used a low-flow extraction rate (<1000 ml/min) and continuously monitored the water level using a water level indicator (Solinst) to ensure minimal drawdown"*. Further, *"SHARP determined that the water being removed from the well had achieved stabilization when three successive readings for water quality parameters agreed within +/- 10%"*. The Sampling Report also indicates that no samples were filtered in the field. However, there is a notation that radiological samples were shipped to the laboratory unpreserved, filtered in the laboratory and then preserved after filtration.

In general, the new pumping equipment utilized in November 2000 reduced the turbidity levels in the samples. For example, the highest turbidity recorded in MW-20D in December 2000 was 32.6 NTUs; in September 1998, the turbidity recorded when the sample was collected was 403.4 NTUs. The highest recorded turbidity at the time of sampling in December 2000 was in MW-23D at 83.8 NTUs. Most other wells were lower; several were 10 NTUs or less.

The new pumping equipment, however, did not address the stabilization of parameters as defined in the Sampling Report. There were several wells where turbidity did not stabilize within 10 percent. Dissolved oxygen similarly was not stable in some wells utilizing the stated criteria of within 10 percent. The typical pumping time for the wells was only ten minutes with readings of the field parameters taken typically at two minute intervals. In general, it appears as though the wells should have been pumped longer in order to reach stabilization and the readings taken at three to five minute intervals.

In March 2001, SHARP moved two of the dedicated pumps to wells MW-18S and MW-26I in anticipation of more frequent sampling in these wells. The report did not note the wells from which the pumps were removed. Also wells *"MW-13I, MW-14I and MW-15I were sampled using a micro bailer with a minimum of purging"* because pumps could not be lowered in the wells. The March 2001 Sampling Report indicates that field parameters were considered stable when *"three successive readings for water quality parameters agreed within +/- 10%"*. This is the same stated criteria as in November

2000. However, the March 2001 Summary Sampling Report has an added criterion in that *"After stabilization, SHARP continued to allow water to flow for at least 10 minutes before collecting a sample"*. The same notation about laboratory filtration for radioactive parameters is included in this report. Samples were collected only from 19 of the 26 wells that had dedicated pumps.

Although the field parameter sheets indicate that stabilization was reached in the field parameters and then readings were continued for another ten minutes, when the data is reviewed, stability was not reached in many cases as indicated. Further, stability was not reached in some of the wells even after the wells were pumped for an additional ten minutes. For example, MW-16I was reportedly stabilized after 12 minutes of pumping. However, the three consecutive readings for turbidity reportedly used to determine stability range from 53.9 NTUs to 125 NTUs. Clearly, these values are not within 10%. As the well was continued to be pumped, the turbidity kept decreasing and had reached 14.3 NTUs prior to sampling. However, the last three reported readings were 24.6, 16.9 and 14.3 NTUs. These readings are not within 10%. Therefore, even after ten additional minutes of pumping, turbidity had not reached stability. In addition, the readings continued to be taken at two-minute intervals instead of three to five minute intervals.

In May 2001, one noted sample collection change from the March 2001 sampling was at MW-13I, MW-14I and MW-15I. During March 2001, these wells were bailed because pumps could not be inserted into the wells. According to the May 2001 Summary Sampling Report, these wells *"were sampled using a micro ¾" low-flow pump with a minimum purge"*. Also, *"Two additional pumps were installed into wells MW-1D and MW-25I in anticipation of sampling these wells on a more-frequent basis"*.

Also, according to the *"dissolved oxygen probe associated with the unit did not operate properly. Although attempts were made to repair and replace the DO probe several times, SHARP was unable to collect reliable DO data during this sampling event"*. This sampling event also exhibits discrepancies in stability of field parameters in some wells, even though the wells were reportedly pumped for an additional ten minutes as in March 2001.

The September 2001 Summary Sampling Report indicates that well sampling procedures were essentially the same as for the March 2001 and May 2001 sampling events. No field sheets were available for review for this sampling event.

In summary, of the data available for review, it appears as though low flow samples have been collected since November 1998 unless a construction problem prevented the insertion of pumping equipment. All data post-1998 indicates that samples collected from wells for metals analyses have not been filtered. However, radiological samples have been filtered in the laboratory prior to preservation.

The techniques employed for low-flow sampling improved with the installation of dedicated pumps and low flow pumps beginning with the November 2000 sampling event. The use of dedicated pumps and the lower flows helps to minimize turbidity.

Lower turbidity is typically more representative of flow in an aquifer. Colloids, if present, remain in total metals analyses providing the sample is not filtered.

One persistent problem observed in the field data sheets is that the field parameters are not reaching stabilization within the prescribed "ten percent" variation specified in the Sampling Reports. The most frequently observed parameter that has not reached stability prior to sampling is turbidity, although others were also occasionally noted. Stability was noted not to have been reached in many wells, even though the wells were pumped for an "additional" ten minutes after the log sheet indicated stability had been reached. Also, the intervals measured for determining stability were most often two-minute intervals when three to five-minute intervals may have been more appropriate.

The result of the implementation of low flow sampling is that turbidity is reduced from previous sampling events. However, true low flow sampling has not been achieved because the field parameters are not stabilized prior to sampling. Based on the field data provided with selected sampling events, it appears as though stability could be achieved if the pumping time was increased prior to sampling. This improvement to the overall sampling methodology should be implemented.

## Reviewing the pH Question

The pH scale is the scale used to measure if something is acidic, alkaline, or neutral. On the pH scale, pure water is measured as the constant neutral point of seven (7.0). Materials that are acidic or liquid acids have pH values lower than 7.0. Materials that are alkaline or liquid alkalis have a pH above 7.0. The pH scale is a logarithmic scale. Each change of one point on the pH scale is 10 times more acid or alkaline than the point above or below. Scaling from neutral at 7.0, battery acid with a pH of 0 is 10 million (10,000,000) times more acid than pure water. Likewise, liquid drain cleaner, which has a pH of 14, is one millionth (0.0000001) as acid as pure water at a pH of 7.0.

In 1999, Bennett & Williams noted an unusual range of pH values being measured for the 1997 and 1998 sampling of the monitoring wells. The variation between the two sampling events with the amount of change was tabulated on Table 3 of that report, here included as Attachment 1. We noted that some of these ranges were excessive and that this issue needed to be addressed as part of the reopening of the US EPA Record of Decision (ROD).

The issue was never adequately addressed and with the closing of a number of the monitoring wells in the summer of 2004, the issue becomes even more critical to understand because many of the wells showing the greatest variation of pH ranges have been taken out of the active monitoring network. Many of these wells are now abandoned. The casings have been pulled and the boreholes grouted shut.

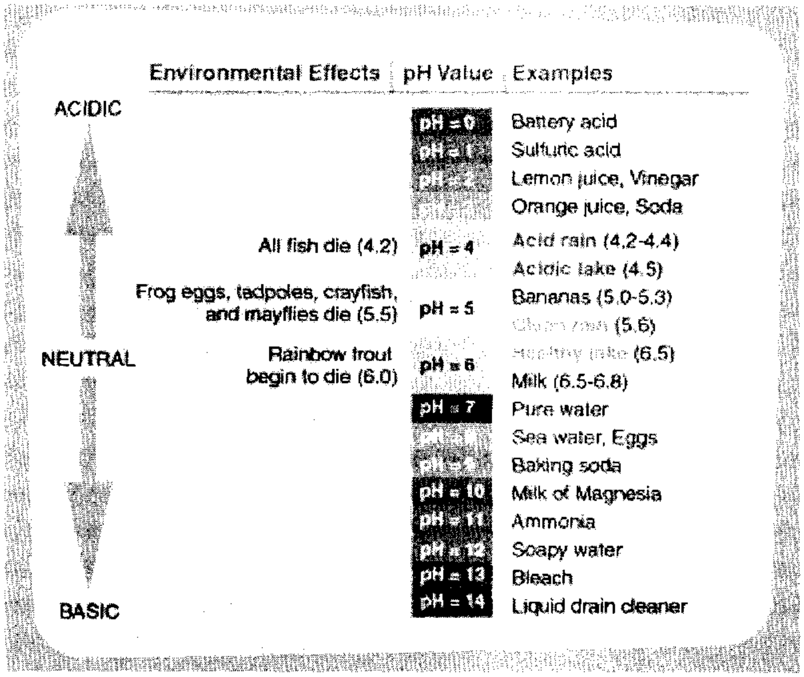

Figure 2: Graphic representation of the pH scale. Source: US EPA web page (http://www.eps.gov/acidrain/site_students/phscale.html).

Most of the monitoring wells around IEL have pH ranges in the 6.0 to 8.0 range. There are, however, several wells that exhibit significant variations to that range of numbers. Readings as low as 5.89 (MW-06-S) to as high as 12.41 (MW-09-D) have been measured between 1997 and 2001, during the various sampling events. This is a range of over six pH points on the pH scale or more than **ONE MILLIONTH** times less acid in the high pH well (MW-09-D) from the most acid reading in MW-06-S. Such an extreme range is **NOT** expected to be found in a natural setting.

As discussed in more detail in the Bennett & Williams 1999 report to US EPA, the natural setting around the IEL site (low-lime glacial deposits and acidic peat bogs overlying acidic sandstones, shales, siltstones, and coal measures) is expected to have a pH of 7.0 or below. Furthermore, the precipitation entering the landfill is expected to have a pH of 5.0 to 5.5. Therefore, any ground-water pH readings significantly above 7.0 are not expected to be naturally found in the area.

