BURGESS & NIPLE

5085 Reed Road | Columbus, OH 43220 | 614.459.2050

Mr. Michael B. Nixon
Superintendent
City of Lancaster, Ohio
Water/Water Pollution Control
800 Lawrence Street
Lancaster, OH 43130-9401

Re: Arsenic Concentrations In Groundwater In the Vicinity of the City of Lancaster Miller Park Potable Water Supply Well Field

December 8, 2015

Dear Mr. Nixon:

Burgess & Niple, Inc. (B&N) has prepared this letter for the City of Lancaster, Ohio (City) to provide additional information regarding arsenic concentrations in groundwater in the vicinity of the City's Miller Park potable water supply well field. In a document dated November 23, 2015, Mr. Robert Hedges, Chairman of the City Water/Water Pollution Control Committee, issued a document entitled *Miller Park Update*. The document expressed concerns regarding arsenic concentrations in groundwater in the vicinity of Miller Park potable water supply well field, as well as potential effects to groundwater that may be originating from the proposed County Jail site at 342 W. Wheeling Street in Lancaster, Ohio, which is located along the south side of the Miller Park well field. The following information has been compiled to address the City's concerns.

Regional Arsenic Concentrations Associated with the late Wisconsin-Aged Drift

The Miller Park potable water supply wells and associated Wellhead Protection Program (WHPP) monitoring wells are all screened within the unconsolidated glacial deposits (or drift) of central Fairfield County, Ohio (*Glacial Map of Ohio*, Ohio Department of Natural Resources, 2005, a copy of which is included in **Attachment 1**). The glacial material was deposited during the Wisconsinan Epoch and consists of extensive deposits (roughly 100 feet thick) of sand and gravel. Background arsenic concentrations in groundwater present within the glacial deposits of the Wisconsinan Epoch have been documented to be elevated. For discussion purposes, elevated will be defined as exceeding the United States Environmental Protection Agency (EPA) Primary Drinking Water Standard (or Maximum Contaminant Level [MCL]) of 10 micrograms per liter (µg/l). The publication entitled *Glacial Sediment Causing Regional-Scale Elevated Arsenic in Drinking Water* (Erickson and Barnes, Ground Water, Volume 43, No. 6 pp. 771-972, November-December 2005) documents a study completed to investigate arsenic concentrations in public drinking water systems associated with the lateral extent of northwest late Wisconsin-aged drift in the upper Midwest. The study determined that twelve percent (212 of 1,764) of public water systems located within the footprint of this glacial drift exceeded the Primary MCL for arsenic, whereas only 2.4 percent (52 of 2,182) of public water systems located outside of the footprint exceeded the MCL. The study concluded that evidence suggests that the distinct physical characteristics of the late-Wisconsin-aged drift cause the natural geochemical conditions necessary to mobilize arsenic in groundwater.

Arsenic Concentrations within the Sand and Gravel Aquifers of Ohio

The Ohio EPA publishes a series of reports to provide information to the professional/technical community about groundwater quality in Ohio's aquifers. The reports use data from the ambient groundwater monitoring program and

the public water system compliance program. In the publication entitled *Major Aquifers in Ohio and Associated Water Quality* (Division of Drinking and Ground Waters, Ohio EPA, April 2014), arsenic concentrations within the sand and gravel aquifers are summarized for the 3,351 samples obtained through July 2013. The average (mean) concentration is 5.59 µg/l, with a standard deviation of 8.79 µg/l, and a maximum concentration of 102 µg/l. 50.2 percent of the samples (1,683) contained arsenic concentrations above the laboratory detection limit.

