Report

A Review of the Former Marble Quarry Landfill Site

Prepared by

Hughes Environmental Consulting Services
157 Strong Ave., Syracuse, NY 13210

Donald J. Hughes, P.E., Ph.D, *Principal*
dhughes171@gmail.com

February 29, 2016

Contents

Appendices

Appendix A: Historical Aerial Photographs, 1940 - 1966

Appendix B: Former Marble Quarry Areas, relative to Current Conditions

Appendix C: Affidavit of J. Marinello, dated November 12, 2015

Appendix D: Letter of Sheila Clarke, submitted to the Mayor and Village Trustees of Tuckahoe, dated December 18, 2011

Appendix E. Vertical profiles of sub-surface soil borings

List of Figures

List of Tables

List of Abbreviations and Definitions

ASTM American Society for Testing and Materials
BCP Brownfield Cleanup Program, a DEC-administered remediation program for cleaning up and re-developing contaminated sites in NY State
DEC Department of Environmental Conservation, agency charged with environmental protection in the NY State
DOH Department of Health, agency charged with protection of human health in NY State
ftbg feet below grade = depth of a soil boring or well below the ground surface
HES HydroEnvironmental Solutions, Inc., consultant for developer Bilwin Development Associates
PID Photo-Ionization Detector, a device which detects general presence of vapors in air. It is non-specific
SCO Soil Cleanup Objective, a measure of an acceptable level of contamination in soils in NY State
USEPA United States Environmental Protection Agency

Chemical Abbreviations

MIBK methyl isobutyl ketone (4-Methyl-2-pentanone), a widely used cleaning solvent
MEK methyl ethyl ketone, a widely used cleaning solvent
PCBs polychlorinated biphenyls, a family of compounds widely in industry for electrical transformers, capacitors, hydraulic fluids, printing inks, and other applications
PCDDs polychlorinated dioxins, a family of highly toxic compounds found in Agent Orange, and produced during waste incineration
PCDFs polychlorinated furans, a family of highly toxic compounds related to PCDDs
PCE perchloroethylene (a.k.a. tetrachloroethene), widely used as a degreasing solvent and dry cleaning fluid
TCE trichloroethene, a chlorinated degreasing solvent

1.0 **Introduction**

This Review Report concerns a contaminated site located adjacent to and west of Marbledale Road in the village of Tuckahoe, NY. The site includes of a pair of former quarry holes which were subsequently filled with a wide variety of municipal, commercial, and industrial wastes. Eyewitness accounts and reports produced for the Brownfield Cleanup Program indicate that this waste material included incinerator ash, demolition debris, asphalt and other debris from road construction, chemical laboratory wastes, pharmaceutical products, automotive debris, refrigeration equipment, and spilled petroleum products. It is asserted by local residents that waste materials from a wide variety of local businesses, including electronics, chemical formulations, printers, and others were deposited into the former quarry holes. At present, the identity of much of the waste materials is unknown to the public; I have not had the opportunity to review any other historical records regarding what was deposited into the landfill.

A developer (Bilwin Development Associates) is proposing to build a 5-story hotel with extensive parking and separate restaurant on a 3.45-acre parcel situated in roughly the center of the area defined by the two waste-filled quarry holes. The "Site" proposed for development is described as "approximately 3.45 acres of vacant land on two adjoining tax parcels [Section 35, Block 1, Lots 1.A-E (0.2 acres) and 1.A-T (3.25 acres)]. The Site is referred to as "Former Marble Quarry Landfill" and is subject to the Brownfield Cleanup Program (BCP) Site No. C360143." (Draft Remedial Investigation Report, Sept. 16, 2015). For the purposes of this report, this will be referred to as the "BCP Site."

The BCP Site straddles the two quarry holes, and each quarry hole extends well beyond the BCP Site. The hotel would be built entirely on the portion of the BCP Site overlying the southern quarry hole. The restaurant would be adjacent to the northern quarry hole. The BCP Site, including sampling locations for the tests submitted to the state Department of Environmental Conservation (DEC), is shown in Figure 1.

This Review Report uses as its primary source of information a series of documents prepared by the developer's environmental consultant, HydroEnvironmental Solutions (HES). These documents include:

- Phase I Environmental Site Assessment, dated September 6, 2013
- Phase II Environmental Site Assessment, dated June 13, 2013
- Supplemental Phase II Environmental Site Assessment, dated January 30, 2014
- Remedial Investigation Report, dated September 16, 2015

As this report was nearing completion, a new version of the Remedial Investigation Report was issued (dated January 14, 2016). Portions of the new report have been reviewed for the purposes of finalizing this review. Also included in the review was the developer's Brownfield Cleanup Program Application, dated Feb. 11, 2014, as well as miscellaneous documents provided by the New York State Department of Environmental Conservation (NYSDEC).