When pH ranges of 8.0 and above are encountered in ground-water samples at IEL, the three most common possible causes are 1) incorrectly functioning pH field meters, 2) ground water contaminated by leaching cement grout used to seal the monitoring well, and 3) materials placed inside the landfill that are alkaline in nature. To further evaluate the potential reason(s) for the high pH readings found around the site, the pH readings recorded in the 1999 report (B&W) were added to a listing of the original pH and final stable pH reading for each of the "Low Flow" stabilization process undertaken during sample taking. These high and low pH readings, along with the amount of change, are shown in Table 1.

A review of "Low Flow" sampling field records from 1998, 2000, and 2001 documented that only 13 of the 54 monitoring wells (24 percent) sampled from 1997 through 2001 during which pH readings were taken, had a pH reading above 8.0. Furthermore, two well nests of note, the MW-09 and MW-11 wells had the highest range. Wells sampled right before and right after "high pH wells" had pH readings in the more typical ranges. Because "high pH" readings were found in all the sampling events, and because wells with "high" readings one sampling round can be found with "high" pH ranges in subsequent sampling rounds, it appears that the widely fluctuating pH ranges are not attributable to equipment failure of the field pH meters used. This leaves the other two common causes to be evaluated.

Table 2 shows the wells (nests) that have pH readings above 8.0 on at least one occasion.

**Table 2**

**Well (Nests) with pH Readings above 8.0**

| Well ID | Highest Reading | No. of Times Exceeds 8.0 | Year(s) | Well Status |
|---|---|---|---|---|
| MW-01-I | 8.83 | 1 | Aug-00 | Retained |
| MW-02-D | 9.93 | 5 | Mar-97, Sept-98, Aug-00, Dec-00, Mar-01 | Abandoned |
| MW-03-D | 8.49 | 2 | Sept-98, Dec-00 | Abandoned |
| MW-09-I | 10.69 | 2 | Mar-97, Aug-00 | Contingency |
| MW-09-D | 12.41 | 4 | Sept-98, Aug-00, Dec-00, Mar-01 | Abandoned |
| MW-10-S | 8.04 | 1 | Sept-98 | Abandoned |
| MW-11-S | 9.44 | 1 | Sept-98 | Sentinel |
| MW-11-D | 11.51 | 3 | Sept-98, Aug-00, Dec-00 | Contingency |
| MW-16-I | 8.08 | 1 | Sept-98 | Abandoned |
| MW-20-S | 8.39 | 3 | Aug-00, Dec-00, Jun-01 | Retained |
| MW-23-S | 8.9 | 1 | Aug-00 | Retained |
| MW-23-I | 10.13 | 1 | Mar-97 | Abandoned |
| MW-26-I | 8.23 | 1 | Dec-00 | Abandoned |

Of the 13 wells exhibiting a pH of above 8.0, during at least one sampling event between March 1997 and September 2001, seven have been abandoned and sealed. Two are contingency wells, one is a sentinel well, and of the remaining three wells, none exhibited a pH above 8.0 in the September 2001 sampling event. Unless additional sampling events of these wells exhibited pH readings of above 8.0 and a water geochemistry analysis is performed, it will be difficult, if not impossible from this remaining set of wells, to determine whether the high pH readings at all the wells came from grout contamination or from materials within the landfill. Six of the abandoned wells, MW-02-D, MW-03-D, MW-09-D, MW-10-S, MW-23-I, and MW-26-I are claimed to be "Clean +10 years" on the Principal Responsible Party's (PRP) Table 8 "Inventory of IEL Monitoring Wells and Recommendations for their Disposition". On that same table, MW-16-I is noted to be "Clean +12 years". MW-16-I is being replaced with a completely new well in another location at the perimeter of the landfill so while the well will have the same basic identifier, the chemistry will be for a different location and the new chemistry will not be usable to answer the high pH readings for the old MW-16-I well. The high pH wells are identified in Table 3.

**Table 3**

**Location of "High" pH Well Nests**

| Well Nest No. | Location of Nest |
|---|---|
| MW-01 | On western edge of landfill fence |
| MW-02 | Northwest corner of landfill fence |
| MW-03 | Southeast portion of landfill |
| MW-09 | East side of landfill within the east boundary fence but near Metzger's Ditch |
| MW-10 | South of the southwest corner of the landfill fence, east of Cleveland Ave. outside the site boundary |
| MW-11 | West of the landfill fence and east of Cleveland Ave., within the site boundary |
| MW-16 | Northern part of landfill |
| MW-20 | East side of landfill just across Metzger's Ditch outside of site boundary |
| MW-23 | South of the landfill property |
| MW-26 | Among the homes west of Cleveland Ave., due west from the MW-11 nest |

It is important to note that the PRPs are claiming that the abandoned wells are "Clean" based, in part, on the fact that pH is not a Priority Pollutant (US EPA 2004) and therefore no Maximum Contaminant Level (MCL) for pH has been assigned for the site. However, levels above 7.0 are **NOT** natural in the area and the "safe" range of pH for Human Health consumption is a pH range of 5 to 9 (US EPA 2004). The two well nests MW-09 and MW-11 show the highest readings. In each case, only two of the three wells in the well nest show "high" pH readings. The MW-09 nest is directly east of the landfill between the landfill and Metzger's Ditch. The MW-11 nest is directly west of the landfill between the landfill and Cleveland Ave. With the exception of MW-26, all the well nests exhibiting pH readings higher than 8.0 are either within the landfill footprint, within the property boundary, or just beyond the property boundary in the area of radial flow. The well nest MW-26 is in the direct east to west regional flow path from the landfill. Therefore, the logical conclusion is that the "high" pH readings are from the landfill. Since all of the MW-11 wells are still open, it may be possible to undertake a definitive test of the three wells to determine if the source of the high pH readings is either grout contamination or the leaching of physical waste(s) in the landfill (or both) that is raising the pH. It may be necessary to install a new well at MW-09 and MW-23 to ascertain the reason for the high pH readings there.

*So Why the Concern?*

Metals mobilization is closely associated with pH, but it is not just low pH levels that can be associated with metals mobilization. If the pH measurement in the well is not representative of the aquifer pH because the pH reading has been masked by grout contamination, then the potential for metals mobilization into the surrounding surface and/or ground water may be significantly higher than expected based on the information being collected.

Conversely, the pH readings may be accurate indicators of leaching coal fly ash, concrete from construction sites and metal slags from the iron and steel industry of the region, all materials known and/or expected to be in the landfill. Water leaching through fly ash commonly has pH readings above 10; water leaching though concrete can have readings above 12; and metals slags can be equally as high ("Geochemistry of Extremely Alkaline (pH>12) Ground Water in Slag-Fill Aquifers", Roadcap and others 2005, Ground Water Vol. 43, No 6 pp 806-816 Nov-Dec 2005). Furthermore, while some metals do not go into solution when pH levels reach these heights, many of them form precipitates that can be weathered into colloidal-sized grains and flushed out through the sand and gravel walls and bottom of the landfill. Other metals do go into solution, such as boron, tin, lead, and vanadium. Still others require an oxidizing condition along with the high pH to be mobile, such as chromium, arsenic, cadmium, cobalt, copper, molybdenum, and nickel (Roadcap and others 2005). Remember this list as a number of these metals become important in the next section. A valid review of the situation should have been undertaken as part of the responses to comments at the reopening of the Record of Decision in 1999.

## The Abandoned Wells

The regulations for monitoring a landfill require that the "Uppermost Continuous Aquifer" must be monitored. Based on historic water well usage in Uniontown, at the IEL location, the "Uppermost Continuous Aquifer" is the sand and gravel. While the regulations do not preclude monitoring higher mounded and/or perched zones and/or deeper portions of the sand and gravel aquifer and/or the underlying bedrock, this monitoring is not required. The adherence to this requirement created the opportunity to abandon at least 33 monitoring wells at the facility and place five more into "Contingency" status. The two documents available to us for review that relate to this issue is the Summary Report on an Assessment of Individual Groundwater Monitoring Wells at the Industrial Excess landfill (IEL) Site and the Regional Hydrogeologic Setting (Sharp 2000, Rev. 2003) and the PRP's Table 8 "Inventory of IEL Monitoring Wells and recommendations for their Disposition (Sharp for the PRPs, date unknown).

In the 2000, rev. 2003 Sharp report, each well was investigated and selected or rejected as a representative of the uppermost aquifer. Wells that were rejected were then subjected to a screening to determine if they would be abandoned, placed in a contingency status, or placed in a sentinel status. Wells that had exhibited a long history of testing "clean" or wells that were not "representative" for whatever reason, could also be removed from the system. In the 2003 version of the Sharp report, Joseph Towarnicky, a Principal and Project Manager for Sharp and Associates Environmental Engineers and Scientists wrote to Timothy Fischer, Remedial Project Manager at US EPA on page one:

> *"Once a potentiometric surface of the uppermost continuous groundwater unit is prepared using those wells identified as most representative of this unit, the historic 'groundwater mound' is reduced to a flat-spot in the dominant regional east-to-west flow."*

Further, on page 8 of this same report, he wrote the following (**bolds are part of the original text**):

> ***"Once a potentiometric surface is prepared using those wells identified as most representative of the uppermost continuous groundwater unit, the historic 'groundwater mound' is reduced to a flat-spot in the dominant regional east-to-west flow."***

These statements directly paraphrase the comments made by Kim Stemen, Senior Project Geologist at Sharp and Associates in a December 12, 2000 letter report to Richard Laubacher, Goodyear Tire & Rubber Company where he stated on his cover page that:

> *"SHARP summarized its findings in this report and defines a list of wells that should be used in the future to generate an accurate potentiometric surface of the uppermost continuous groundwater unit. When these wells are used to construct a potentiometric surface map, the historic 'groundwater mound' is reduced to a flat-spot in the dominant regional east-to-west flow."*

This approach to establishing a new ground-water monitoring network years beyond the initial evaluation of the IEL site creates several significant breaches of logic. The following logic sequences demonstrate why a flat spot cannot exist at the site if all known information about the site is taken into consideration. These fundamental conclusions about the site can be reduced to a series of "*Given....Therefore*" and "*If...Then*" statements.