Based upon the observed variability of the data set and using simple statistical comparisons, a rough estimate can be calculated to determine the expected range of arsenic concentrations in the Ohio sand and gravel aquifers. The statistical Empirical Rule (68-95-99.7) states that if the population of a statistical data set has a normal distribution (where the data are in the shape of a bell curve), the population mean and standard deviation can be used to calculate an expected range of the data. Although the distribution of this data set is not detailed in the Ohio EPA publication, the Empirical Rule can be used to create a generalized estimated range of the data. Based upon the observed mean of 5.59 µg/l and standard deviation of 8.79 µg/l, 68-percent of the data would be expected to lie within 1 standard deviation of the mean (up to 14.38 µg/l) and 95-percent of the data would lie within 2 standard deviations of the mean (up to 23.17 µg/l). Based upon the percentage of detections, the observed variability of the data, the overall maximum concentration, and the rough estimates of the range of the data set, the publication provides evidence to demonstrate that elevated levels of arsenic are naturally occurring in the sand and gravel aquifers of Ohio. In addition, these detected concentrations are often in excess of the U.S. Primary MCL of 10 µg/l.

Arsenic Concentrations in Fairfield and Franklin Counties

There are several community potable water supply well fields within Fairfield County and adjacent Franklin County that encounter elevated arsenic concentrations within the sand and gravel aquifers. Based upon reports filed as part of the Ohio EPA Ambient Ground Water Quality Monitoring Program, the following data was discovered:

- **Sugar Grove Wellfield, Well Number 4** – Out of 43 samples collected from May 1994 to September 2014, only 3 arsenic results have been reported as nondetect and the maximum concentration was reported at 15.4 µg/l.
- **Obetz Wellfield, Well Number S1** – Out of 32 samples collected from June 1994 to October 2014, none of the arsenic results have been reported as nondetect, the mean concentration has been 16.2 µg/l, and the maximum concentration was reported at 19 µg/l.
- **Baltimore Wellfield, Well Number 1** – Out of 19 samples collected from October 1993 to March 2014, none of the arsenic results have been reported as nondetect, the mean concentration has been 10.8 µg/l, and the maximum concentration was reported at 12 µg/l.

These reports further support the fact that naturally occurring arsenic concentrations are present in groundwater within the local sand and gravel aquifers that exceed the U.S. EPA Primary MCL of 10 µg/l.

Local Arsenic Concentrations within the Vicinity of the Miller Park Potable Water Supply Well Field

Monitoring wells included in the City's WHPP have been sampled and analyzed since October 1995. Specifically, monitoring wells MW-1S, MW-1D, MW-2, MW-3, MW-4S, MW-4D, MW-5S, MW-5D, MW-6S, MW-6D, MW-7, MW-8, MW-9S, and MW-9D are positioned around the Miller Park potable water supply well field. **Attachment 2** includes a map that displays the locations of the potable water supply wells and the WHPP monitoring network in the vicinity of Miller Park. **Attachment 3** presents a table that summarizes the arsenic concentrations reported for the monitoring network, specifically the number of samples, the percentage of the data that were reported below the laboratory detection limit, the minimum value, the maximum value, the number of results that have exceeded the U.S. EPA Primary MCL of 10 µg/l, and the percentage of those exceedances with respect to the total number of results. The following conclusions were made:

- 10 of the 14 monitoring wells (all wells except MW-6S, MW-8, MW-9S, and MW-9D) have had a reported arsenic concentration that exceeded the Primary MCL.
- Concentrations have ranged from nondetect to 57.0 µg/l.
- Over half of the results in MW-1D (61.3%), MW-3 (87.1%), MW-4S (74.2%), MW-5D (95.8%), MW-6D (64.5%), and MW-7 (90.3%) have exceeded the Primary MCL.
- Only monitoring wells MW-6S and MW-8 have had 100% of the data reported as nondetect.
- 100% of the data reported for MW-4S, MW-5D, MW-9S, and MW-9D have been reported above the laboratory detection limit.

This data demonstrates that there are arsenic concentrations in groundwater in the vicinity of the Miller Park potable water supply well field that exceed the U.S. EPA Primary MCL of 10 µg/l. These exceedances have occurred in both shallow and deep wells and have been present in samples collected since October 1995 on a regular basis.

Based upon reports filed by the City as part of the Ohio EPA Ambient Ground Water Quality Monitoring Program, the following data was discovered:

- **Miller Park Wellfield, Well Number 28** – Out of 22 samples collected between March 1992 and September 2014, only 1 arsenic result has been reported as nondetect, the mean concentration has been 12 µg/l, and the maximum concentration was reported at 18 µg/l.

The water obtained by the water supply wells in Miller Park is processed through the City's water treatment plant prior to being distributed for potable use. To date, there have been no exceedances of the U.S. EPA Primary MCL for arsenic within tap water distributed by the City. This provides sound evidence that the treatment process utilized by the City has been effective at reducing naturally occurring arsenic concentrations from the sand and gravel aquifer to concentrations that are below the regulatory health-risk-based levels prior to distribution to the community.

Effects from the Proposed County Jail Site

As presented on the map included in **Attachment 2**, WHPP monitoring wells MW-9S and MW-9D are located on the north side of the proposed County Jail site, just south of the Miller Park potable water supply well field. As summarized in the table included in **Attachment 3**, these two monitoring locations are two of the four wells to never have had an arsenic concentration reported above the U.S. EPA Primary MCL. Historical arsenic concentrations reported for monitoring wells MW-4S and MW-5D have been over 6 times higher than those observed in MW-9S and MW-9D, and one or more concentrations reported for MW-1S, MW-1D, MW-2, MW-3, MW-4D, MW-5S, MW-6D, and MW-7 have been above the Primary MCL. Arsenic concentrations reported for water supply wells 15 and 23 (located closest to the proposed County Jail) have never exceeded the U.S. EPA Primary MCL to date. Although the data sets for MW-9S and MW-9D are relatively small (only four samples have been collected since the wells were installed in early 2015), arsenic levels reported to date have been some of the lowest in the area and will have less influence on water quality with respect to arsenic than other portions of the aquifer in and around the Miller Park well field. It does not appear that historical operations at the proposed County Jail site have affected arsenic concentrations in groundwater to levels that would pose a health risk higher than those that are already present due to the naturally occurring arsenic concentrations in the area.

Clarification on Regulatory Requirement to Discontinue Use of Potable Water Supply Wells

Mr. Hedges stated the following on page 2 of the Miller Park Update:

> *"Based upon the results of this limited sampling, there appears to be a potential for waters produced from Production Well No. 23 to exceed the current drinking water MCL of 10 µg/l for arsenic and would certainly exceed an MCL of 5 µg/l should EPA reduce the MCL to the June 2000 proposed level in the future. As you*

may recall, during a previous open session of Lancaster City Council, Superintendent Nixon acknowledged that the treatment plant at the Miller Park Well Field does not have the capability of removing toxic metals such as arsenic from waters produced from the well field. EPA has long held that "dilution is not the solution of pollution", meaning that it is not acceptable to comingle 'polluted' waters with 'clean' in order to achieve water quality compliance. Therefore, if waters produced from Production well No. 23 (or any other production well) exceed the MCL for a primary water quality parameter, those waters should be diverted out of the water plant influent stream until either the water quality problem is abated or treatment technology is implemented in the plant to effectively remove such contaminants. In such an instance, the initial corrective action typically implemented is to divert the pumpage from the impacted well (or wells) to waste discharge either to a sanitary sewer or, with proper discharge permits, to a surface water body. Such an initial corrective action serves to help protect the remaining wells within the well field by intercepting the contaminant plume, but such action does not mitigate the source of the contamination or otherwise alter the migration of the contaminant plume."