- *Given* that the IEL landfill, consisting of at least 33 percent coal ash, is situated in the side of a glacial kame comprised of sands and gravels, *therefore* the primary porosity of the waste is lower than the primary porosity of the surrounding in-situ materials. This means that water in the landfill is mounded.

- *Given* that water drains by gravity, more quickly through the surrounding in-situ materials than it does through the waste, *therefore* water moving through the waste mounds because of the retardation caused by the lower primary porosity in at least portions of the waste. (This condition has been mapped for years at the site using the data from the shallow and intermediate wells, most notably by the US Geological Survey). This means that water in the landfill is mounded.
- *If* a number of the shallow and/or intermediate wells were measuring water levels and water chemistry in perched zones that supported mounding, *then* the removal of these wells from the water levels and chemistry monitoring of the facility removes the ability to detect the water levels and the chemistry in the mounded area. Therefore, *it does not* remove the physical presence of the mounding or the chemistry previously documented by those mounded wells. This means that the mounded water in the landfill is still there, even though it can no longer be measured.

If, however, one assumes that the flat spot postulated by SHARP actually exists, then another series of logical assumptions must be made.

- *If* one accepts that there is no mounding under the landfill, *then* the landfill is leaching as fast as the surrounding sand and gravel which has been measured as draining as fast as *"greater than 12 inches per hour"* (Soil Survey Stark County Ohio, Christman and others 1971, USDA). Therefore, all the precipitation reaching the top of the landfill must flow through all of the wastes and out the bottom of the landfill.

By using this series of arguments, many soluble materials will have washed out of the landfill and into the uppermost continuous aquifer. Most of the VOCs will have leached out of the landfill. However, since rainwater has a pH of 5.0 to 5.5 and there is no natural significant buffer it present in the area, the metals and associated radiological materials will continue to flush out of the landfill with each precipitation event. Since there are still private wells being pumped in the area without "Low Flow" or filtration systems in place and there are still lakes, ponds, and wetlands to the west of the facility and Metzger's Ditch to the east of the facility, the potential still exists to complete the pathway for human and environmental exposures for contaminant transport out of the landfill. The risks to the public still exist. It is just no longer possible to determine how contaminated some of that ground water is because the wells monitoring the mounded area around the landfill have been abandoned and removed from the system.

In a number of cases, the arguments made for abandoning the wells were that the wells tested "clean" for some period of years. That information is contained in the Rationale section of the PRP's Table 8 "Inventory of IEL Monitoring Wells and Recommendations for their Disposition". Using a chemistry data base for IEL that was developed for a previous application (with permission, Ted Schribner, Aronson & Associates 2005), Bennett & Williams searched each well for exceedances of the MCLs for metals and alpha and beta radiation. In the case of the abandoned wells, VOCs were also searched to determine if these wells were "clean" as reported. The outcome of that screening is found in our Table 1 in the "Notes" section. We tabulated MCL violations only back as far as 1997 because we did not know what year the PRP's Table 8 was generated. Since the wells were abandoned and grouted in the summer of 2004, the March 1997 monitoring round was just over 7 years before that event. The last monitoring round for which we have data before that was March 1993, just over 11 years earlier than the possible date for the PRP's Table 8. Since many of the notations on the PRP's Table 8 claimed "Clean + 10 years", we decided not to use the older data for this tabulation. Table 4 summarizes the number of wells that were claimed to be clean and the number that actually were for each classification.

**Table 4. Monitoring Wells Claimed to Be Clean and Observed Status**

| *Monitoring Well Status* | *Number Claimed Clean* | *Number Actually Clean* | *Total This Category Above MCLs* |
|---|---|---|---|
| Abandoned Wells (33/34 with MW-08) | 18 | 3 w/pH<br>7w/out pH | 28 w/pH<br>24 w/out pH |
| Contingency Wells (5) | 5 | 1 w/pH<br>2 w/out pH | 3 w/out pH |
| Sentinel Wells (5) | 1 | 0 w/out pH | 3 w/out pH |
| Retained Monitoring Wells (15/4 New) | 11 | 1 w/out pH | 14 w/pH<br>13 w/out pH |

When Table 4 is reviewed, out of the total 35 wells claimed to be "clean" by the PRPs (Column 2), only 10 of them were observed to be "clean" without taking pH into consideration (Column 3). When pH levels were added as a screening factor, only 5 wells were observed to be "clean".

With regard to abandoned wells, according to SHARP, monitoring wells were removed from the system because a well:

- represented mounding conditions,
- was single cased through the landfill,
- was broken,
- was dry,
- was completed in Carlisle Muck (the peat bog),
- monitored a deep zone and/or
- was "clean".

Of the 33 wells that were abandoned, (the information on MW-08 is missing) 24 of these wells had MCL exceedances for metals, radiological parameters, or VOCs at least once since 1997 and 4 more exhibited excessive pH readings only. This means that 28 of the 33 wells were providing valuable information in the monitoring of the IEL site and are now gone.

Wells that were reporting important ground-water chemistry exceedances and conditions were destroyed. However, the only way that either Ohio EPA or US EPA could have recognized the importance of these monitoring wells was to create a ground-water chemistry database and screen each well. Typically, that is not done at either agency. The standard practice is to take the information presented by the consultants for the site as accurate and factual and, usually after asking for clarifications on some points, accept the report as truthful and accurate. This time, for whatever reason, the checks and balances broke down.

### *Why are the MCL Exceedances Important?*

Contaminants are leaving the landfill and moving into the surface and ground water of the region in levels that are above the MCLs. MCLs are a "measuring stick" commonly used to determine if a site is releasing contamination. While many of the monitoring wells that supplied that information are now abandoned and grouted with no ability to continue monitoring these releases (unless the wells are replaced), there is no reason to expect that the releases are no longer occurring just because the monitoring points are gone. The MCL exceedances fall into three classifications: metals, radiological parameters, and/or VOCs. Each set has a separate set of concerns and sources within the landfill. Because almost all common radiological materials are metals, with the exception of radon and hydrogen, which are gases, there is a natural subset of metals that are radioactive. All coal and coal ash generated in Ohio is radioactive. There are three natural uranium isotopic decay chains that decay uranium to lead. In addition, there are other "man-made" radioactive metal elements and a "man-made" Uranium decay chain that can be identified by a separate set of metal isotopes. Each decay chain is well documented and understood. We will not be discussing radiological issues in depth in this report; that is the subject of research by other scientists working for CCLT on this site. However, since radiological parameters have triggered MCL exceedances for both alpha and beta forms of radiation, we note the wells were these exceedances have been encountered.

Table 1 summarizes the parameters exceeding MCLs and the dates of sampling when those MCLs were exceeded. Metal MCL exceedances were recorded for antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, selenium, and thallium. In addition, MCL exceedances for nitrites and cyanide were also listed in this section because they are inorganic parameters. By far the most common MCL exceedances were for arsenic and lead. Reviewing this list against the list of common metals found to be soluble in high pH settings (Roadcap and others 2005), arsenic, cadmium, chromium, copper, and lead are common to both lists. Barium is noted to be insoluble at a high pH, but if forms a precipitate and that precipitate is mobile though the sand and gravel surrounding the landfill. In addition, all of the metals found in excess of MCLs are present in Ohio coals (Analyses of Ohio Coals, Botoman and Stith 1981, ODNR Div. Geological Survey) so one has to look no further than the approximately 450 acre/feet of coal ash in the landfill to find a source for all the metals that exceed the MCLs. Table 5 summarizes the metals that are above MCLs for each well since the March 1997 sampling event.