The current regulatory requirement for municipalities distributing potable water to communities includes the U.S. EPA Primary MCL of 10 µg/l for arsenic. This limit is applicable for potable water that has been treated at a water treatment plant and arrives at the recipient's location at a tap. The water obtained by the water supply wells in Miller Park is processed through the City's water treatment plant prior to being distributed for potable use. To date, there have been no exceedances of the U.S. EPA Primary MCL for arsenic within tap water distributed by the City even though elevated concentrations exist in the pre-treatment groundwater. This provides sound evidence that the treatment process utilized by the City has been effective at reducing naturally occurring arsenic concentrations within the sand and gravel aquifer to levels that are below the regulatory health-risk-based limit prior to distribution to the community. Therefore, the City continues to meet the current regulatory requirements.

With respect to historically proposed drinking water standards for arsenic, or other proposed standards for various constituents, they do not apply until they have sufficient risk-based studies completed, are proposed through regulatory legislature, gone through a public review process, enacted into law, and an enforcement date is declared. The Safe Drinking Water Act (SDWA) requires U.S. EPA to review each national primary drinking water regulation at least once every six years and revise them, if appropriate. As part of the "Six-Year Review," U.S. EPA evaluates any newly available data, information, and technologies to determine if any regulatory revisions are needed. Revisions must maintain or strengthen public health protection. The review completed in March 2010 concluded that revisions to the arsenic limit were not appropriate at that time. The latest review is scheduled to be completed in 2016. It is beneficial for the City to remain proactive in groundwater monitoring as the City has since 1995 as one of the first communities in Ohio to devise and implement a WHPP. The WHPP groundwater monitoring network is well designed to assess a potential groundwater issue prior to impacting the City's water supply. With regard to treatment processes and regulatory compliance, only the current drinking water standards apply. Based on recent discussions with Ohio EPA, there are no known measures in place to lower the arsenic MCL for finished drinking water.

With regard to the statement about diverting water out of the water plant influent stream in the event an arsenic concentration is measured to exceed the Primary MCL in a sample obtained from the well prior to treatment, Ohio EPA has no such regulatory requirement. The City has indicated that there is no requirement defined in their WHPP Plan or in any City Ordinance. The purpose of operating a water treatment plant is to improve water quality obtained from local water sources so that it may be distributed to recipients with concentrations of constituents that meet regulatory standards. To date, the City has continued to collect groundwater within the sand and gravel aquifer in the vicinity of Miller Park that has been documented to contain background arsenic concentrations above the U.S. EPA Primary MCL, process it through the water treatment plant, and reduce the arsenic concentrations to levels below the regulatory standard prior to distribution to the community.

Conclusions

Arsenic is naturally occurring in groundwater within the Wisconsinan Epoch glacial deposits that are distributed across the Midwest. Moreover, naturally occurring arsenic has been detected in over half of the historical pre-treatment groundwater samples collected in Ohio as part of the ambient groundwater monitoring program and the public water system compliance program. Numerous municipalities have had issues with meeting the U.S. Primary MCL in their finished drinking water. Several municipalities in Central Ohio have arsenic concentrations in groundwater that are above the U.S. EPA Primary MCL prior to treatment at their water treatment facility, including the City of Lancaster. Concentrations in the vicinity of the Miller Park portable water supply well field have been documented to be more than 5 times higher than the Primary MCL in the pre-treatment groundwater. It is important to note that some of the lowest concentrations have been reported in the vicinity of the proposed County Jail site. Although elevated concentrations of arsenic have been documented in the WHPP monitoring wells and the City potable water supply wells, the existing treatment process at the City's water treatment facility has been effective at reducing these naturally occurring concentrations within the sand and gravel aquifer to levels that are below the Primary MCL in finished drinking water prior to distribution to the community. Therefore, the City of Lancaster continues to meet the current regulatory requirements.

If you have any questions or comments, please do not hesitate to call.

Sincerely,

Michael E. Leone, CPG
Project Director

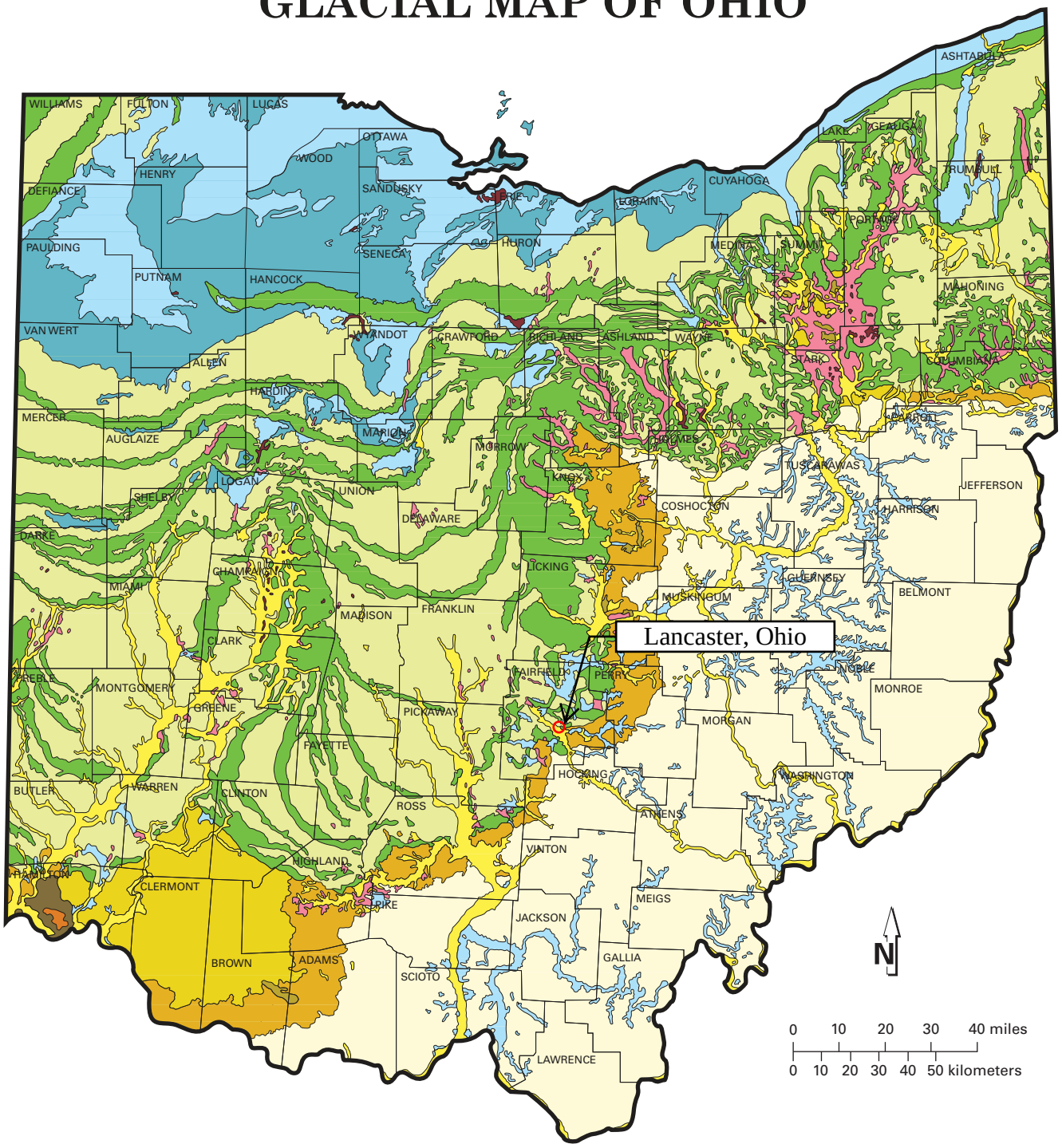
Thomas J. Mignery, CPG, VAP CP
Principal in Charge