## Table 5

## Wells Exceeding MCLs for Metals Since 1997

| Well Class | Well ID | Metal | Dates | Total # 1990-2001 |
|---|---|---|---|---|
| Abandoned Wells | MW-03-S | Lead | Mar-97 | 1 |
| | MW-03-D | Arsenic | Sept-98 | 1 |
| | | Thallium | Mar-97 | 1 |
| | MW-04-S | Arsenic | Mar-97, Sept-98 | 8 |
| | | Cadmium | Mar-97 | 4 |
| | MW-05-S | Arsenic | Mar-97 | 6 |
| | MW-06-S | Arsenic | Dec-00 | 3 |
| | | Thallium | Dec-00, June-01 | 2 |
| | MW-07-S | Arsenic | Dec-00, June-01 | 2 |
| | MW-14-S | Arsenic | Mar-97, Dec-00, Mar-01, May-01, Sept-01 | 11 |
| | | Cadmium | Mar-97 | 1 |
| | | Thallium | Dec-00 | 1 |
| | MW-15-S | Thallium | Dec-00 | 1 |
| | MW-15-I | Arsenic | Mar-97 | 1 |
| | | Lead | Mar-97 | 1 |
| | MW-17-S | Arsenic | Mar-97, Dec-00, Mar-01, May-01, Sept-01 | 7 |
| | | Thallium | Dec-00 | 1 |
| | MW-17-D | Arsenic | Mar-97 | 1 |
| | MW-20-I | Arsenic | Sept-98 | 2 |
| | MW-20-D | Thallium | Mar-97 | 1 |
| | MW-24-S | Arsenic | Mar-97, Sept-98, Dec-00 | 4 |
| | MW-25-I | Cadmium | Mar-97 | 1 |
| | | Chromium | Mar-97, Dec-00 | 3 |
| | MW-26-I | Cadmium | Mar-97 | 1 |
| | MW-27-S | Arsenic | Sept-98 | 1 |
| | | Chromium | Sept-98 | 3 |
| | | Lead | Mar-97, Sept-98 | 3 |
| | | Thallium | Sept-98 | 1 |
| | MW-27-D | Arsenic | Sept-98 | 1 |
| | | Cadmium | Mar-97 | 1 |
| | MW-28-D | Cadmium | Mar-97 | 1 |
| | | Lead | Mar-97 | 1 |
| Contingency Wells | MW-01-D | Cadmium | Mar-97 | 6 |
| | MW-11-D | Arsenic | Sept-98 | 1 |
| | MW-21-I | Chromium | Sept-98 | 1 |

**Table 5. continued.**

| **Well Class** | **Well ID** | **Metal** | **Dates** | **Total # 1990-2001** |
|---|---|---|---|---|
| Sentinel Wells | MW-01-S | Arsenic | Mar-97 | 1 |
| | | Lead | Mar-97 | 1 |
| | MW-11-S | Chromium | Sept-98 | 2 |
| | | Lead | Mar-97 | 3 |
| | MW-21-S | Thallium | June-01 | 1 |
| Monitoring Wells | MW-10-I | Cadmium | Mar-97 | 1 |
| | MW-12-I | Cadmium | Mar-97, Sept-98 | 5 |
| | | Chromium | Sept-98 | 1 |
| | | Lead | Mar-97 | 3 |
| | | Selenium | Mar-97 | 1 |
| | | Thallium | Mar-97 | 2 |
| | MW-18-S | Arsenic | Mar-97 | 3 |
| | | Lead | Mar-97, Sept-98 | 7 |
| | | Thallium | Dec-00 | 1 |
| | MW-18-I | Chromium | Sept-98 | 2 |
| | | Thallium | Dec-00 | 1 |
| | MW-20-S | Arsenic | Dec-00 | 2 |
| | MW-22-I | Cadmium | Mar-97 | 1 |
| | | Lead | Mar-97 | 1 |
| | MW-23-S | Lead | Mar-97 | 4 |
| | MW-24-I | Chromium | Sept-98 | 2 |
| | | Lead | Mar-97 | 1 |
| | MW-26-S | Lead | Mar-97 | 1 |
| | MW-27-I | Arsenic | Dec-00 | 2 |
| | | Chromium | Sept-98 | 1 |

The number of contaminated wells and the number of separate metals and number of MCL exceedances are higher in the Abandoned Well set than any other set. Whether this underlying information was factored into the decision as to which wells were to be abandoned is not known. What is obvious from this process is that valuable monitoring wells that identified metals contamination moving out of the site were lost when the decision was made to abandon the wells in the summer of 2004.

Of specific note is the issue of thallium. In various documents, Sharp makes references to thallium as being a background contaminant coming from the bentonite in the grout and from clays. References are made to the fact that it is found in background wells (which is not possible to determine because there are no true background wells in the system). There is also information that indicates laboratory results were reported with a detection level above the MCL for thallium. For instance, in the Summary Report on the November 2000 Sampling Event (lab dates Dec-00), Sharp notes on page 7 that *"Thallium was detected in 13 wells at concentrations that ranged from 7.2 ug/L to 12.5 ug/L. These wells are located upgradient, on-site, and downgradient of the site".*

Furthermore they state *"The instrument detection limit for thallium was 7.1 ug/l. The MCl for thallium is 2 ug/l. Thallium is definitely present above the MCL in 13 wells and potentially present in all site wells."*

This set of comments is revealing. The PRPs are accepting laboratory detection limits that are above the MCLs. This in itself creates some serious problems when screening for exceedances of MCLs. The other perplexing logic problem is the claim that the thallium is from the bentonite and the naturally occurring clays. If this is true, then there should be thallium MCL exceedances all over Ohio where bentonite is used in the plugging and grouting of monitoring wells (and public supply water wells). Ohio EPA Northeast District Office indicated that thallium MCL exceedances are rare in this part of the state, but that part of the problem is that the MCL is so low that it is difficult to test.

However, at IEL, there are measurements of thallium that exceed the MCL by 5 to 10 times the MCL. Thallium is present in coals and coal ash. In a number of cases, the reported amount of thallium in coal ash is above the MCLs. Therefore, lacking massive thallium contamination patterns in monitoring wells all over Ohio and with documented levels of high thallium values in coal ash, the much more logical conclusion to be drawn is that the thallium, like the pH and most, if not all of the other metal exceedances, is moving in the ground water out of the landfill.

Wells have also shown MCL exceedances for alpha and beta radiation. This list is much shorter than the list for metals. Summarizing from Table 1, Table 6 gives a short reference to the monitoring system, wells affected, and the dates of the studies.

**Table 6**

**MCL Exceedances for Gross Alpha and Gross Beta**

| Well Class | Well ID | Metal | Dates | Total # 2000-2001 |
|---|---|---|---|---|
| Abandoned Wells | MW-12-D | Gross alpha | 2000 | 1 |
| | MW-14-S | Gross alpha | 2000, 2000? | 2 |
| | | Gross beta | 2000, 2000? | 2 |
| | MW-14-I | Gross alpha | 2000 | 1 |
| | MW-16-I | Gross alpha | 2000 | 1 |
| | MW-17-I | Gross alpha | 2000, 2001 | 2 |
| | | Gross beta | 2000, 2001 | 2 |
| | MW-26-I | Gross alpha | 2000, 2001 | 2 |
| Contingency Wells | MW-01-D | Gross alpha | 2000 | 1 |
| Monitoring Wells | MW-23-S | Gross alpha | 2000, 2000?, 2001 | 3 |

This summary table shows, once again, the "problem wells" are removed from the system when they are determined to be either mounded or deep and clean. The removal of the monitoring wells at these locations does not remove the conditions that permitted detections of alpha and beta radiation above the MCLs at these locations. It is only prudent to assume that the conditions that produced the MCL exceedances in 2000 and 2001 still exist at these locations and that radiological materials are moving out of the landfill and into the surrounding surface and ground waters, at least at these locations.

*Well (Nests) That Must Be Replaced or Reactivated*

Many of the wells that have been abandoned need to be replaced. The reasons for their replacements, however, are multiple. The wells that need to be replaced and the reasons are stated below. Some wells need to be replaced for several reasons.

- *Required Action.* Reinstall Monitoring Wells MW-04S, MW-05S, MW-06S, and MW-09S. Reposition MW-07S outside of the waste.
- *Why? Because they monitored the shallow ground water (completed in Carlisle Muck) that enters Metzger's Ditch and drains to the Tuscarawas River.* This contaminant transport route is now no longer monitored. This route has a direct exposure route to human receptors and is probably the most critical exposure route still in existence for the landfill. We have not evaluated if the NPDES permit for the site will duplicate this level of screening, but they usually do not.

- *Required Action.* Reinstall Monitoring Wells MW-03S, MW-03D, MW-04S, MW-05S, MW-06S, MW-07S, MW-12D, MW-13S, MW-13I, MW-14S, MW-14I, MW-15S, MW-15I, MW-16I, MW-17S, MW-17D, MW-20I, MW-20D, MW-24S, MW-25I, MW-26I, MW-27S, MW-27D, MW-28D.
- *Why? Because the PRP's claimed they were "Clean", when these wells were detecting parameters above MCLs.* By replacing these wells in the same locations and at the same depths where they were historically, it may be possible to recreate the pattern of observation that historically demonstrated contaminants leaving the landfill exceeded MCLs. These wells were mistakenly removed from the monitoring well network in the rush to "flatten" the mounding under the landfill site.

Remaining wells that still are present at the site, but are no longer monitored need to be returned to active monitoring status. The wells that need to reactivated and the reasons are stated below.

- *Required Action.* Reactivate and sample the following wells currently in "Contingency Well" status: monitoring wells MW-01D, MW-09I, MW-11D, MW-21I.
- *Why? Because these wells are documenting contaminants leaving the landfill in levels exceeding MCLs.*

- *Required Action.* Reactivate and sample the following wells in "Sentinel Wells" status: monitoring wells MW-01I, MW-11I, MW-21I

- *Why? Because these wells had exceedances of MCLs during the last 10 years of monitoring.* This information is vital to plotting the transport of contaminants out of the landfill.

## Additional Comments on the Sharp 2000 Rev. 2003 Report

A preliminary review of the Cross-Sections in this report revealed that, in several situations, the materials intersected in the boring logs DID NOT agree with the materials surrounding them in the sections. Cross sections are supposed to represent the spatial distribution of materials that are encountered in the borings. No explanation was provided as to why the materials in the borings were different than the materials surrounding them and/or on what basis, the surrounding materials were given a different description, since the collected data used to determine the cross sections should be derived from the boring logs. Examples of cross sections and borings that have discrepancies are presented below:

On cross-section # 3, borings 11-I, and 1-I are logged at the bottom of the sections as being completed in *"Fine grained clastics (silts and/or clays)"*, but the surrounding materials are mapped as either *"Carlisle Muck"* on the left side of 11-I (white) or *"Till"* to the right of 11-I and surrounding 1-I (brown). There are several other glacial stratigraphic units that can be described as 'fine grained clastics" without being glacial till. Unless there is more information that can be used to document that this is a correct correlation at these locations, the surrounding sections of the Cross-Section should be colored green, not white or brown.

A similar discrepancy exists on Cross-Section #4 at 1-I as well. Not only is the *"fine grained clastics"* section of the boring log surrounded with *"till"*, but so is the *"sand"* section of the bottom of the boring. If there is supporting information that collaborates this change in mapping, it should be footnoted on the drawings.

## Summary and Conclusions

### *Landfill Setting*

- The IEL landfill is a filled-in old sand and gravel extraction pit.
- The IEL landfill is not a modern landfill with liners, sidewalls, and a cover.
- Over one billion gallons of water have moved through the landfill since it first opened.
- Approximately 24 to 26 inches of precipitation a year still leach through the landfill and recharge the aquifer.
- There are no true existing upgradient wells at the site.
- The site has historically demonstrated a mounded radial flow pattern into the surrounding community.

### *Low Flow Ground-Water Sampling*

- Low flow sampling was designed to capture colloidal particles with attached metals previously lost by filtering the collected samples.
- Low flow sampling was implemented at the site in September 1998.
- After September 1998, samples were no longer field filtered.
- To achieve true low flow sampling, a series of field monitored parameters have to reach stabilization before the samples are collected.
- The field technique employed for low flow sampling has improved through the years. However, the field data sheets from the May 2001 sampling event indicate that samples were still collected before all field parameters reached stabilization.

### *The pH Question*

- The natural conditions at the landfill do not support pH readings in ground water above 7.0 at the site.
- A number of wells at the site, many of them now abandoned and sealed, had pH readings above 7.0 (as high as 12.41).
- Bennett & Williams recommended that the pH issue be investigated in the 1999 report to USEPA.
- The pH issue was never fully addressed.
- There are three probable causes of the "high" pH readings in some wells.
- One reason, a faulty pH meter, does not appear to explain the results.
- The "high" pH readings are caused either by grout contamination of the well or by naturally high pH waste materials in the landfill.
- Waste materials in the landfill with high pH values have been documented.
- The wells with the highest pH values have either been abandoned or removed from active monitoring status.
- With these wells no longer monitored, it is difficult now to determine whether the "high" pH values are caused by defects in the well installations or by migration of leachate from the high pH wastes.
- Because a number of metals found at the site are mobile in high pH conditions, it is important to understand the geochemistry of the water in order to understand contaminant migration to adequately monitor the site.

### *Abandoned Wells*

- It was postulated in site reports that many of the wells at the site were not monitoring the "Uppermost Continuous Aquifer" and should be removed from the monitoring network.
- During summer 2004, 33 of these wells were abandoned and grouted. Five more were placed in "Contingency Status"; three were placed in "Sentinel Well" status. These wells are also no longer sampled.
- Site reports claimed that 35 of all the wells at the site were "clean". One of the reasons for abandoning some monitoring wells was this "clean" designation.

- When the "clean" status was carefully reviewed as part of this work effort, it was determined that only 10 of these 35 wells were "clean".
- Reports postulated that the uppermost aquifer system under the landfill was not "mounded" but instead was "flat". The factual information known about the landfill does not support this conclusion.
- To accurately monitor the IEL site, a number of wells need to be replaced and/or reactivated.

*The 2003 Cross Sections*

- Several borings on two of the cross sections are placed into geologic stratigraphic units that do not agree with the descriptions on the logs. These should have been corrected or footnoted on the drawings to explain the discrepancies.

This concludes our review. If you have any questions and/or need further clarification, please do not hesitate to contact us.

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JWR/lka
Attachments (3)
I:projects:05-14:12-21-05 Existing Conditions Report

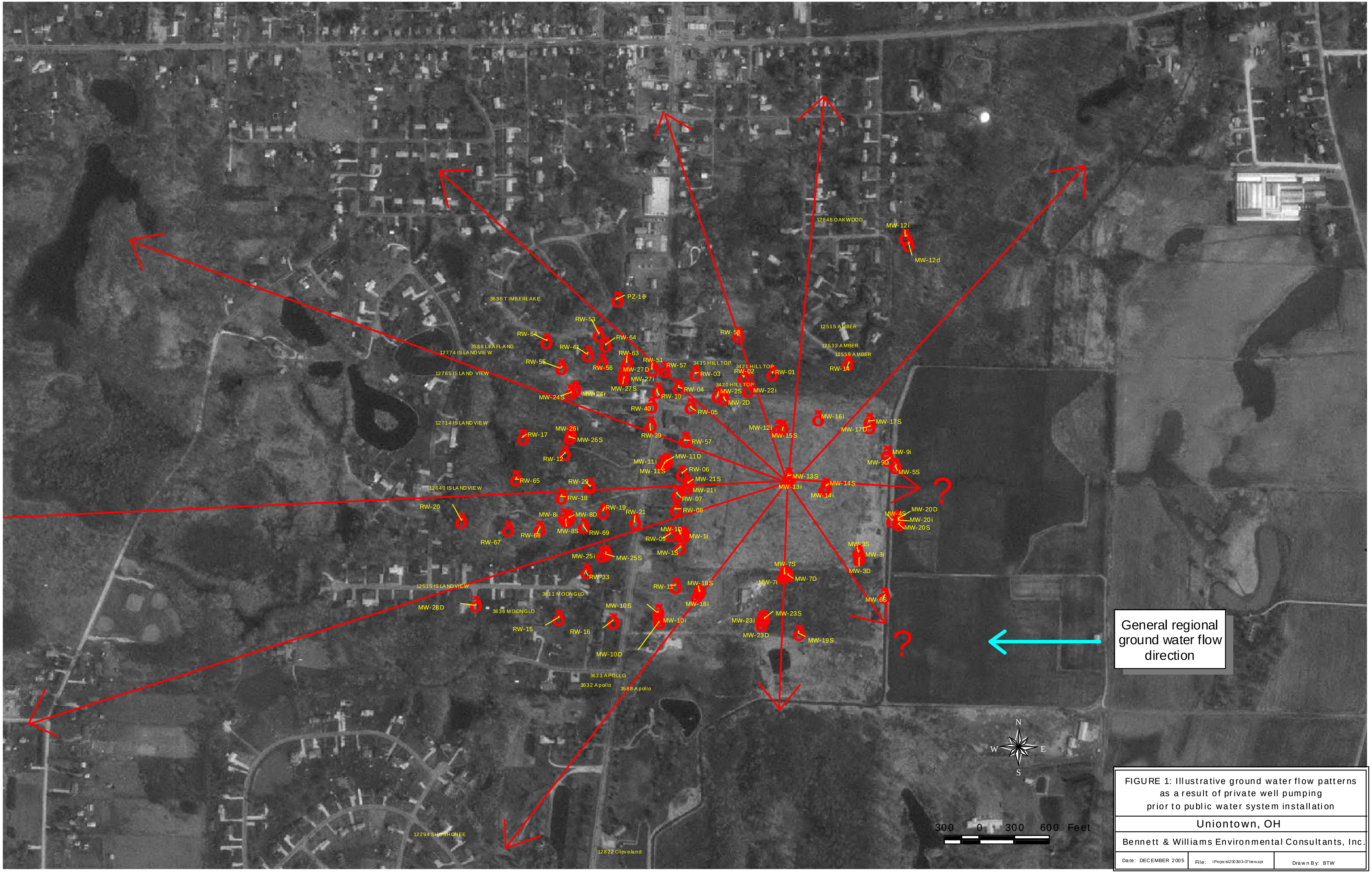

FIGURE 1: Illustrative ground water flow patterns
as a result of private well pumping
prior to public water system installation

Uniontown, OH

Bennett & Williams Environmental Consultants, Inc.

| | | |
|---|---|---|
| Date: DECEMBER 2005 | File: I:Projects\2003\03-07\new.apr | Drawn By: BTW |