MEL:cmc
Attachments

ATTACHMENT 1

GLACIAL MAP OF OHIO

GLACIAL MAP OF OHIO



WISCONSINAN (14,000 to 24,000 years old)	ILLINOIAN (130,000 to 300,000 years old)	PRE-ILLINOIAN (older than 300,000 years)	
Ground moraine	Ground moraine	Ground moraine	Kames and eskers
Wave-planed ground moraine	Dissected ground moraine	Dissected ground moraine	Outwash
Ridge moraine	Hummocky moraine		Lake deposits
			Peat
			Colluvium

Recommended citation: Ohio Division of Geological Survey, 2005, Glacial map of Ohio: Ohio Department of Natural Resources, Division of Geological Survey, page-size map with text, 2 p., scale 1:2,000,000.

GLACIAL DEPOSITS OF OHIO

Although difficult to imagine, Ohio has at various times in the recent geologic past (within the last 1.6 million years) had three-quarters of its surface covered by vast sheets of ice perhaps as much as 1 mile thick. This period of geologic history is referred to as the Pleistocene Epoch or, more commonly, the Ice Age, although there is abundant evidence that Earth has experienced numerous other "ice ages" throughout its 4.6 billion years of existence.

Ice Age glaciers invading Ohio formed in central Canada in response to climatic conditions that allowed massive buildups of ice. Because of their great thickness, these ice masses flowed under their own weight and ultimately moved south as far as northern Kentucky. Oxygen-isotope analysis of deep-sea sediments indicates that more than a dozen glaciations occurred during the Pleistocene. Portions of Ohio were covered by the last two glaciations, known as the Wisconsinan (the most recent) and the Illinoian (older), and by an undetermined number of pre-Illinoian glaciations.

Because each major advance covered deposits left by the previous ice sheets, pre-Illinoian deposits are exposed only in extreme southwestern Ohio in the vicinity of Cincinnati. Although the Illinoian ice sheet covered the largest area of Ohio, its deposits are at the surface only in a narrow band from Cincinnati northeast to the Ohio-Pennsylvania border. Most features shown on the map of glacial deposits of Ohio are the result of the most recent or Wisconsinan-age glaciers.

The material left by the ice sheets consists of mixtures of clay, sand, gravel, and boulders in various types of deposits of different modes of origin. Rock debris carried along by the glacier was deposited in two principal fashions, either directly by the ice or by meltwater from the glacier. Some material reaching the ice front was carried away by streams of meltwater to form outwash deposits. Material deposited by water on and under the surface of the glacier itself formed features called kames and eskers, which are recognized by characteristic shapes and composition. A distinctive characteristic of glacial sediments that have been deposited by water is that the material was sorted by the water that carried it. Thus, outwash, kame, and esker deposits normally consist of sand and gravel. The large boulder-size particles were left behind and the smaller clay-size particles were carried far away, leaving the intermediate gravel- and sand-size material along the stream courses.

Material deposited directly from the ice was not sorted and ranges from clay to boulders. Some of the debris was deposited as ridges parallel to the edge of the glacier, forming terminal or end moraines, which mark the position of the ice when it paused for a period of time, possibly a few hundred years. When the entire ice sheet receded because of melting, much of the ground-up rock material still held in the ice was deposited on the surface as ground moraine. The oldest morainic deposits in Ohio are of Illinoian and pre-Illinoian age. Erosion has significantly reduced these deposits along the glacial boundary, leaving only isolated remnants that have been mapped as dissected ground moraine and hummocky moraine.

Many glacial lakes were formed in Ohio during the Ice Age. Lake deposits are primarily fine-grained clay- and silt-size sediments. The most extensive area of lake deposits is in northern Ohio bordering Lake Erie. These deposits, and adjacent areas of wave-planed ground moraine, are the result of sedimentation and erosion by large lakes that occupied the Erie basin as Wisconsinan-age ice retreated into Canada. Other lake deposits accumulated in stream valleys whose outlets were temporarily dammed by ice or outwash. Many outwash-dammed lake deposits are present in southeastern Ohio far beyond the glacial boundary. Peat deposits are associated with many lake deposits and formed through the accumulation of partially decayed aquatic vegetation in oxygen-depleted, stagnant water.