## Table 1 - Status of Wells

After June 2004

| Well ID | pH Range Hi-Low | # Change | Parameter Above MCL | Metals Year (Recent) | Radioactivity - Alpha pCi/l > Detect | > MCL 5 pCi/L | Year | Radioactivity - Beta pCi/l > Detect | > MCL 50 pCi/L | Year | Parameter Above MCL | VOCs Year | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Abandoned Wells* | | | | | | | | | | | | | |
| MW-02-S | none | 0 | | | | | | | | | | | Sharp Report claims "Dry since 1988". No data on this well. |
| MW-02-D | 9.93 - 7.29 | 2.64 | Arsenic<br>Beryllium<br>Copper<br>Lead | Dec-91, May-92<br>Dec-92<br>Dec-91<br>Dec-91, May-92, March-93 | | | | | | | | | Sharp Report claims "Clean +10 years." Has excessive pH readings since 1997. |
| MW-03-S | 6.55 (1) | 0 | Arsenic<br>Lead | Dec-90, Aug-92<br>March-97 | | | | | | | | | Sharp Report claims "Clean +10 years". Exceeds MCL for Lead March 1997. |
| MW-03-D | 8.49 - 7.63 | 0.86 | Arsenic<br>Lead<br>Thallium | Sept-98<br>Dec-92<br>March-97 | | | | | | | | | Sharp Report claims "Clean +10 years". Exceeds MCLs for Arsenic Sept 1998 and Thallium March 1997. Has pH values above 8.0 since 1997. |
| MW-04-S | 7.11 - 6.22 | 0.89 | Arsenic<br>Beryllium<br>Cadmium<br>Lead | Aug-90, Dec-90, Dec-91, Aug-92, Dec-92, March-93, March-97, Sept-98<br>Dec-90<br>Dec-90, Dec-91, Aug-92, March-97<br>Aug-90, Dec-91, Aug-92, Dec-92, March-93 | | | | | | | | | Sharp Report states "Completed in Carlisle Muck". Exceeds MCLs for Arsenic March 1997 & September 1998, and Cadmiun March 1997. |
| MW-05-S | 7.17 - 6.45 | 0.72 | Arsenic<br>Cadmium | Aug-90, Dec-90, Dec-91, May-92, Aug-92, March-97<br>Dec-90 | | | | | | | | | Sharp Report states "Completed in Carlisle Muck". Exceeds MCL for Arsenic March 1997. |
| MW-06-S | 6.92 - 5.89 | 1.03 | Arsenic<br>Lead<br>Thallium | Dec-91, March-93, Dec-00<br>Aug-90, Aug-92, March-93<br>Dec-00, June-01 | | | | | | | | | Sharp Report states "Completed in Carlisle Muck", Exceeds MCLs for Arsenic December 2000 & Thallium December 2000 and June 2001. |
| MW-07-S | 6.79 - 6.16 | 0.63 | Arsenic<br>Cadmium<br>Lead | Dec-00, June-01<br>Dec-90<br>Dec-91, Dec-92 | | | | | | | Benzene | Dec-91 | Sharp Report states "Completed partly in waste and Carlisle Muck". Exceeds MCLs for Arsenic December 2000 and June 2001. |
| MW-08D | none | 0 | Cadmium<br>Lead | May-92, Aug-92, March-93<br>Aug-92, March-93 | | | | | | | | | |
| MW-09-S | 6.99 - 6.49 | 0.5 | Arsenic<br>Lead | Dec-90, May-92, Aug-92<br>Dec-90, May-92, Aug-92 | | | | | | | | | Sharp Report claims "Completed in Carlisle Muck". No MCL violations since 1992. |
| MW-09-D | 12.41 - 6.75 | 5.66 | | | | | | | | | | | Sharp Report claims "Clean +10 years". Excessive high pH and pH range in this well nest. |
| MW-10-S | 8.04 - 7.12 | 0.92 | Arsenic<br>Cadmium<br>Lead | May-92<br>Dec-90<br>Aug-90, May-92, Dec-92 | | | | | | | | | Sharp Report claims "Clean +10 years". No MCL violation since 1992, pH range goes above 8.0. |
| MW-10-D | 7.9 - 6.61 | 1.29 | | | | | | | | | | | Sharp Report claims "Clean +10 years". No violations of MCLs reported, pH range a little high. |
| MW-12-D | 7.65 - 6.9 | 0.75 | chromium<br>Lead | Dec-91, May-92, Aug-92, March-93<br>Dec-91, May-92, | | 6.82 | 2000 | 6.85 | no | 2000 | | | Sharp Report claims "Clean +10 years". Exceeds MCLs for alpha in 2000. |
| MW-13-S | none | 0 | Arsenic<br>Lead | Dec-91, May-92, Aug-92, March-93<br>Dec-91 | | | | | | | Benzene | Dec-91, May-92, Aug-98, Dec-92 | Sharp Report claims "very high detection limits" as reason for abandonment. Exceeds MCLs for Benzene in August 1998. |
| MW-13-I | 6.89 - 6.54 | 0.35 | | | | | | | | | Benzene | May-92, March-97 | Sharp Report claims well is "broken". Exceeds MCLs for Benzene in March 1997. |

# Table 1 - Status of Wells

| Well ID | pH Range Hi-Low | # Change | Parameter Above MCL | Metals Year (Recent) | Radioactivity - Alpha pCi/l > Detect | Radioactivity - Alpha pCi/l > MCL 5 pCi/L | Radioactivity - Alpha pCi/l Year | Radioactivity - Beta pCi/l > Detect | Radioactivity - Beta pCi/l > MCL 50 pCi/L | Radioactivity - Beta pCi/l Year | VOCs Parameter Above MCL | VOCs Year | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-14-S | 6.77 - 6.28 | 0.49 | Arsenic | Dec-91, May-92, Aug-92, Dec-92, March-93, Sept-94, March-97, Dec-00, March-01, May-01, Sept-01 | | 16.98 | 2000? | | 70.61 | 2000? | Benzene | Dec-91, May-92, Dec-92, March-93, Sept-98 | Sharp Report claims "single cased well within landfill" & "very high detection limits" as reason for abandonment. Exceeds MCLs for Benzene in August 1998, Arsenic in March 1997, Dec 2000, March 2001, May 2001, & Sept 2001; Cadmium in March 1997; Thallium in Dec 2000, alpha in two rounds in 2000, beta in two rounds in 2000. |
| | | | Barium | Aug-92 | | 15.17 | 2000 | | 60.7 | 2000 | | | |
| | | | Beryllium | Dec-91, Aug-92 | | | | | | | | | |
| | | | Cadmium | March-97 | | | | | | | | | |
| | | | Chromium | Dec-91, May-92, Aug-92 | | | | | | | | | |
| | | | Lead | Dec-91, May-92, Aug-92, Sept-94 | | | | | | | | | |
| | | | Thallium | Dec-00 | | | | | | | | | |
| MW-14-I | 7.13 - 6.58 | 0.55 | | | | 6.08 | 2000 | 5.79 | | 2000 | Benzene | May-92, Sept-98 | Sharp Report claims well is "broken". Exceeds MCLs for Benzene in Sept 1998 and alpha in 2000. |
| MW-15-S | 7.43 - 6.96 | 0.47 | Arsenic | Aug-92 | | | | 12.47 | | 2000 | 1, 2-Dichloroethane | March-97, Sept-98 | Sharp Report claims "single cased well within landfill" and "very high detection limits". Exceeds MCLs for Nitrite, March 1997; Thallium, December 2000; and Benzene March 1997 |
| | | | Barium | Sept-94 | | | | | | | Benzene | Dec-91, May-92, Aug-92, Dec-92, March-97 | |
| | | | Lead | Aug-92 | | | | | | | Cis-1,2-Dichloroethene | Dec-91 | |
| | | | Nitrite | March-97 | | | | | | | Ethylbenzene | Dec-91, Aug-92, Dec-92 | |
| | | | Thallium | Dec-00 | | | | | | | Styrene | Dec-91 | |
| | | | | | | | | | | | Toluene | Dec-91 | |
| | | | | | | | | | | | Trichlorethene | Dec-91 | |
| MW-15-I | 7.74 - 7.15 | 0.59 | Arsenic | March-97 | | | | | | | 1, 2-Dichloroethane | March-97 | Sharp Report claims "single cased well within landfill". Exceeds MCLs for both arsenic and lead March 1997. |
| | | | Lead | March-97 | | | | | | | | | |
| MW-16-I | 8.08 - 6.5 | 1.58 | | | | 13.81 | 2000 | yes | | 2000 | | | Sharp Report claims "single cased well within landfill" and "Clean +12 years". Exceeds MCL for alpha in 2000. Have pH high reading over 8.0. |
| | | | | | 4.72 | | 2000 | 3.55 | | 2000 | | | |
| MW-17-S | 7.64 - 6.01 | 1.14 | Arsenic | March-93, Sept-94, March-97, Dec-00, March-01, May-01, Sept-01 | | 10.92 | 2000 | | 64.57 | 2000 | Benzene | Aug-92, Dec-92, March-93 | Sharp Report claims "single cased well within landfill". Exceeds MCL for Arsenic March 1997, Dec 2000, March 2001, May 2001, & Sept 2001; Thallium Dec 2000; alpha 2000 & 2001. |
| | | | Barium | Aug-92, Dec-92, | | 24.87 | 2001 | | 66.68 | 2001 | | | |
| | | | Beryllium | Dec-92 | | | | | | | | | |
| | | | Cadmium | Aug-92, | | | | | | | | | |
| | | | Chromium | Dec-92 | | | | | | | | | |
| | | | Lead | Dec-92, Sept-94 | | | | | | | | | |
| | | | Thallium | Dec-00 | | | | | | | | | |
| MW-17-D | 7.86 - 6.23 | 1.63 | Antimony | Dec-92 | | | | 2.78 | | 2000 | | | Sharp Report claims "single cased well within landfill". Exceeds MCL for Arsenic March 1997. Has a relatively high range for pH. |
| | | | Arsenic | March-97 | | | | 3.21 | | 2000 | | | |
| MW-19-S | 7.45 - 6.85 | 0.6 | Arsenic | Dec-91 | | | | 3.39 | | 2000 | | | Sharp Report claims "Clean +10 years". No MCLs exceeded after May 1992. |
| | | | Beryllium | Dec-92 | | | | | | | | | |
| | | | Lead | Dec-91, May-92 | | | | | | | | | |
| MW-20-I | 7.93 - 7.31 | 0.62 | Arsenic | March-91, Sept-98 | | | | yes | | 2000 | | | Sharp Report Claims "Clean +10 years". Exceeds MCL for Arsenic Sept 1998. |
| | | | Lead | March-93 | | | | | | | | | |
| MW-20-D | 7.64 - 6.97 | 0.67 | Thallium | March-97 | | | | 2.01 | | 2000 | | | Sharp Report claims "Clean +10 years". Exceeds MCL for Thallium March 1997. |
| | | | | | 2.54 | | 2001 | 2.56 | | 2001 | | | |
| MW-23-I | 10.13 - 6.52 | 3.61 | Lead | May-92 | | | | yes | | 2000? | | | Sharp Report claims "Clean +10 years". Extremely high pH readings and pH range left unexplained. |
| MW-23-D | 7.66 - 6.61 | 1.05 | | | | | | 4.03 | | 2000 | | | Sharp Report claims "Clean +10 years". No MCL exceedances noted. |

## Table 1 - Status of Wells

After June 2004

| Well ID | pH Range Hi-Low | # Change | Parameter Above MCL | Metals Year (Recent) | Radioactivity - Alpha pCi/l > Detect | > MCL 5 pCi/L | Year | Radioactivity - Beta pCi/l > Detect | > MCL 50 pCi/L | Year | Parameter Above MCL | VOCs Year | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-24-S | 7.05 - 6.74 | 0.31 | Antimony<br>Arsenic<br>Barium<br>Beryllium<br>Cadmium<br>Chromium<br>Lead | Dec-92<br>May-92, March-97, Sept-98 Dec-00<br>Dec-92<br>Dec-92, March-93<br>May-92<br>Dec-92, March-93<br>May-92, Dec-92 | | | | | | | | | Sharp Report claims "Clean +10 years". Exceeds MCLs Arsenic March 1997, Sept 1998, Dec 2000. |
| MW-25-I | 7.33 - 6.83 | 0.5 | Cadmium<br>Chromium<br>Lead | March-97<br>Aug-92, March-97 Dec-00<br>Aug-92, Dec-92 | | | | | | | | | Sharp Report claims "Clean +10 years". Exceeds MCLs for Chromium March 1997 and Dec 2000. |
| MW-26-I | 8.23 - 7.03 | 1.2 | Cadmium | March-97 | | 9.55<br>7.22 | 2000<br>2001 | 4.97 | | 2001 | | | Sharp Report claims "Clean +10 years". Exceeds MCLs Cadmium March-1997; alpha 2000, & 2001. |
| MW-27-S | 7.26 - 6.83 | | Antimony<br>Arsenic<br>Barium<br>Beryllium<br>Cadmium<br>Chromium<br>Copper<br>Lead<br>Mercury<br>Thallium | Dec-92<br>Sept-98<br>Dec-92, March-93<br>May-92, Aug-92, Dec-92<br>Aug-92, Dec-92<br>May-92, Aug-92, Sept-98<br>Dec-92<br>May-92, March-97, Sept-98<br>Aug-92, Sept-92<br>Sept-98 | | | | | | | | | Sharp Report claims"Clean +10 years". Exceeds MCLs Arsenic Sept 1998; Chromium Sept 1998; Lead March 1997, Sept 1998; Thallium, Sept 1998. |
| MW-27-D | 7.44 - 7.20 | 0.24 | Arsenic<br>Cadmium<br>Lead | Sept-98<br>March-97<br>Aug-92 | | | | | | | | | Sharp Report claims "Clean +10 years". Exceeds MCLs Arsenic Sept 1998. |
| MW-28-D | 7.40 - 6.60 | 0.8 | Cadmium<br>Lead | March-93, March-97<br>March-93, March-97 | | | | | | | | | Sharp Report claims "Clean +10 years". Exceeds MCLs Cadmium and Lead March 1997. |
| *Contingency Wells* | | | | | | | | | | | | | |
| MW-01-D | 7.79 - 7.07 | 0.72 | Cadmium<br>Lead | Dec-90, May-92, Aug-92, Dec-92, March-93, March-97<br>Dec-91, May-92, Aug-93, March-94 | | 6.56 | 2000 samp | 6.28 | | 2000 samp | | | Sharp Report claims "Clean +14 years". Exceeds MCL for Cadmium March 1997, exceeds alpha 2000. |
| MW-07-D | 7.99 - 7.14 | 0.85 | Barium | Dec-90 | | | | | | | | | Sharp Report claims "Clean +10 years". No metals, pH or, radiologicals exceeded in that time. |
| MW-09-I | 10.69 - 6.7 | 3.99 | Chromium | Dec-92 | | | | | | | | | Sharp Report claims "Clean +10 years". No metals, or radiologicals exceeded in that time. Excessive high pH and pH variation in this well nest. |
| MW-11-D | 11.51 - 7.51 | 4 | Arsenic<br>Lead | Sept-98<br>Sept-94 | | | | | | | | | Sharp Report claims "Clean +10years". Exceeds MCL for Arsenic Sept-1998. Excessive high pH and pH variations in this well nest. |
| MW-21-I | 7.72 - 6.72 | 1 | Chromium | Sept-98 | | | | 6.51 | | 2000 | | | Sharp Report claims "Clean +10 years". Exceeds MCL Chromium Sept 1998. |
| *Sentinel Wells* | | | | | | | | | | | | | |
| MW-01-S | 7.54 - 6.48 | 1.06 | Arsenic<br>Lead | March-97<br>March-97 | | | | | | | | | Sharp Report Claims "Clean +10 yrs". Exceeds MCLs for Arsenic & Lead March 1997. |
| MW-11-S | 9.44 - 6.83 | 2.61 | Arsenic<br>Chromium<br>Lead | Aug-92<br>Sept-94, Sept-98<br>Dec-91, May-92, March-97 | | | | | | | | | Sharp Report claims "single detection of Toluene at 1.3 ppb in 12/00". Did not screen for VOCs so cannot confirm. Exceeds MCLs for Chromium Sept 1998 & Lead March 1997. Excessive high pH and pH variation in this well nest. |
| MW-21-S | 7.38 - 6.62 | 0.76 | Arsenic<br>Thallium | March-93, Sept-94<br>Jun-01 | | | | 18.24 | | 2000 | | | Sharp Report claims "contaminated shallow sentinel well". Exceeds MCL for Thallium June 2001, not screened for VOCs.N150 |