The term glacial drift commonly is used to refer to any material deposited directly (*e.g.*, ground moraine) or indirectly (*e.g.*, outwash) by a glacier. Because the ice that invaded Ohio came from Canada, it carried in many rock types not found in Ohio. Pebbles, cobbles, and boulders of these foreign rock types are called erratics. Rock collecting in areas of glacial drift may yield granite, gneiss, trace quantities of gold, and very rarely, diamonds. Most rocks found in glacial deposits, however, are types native to Ohio.

Certain deposits left behind by the ice are of economic importance, particularly sand and gravel, clay, and peat. Sand and gravel that have been sorted by meltwater generally occur as kames or eskers or as outwash along major drainageways. Sand and gravel are vital to Ohio's construction industry. Futhermore, outwash deposits are among the state's most productive sources of ground water.

Glacial clay is used in cement and for common clay products (particularly brick). The minor quantities of peat produced in the state are used mainly for mulch and soil conditioning.

ATTACHMENT 2

MILLER PARK MONITORING WELLS AND POTABLE WATER SUPPLY WELLS MAP

CITY OF LANCASTER, OHIO
SPIRIT 1800 PRIDE

LEGEND

- M.P. Monitoring Wells
- Streets
  2012 Ortho Imagery
- M.P. Water Supply Wells

Disclaimer

Map produced by the City of Lancaster, Department of Engineering

Data provided by the Fairfield County Auditor GIS Department

All data created by Fairfield County Auditor GIS Department has been developed to meet National Map Accuracy Standards. All GIS data layers are referenced in the Ohio State Plane Coordinate System, Horizontal - North American Datum (NAD) 83 (95) Vertical data -North American Datum Vertical Datum (NAVD) 88, Units - Surveyors Feet.

All data has been developed from public records that are constantly undergoing change and is not warranted for content, completeness or accuracy. City of Lancaster does not warrant, guarantee or represent the data to be fit for a particular use or purpose.

If detailed information is required for data layers shown, please contact the City of Lancaster, Department on Engineering.

Please notify the City of Lancaster, Department of Engineering with any discrepancies.

Miller Park Monitoring Well Locations

N

0 200 400 800

Feet

December 2, 2015

ATTACHMENT 3

ARSENIC CONCENTRATIONS IN THE MILLER PARK WHPP MONITORING NETWORK

City of Lancaster, Ohio
Miller Park Potable Water Supply Well Field
Arsenic Concentrations in the WHPP Monitoring Network

Well No.	Sample Size	Percent ND	Minimum (µg/l)	Maximum (µg/l)	No. Values >10 µg/l	Percent >10 µg/l
MW-1S	31	22.6%	ND	12.0	2	6.5%
MW-1D	31	6.5%	ND	16.0	19	61.3%
MW-2	31	41.9%	ND	18.0	2	6.5%
MW-3	31	6.5%	ND	28.0	27	87.1%
MW-4S	31	0.0%	1.7	57.0	23	74.2%
MW-4D	31	12.9%	ND	13.0	4	12.9%
MW-5S	31	90.3%	ND	13.0	1	3.2%
MW-5D	24	0.0%	7.0	53.0	23	95.8%
MW-6S	25	100.0%	ND	ND	0	0.0%
MW-6D	31	6.5%	ND	20.0	20	64.5%
MW-7	31	3.2%	ND	30.0	28	90.3%
MW-8	31	100.0%	ND	ND	0	0.0%
MW-9S	4	0.0%	5.0	9.0	0	0.0%
MW-9D	4	0.0%	6.0	8.0	0	0.0%

All concentrations are reported as dissolved arsenic.
µg/l = micrograms per liter or parts per billion.