## Table 1 - Status of Wells

| Well ID | pH Range | | Metals | | Radioactivity - Alpha pCi/l | | | Radioactivity - Beta pCi/l | | | VOCs | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hi-Low | # Change | Parameter Above MCL | Year (Recent) | > Detect | > MCL 5 pCi/L | Year | > Detect | > MCL 50 pCi/L | Year | Parameter Above MCL | Year | |
| *Retained Monitoring Wells for Uppermost Groundwater Aquifer (and other assignments)* | | | | | | | | | | | | | |
| MW-01-I | 8.83 - 6.74 | 2.09 | Beryllium<br>Chromium | Dec-90<br>Dec-90 | | | | | | | | | Has excessive pH range since 1997. |
| MW-03-I | 7.89 - 6.75 | 1.14 | | | | | | | | | | | Sharp Report claims "Clean +5 years", No noted excedences. |
| MW-07-I | 7.91 - 6.78 | 1.13 | Arsenic<br>Beryllium<br>Nitrite | March-93<br>March-93<br>March-97 | | | | | | | | | Sharp Report claims "Clean + 10 years". Exceeds MCL for Nitrite March 1997. |
| MW-10-I | 7.48 - 7.12 | 0.36 | Cadmium<br>Lead | March-97<br>Dec-91 | | | | | | | | | Sharp Rept claims "Clean +10 years". Exceeds MCLfor Cadmium March 1997. |
| MW-11-I | 7.29 - 6.48 | 0.81 | | | | | | | | | | | Sharp Report states "Current analyses detect contaminants". Reviewed only Metals, pH, and possibly radiologicals, not VOCs so cannot confirm. |
| MW-12-I | 7.54 - 6.46 | 1.08 | Arsenic<br>Barium<br>Cadmium<br>Chromium<br>Lead<br>Selenium<br>Thallium | May-92, Aug-92<br>March-93<br>Dec-90, May-92, Aug-92, March-97, Sept-98<br>Sept-98<br>May-92, Aug-92, March-97<br>March-97<br>Aug-92, March-97 | | | | | | | | | Sharp Report claims "Clean +10 years". Exceeds MCLs for Cadmium March 1997 & Sept 1998, Chromium for Sept 1998, Lead for March 1997, Selenium for March 1997, and Thallium for March 1997. |
| MW-13-N | New well | 0 | | | | | | | | | | | Sharp Report claims this well is to replace MW-13-I which is "broken". The chemistry data for the new well reported in the Canton Repository (April 25, 2003) shows a significant decrease in benzene levels from the previous monitoring well. |
| MW-14-N | New well | 0 | | | | | | | | | | | Sharp Report claims this well is to replace MW-14-I which is "broken". The chemistry data for the new well reported in the Canton Repository (April 25, 2003) shows a significant decrease in benzene levels from the previous monitoring well. |
| MW-16-N | New Well | | | | | | | | | | | | To be installed outside the landfill perimeter in a new location so historic readings of MW-16-I will not transfer. |
| MW-17-N | New Well | | | | | | | | | | | | To be installed outside the landfill perimeter in a new location so historic readings of MW-17-S & D will not transfer. |
| MW-18-S | 7.37 - 6.37 | 1 | Antimony<br>Arsenic<br>Beryllium<br>Cadmium<br>Chromium<br>Lead<br>Thallium | Dec-92<br>May-92, Sept-94, March-97,<br>May-92, Dec-92<br>Aug-92<br>May-92, Aug-92, March-93, Sept-94<br>Dec-91, May-92, Aug-92, March-93, March-94, March-97 Sept-98,<br>Dec-00 | | | | 0.55 | | 2000 | | | Sharp Report claims "Clean +10 years". Exceeds MCLs Arsenic, March 1997; Lead, March 1997 & Sept 1998; and Thallium, Dec 2000. |
| MW-18-I | 7.91 - 6.78 | 1.13 | Chromium<br>Lead<br>Thallium | Sept-94, Sept-98<br>May-92<br>Dec-00 | | | | 3.59 | | 2000 | | | Sharp Report claims "Clean +10 years". Exceeds MCLs Chromium Sept 1998, Thallium, Dec 2000. |
| MW-20-S | 8.39 - 7.16 | 1.23 | Arsenic<br>Lead | May-92, Dec-00<br>May-92 | | | | yes | | 2000 | | | Sharp Report claims "Clean +10 years". Exceeds MCL Arsenic Dec 2000. |
| MW-22-I | 7.69 - 6.00 | 1.69 | Cadmium<br>Lead | March-97<br>March-97 | | | | 16.45 | | 2000 | | | Sharp Report claims "Clean +10 years". Exceeds MCLs Cadmium & Lead March 1997. Relatively high variation of pH. |
| MW-23-S | 8.9 - 6.8 | 2.1 | Arsenic<br>Beryllium<br>Cadmium<br>Lead | Dec-91, May-92, Dec-92, March-93<br>Aug-92, Dec-92<br>Aug-92<br>Dec-92, May-92, March-93, March-97 | | 7.47<br>12.96<br>8.06 | 2000<br>2001<br>Date? | 20.16<br>20.58<br>18.89 | | 2000<br>2001<br>Date? | | | Sharp Report claims "Completed partially within the Carlisle Muck". Exceeds MCLs Lead, March 1997; alpha 2000, 2001?, and ?, pH readings above 8.0 and high pH range. |
| MW-24-I | 7.10 - 6.48 | 0.62 | Chromium<br>Lead | Sept-94, Sept-98<br>March-97 | | | | | | | | | Sharp Report claims "Clean +10 years". Exceeds MCLs Chromium Spet 1998 and Lead March 1997. |

## Table 1 - Status of Wells

| Well ID | pH Range Hi-Low | # Change | Metals Parameter Above MCL | Metals Year (Recent) | Radioactivity - Alpha pCi/l > Detect | Radioactivity - Alpha pCi/l > MCL 5 pCi/L | Radioactivity - Alpha pCi/l Year | Radioactivity - Beta pCi/l > Detect | Radioactivity - Beta pCi/l > MCL 50 pCi/L | Radioactivity - Beta pCi/l Year | VOCs Parameter Above MCL | VOCs Year | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-25-S | 7.48 - 7.04 | 0.44 | Arsenic<br>Beryllium<br>Cadmium<br>Chromium<br>Lead | May-92<br>Dec-92<br>Aug-92<br>Aug-92<br>May-92 | | | | | | | | | Sharp Report claims "Clean +10 year". Last exceeds MCLs in 1992. |
| MW-26-S | 7.29 - 6.78 | 0.51 | Lead | March-97 | 3.18 | | 2001 | | | | | | Sharp Report claims "Clean +10 years". Exceeds MCL Lead March 1997. |
| MW-27-I | 7.46 - 6.93 | 0.53 | Arsenic<br>Chromium<br>Lead | Aug-92, Dec-00<br>Sept-98<br>Aug-92 | | | | | | | | | Sharp Report claims "Clean +5 years, trace of VOCs in Mar 1997". Exceeds MCLs for Arsenic Dec 2000, Chromium Sept 1998, did not screen for VOCs. |

Notes: Metals and VOC information comes from a data base developed in house for an earlier project at the site. The data entries stop at 2001 and the data has not been through a QA/QC proceedure.
The pH data comes from the Bennett & Williams 1999 report, Table # 3 and from the low flow sampling sheets from Sharp & Associates for the 2000 and 2001 sampling events. Yellow boxed pH ranges have a pH high of 8.0 to 8.99, orange boxed pH ranges have a high of 9.00 or higher. Blue boxed # Change column show a pH variation of between 1.01 and 1.5. Green boxed # change column show a pH variation of 1.51 and above.
The Radioactivity information comes from Tables for Radioactivity reports for 2000 and 2001. The sheets were supplied by Chris Borello, we do not have the original reports although Dr. Ann Christy requested them on more than one occasion for her Biological Engineering course at The Ohio State University. The term "Sharp Rept" refers to the information on Table 8 "Inventory of IEL Monitoring Wells and Recommendations for their Disposal" taken from a document with the reference 2101/IEL/Table 8, date unknown but assumed to be before the June 2004 date when the abandoned wells were sealed.

**Table 3**
**pH Variations in Monitoring Wells**

| Monitoring Well # | March 1997 | September 1998 | Change |
|---|---|---|---|
| MW-1S | 6.48 | 7.54 | +1.06 |
| MW-1i | 7.06 | 7.79 | +0.73 |
| MW-1D | 7.5 | 7.79 | +0.29 |
| MW-2D | 9.93 | 8.05 | -1.88 |
| MW-3S | 6.55 | n/a | |
| MW-3I | 7.47 | 6.75 | -0.72 |
| MW-3D | 7.8 | 8.03 | +0.23 |
| MW-4S | 6.9 | 6.22 | -0.68 |
| MW-5S | 6.45 | 7.1 | +0.65 |
| MW-6S | 6.4 | 6.4 | same |
| MW-7S | 6.45 | 6.16 | -0.29 |
| MW-7I | 7.91 | 7.29 | -0.62 |
| MW-7D | 7.99 | 7.28 | -0.71 |
| MW-9S | 6.49 | 6.99 | +0.5 |
| MW-9I | 9.35 | 7.57 | -1.78 |
| MW-9D | 6.75 | 11.43 | +4.68 |
| MW-10S | 7.19 | 8.04 | +0.85 |
| MW10I | 7.12 | n/a | |
| MW10D | 7.3 | 7.9 | +0.6 |
| MW-11S | 6.87 | 9.44 | +3.57 |
| MW-11I | 6.99 | 7.29 | +0.3 |
| MW-11D | 7.51 | 11.97 | +4.46 |
| MW-12D | n/a | 6.9 | |
| MW-12D (resample) | n/a | 7.18 | |
| MW-12I | n/a | 7.1 | |
| MW-12I (bailed) | n/a | 7.22 | |
| MW-12I (resample) | n/a | 6.9 | |
| MW-13I | 6.89 | 6.73 | -0.16 |
| MW-14S | 6.48 | 6.28 | -0.2 |
| MW-14I | 7.04 | 6.94 | -0.1 |
| MW-15S | 7.43 | 7.03 | -0.4 |
| MW-15I | 7.43 | n/a | |
| MW-16I | 6.5 | 8.08 | +1.58 |
| MW-17S | 6.74 | 6.01 | -0.73 |
| MW-17D | 6.23 | 7.13 | +0.8 |
| MW-18S | 6.37 | 7.37 | +1.0 |
| MW-18I | 6.78 | 7.91 | +1.13 |
| MW-18I (bailed) | n/a | 7.91 | |
| MW-19S | 6.87 | 7.01 | +0.14 |
| | | | |

## Table 3- Continued
## pH Variations in Monitoring Wells

| Monitoring Well # | March 1997 | September 1998 | Change |
|---|---|---|---|
| MW-20S | 7.36 | 7.16 | -0.2 |
| MW-20I | 7.31 | 7.39 | +0.08 |
| MW-20D | 7.64 | 7.24 | -0.4 |
| MW-21S | 6.62 | 7.38 | +0.76 |
| MW-21I | 7.22 | 7.72 | +0.5 |
| MW-22I | 7.68 | 7.49 | -0.19 |
| MW-23S | 6.8 | 7.08 | +0.28 |
| MW-23I | 10.13 | 7.6 | -2.53 |
| MW-23D | 6.96 | 7.65 | +0.69 |
| MW-24S | 6.74 | 7.05 | +0.31 |
| MW-24S (bailed) | n/a | 7.38 | |
| MW-24I | 6.96 | 7.09 | +0.13 |
| MW-25S | 7.37 | 7.48 | +0.11 |
| MW-25I | 7.15 | 7.33 | +0.18 |
| MW-26S | 7.29 | 7.34 | +0.05 |
| MW-26i | 7.03 | 7.31 | +0.28 |
| MW-27S | 7.25 | 7.21 | -0.04 |
| MW-27S(bailed) | n/a | 7.29 | |
| MW-27I | 7.46 | 6.93 | -0.57 |
| MW-27D | 7.44 | 7.35 | -0.09 |
| MW-28D | 7.29 | 7.23 | -0.06 |