1.1 Areal Extent of contamination

Beginning in the late 1800s, a marble quarry was created along the west side of Marbledale Road in the village of Tuckahoe, NY. The site and adjoining areas were quarried by Conlin Marble Co. (and its predecessors) for the Inwood Marble from the late 1800s until the1930s. Aerial photos from 1925, 1926, 1940, 1947, 1954, 1960, 1964, 1974 and 1989 were reviewed for the preparation of this report. As shown in **Appendix A**, the 1940 and 1947 photographs show two elongate quarry holes, each about 100 feet wide and roughly 800-feet long, located just west of Marbledale Road in Tuckahoe, south of Fisher Avenue. (There is a third quarry hole to the north of Fisher Ave which was not filled in with waste, due to citizen objections. This is now a park.)

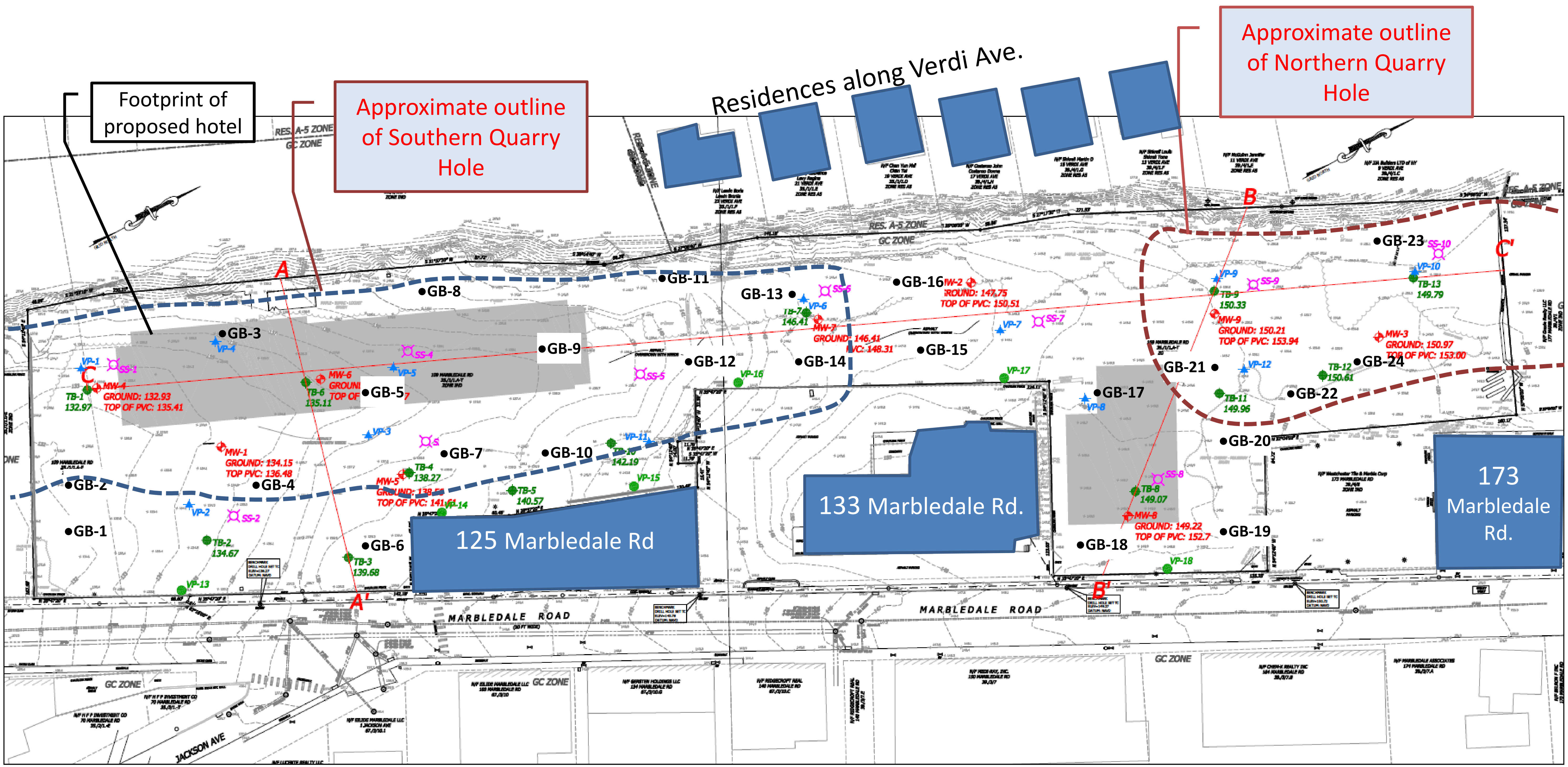
The 1954 aerial photo shows the northern lobe of the quarry filled in, but the southern lobe still containing water. A photo from 1960 (not shown) also shows the southern lobe filled with water. As seen in the 1964 photo, much, but not all, of the southern portion of the quarry is filled in. The southern hole appears to be still below the surrounding land surface. There is much debris on site. In 1966, the southern hole appears further filled-in. Later aerial photos (1974, 1989) show the southern and northern portions of the quarry completely filled-in.

The physical extent of the waste-filled quarry holes have been compared with the site proposed for development—the BCP Site—in **Appendix B**. As shown in the figure, ***about one-third of the southern quarry hole and three-quarters of the northern quarry hole lie outside the BCP Site.*** **It is important to note that, because the Brownfield Cleanup Program focuses only on the parcels proposed for development, none of the areas outside the BCP Site have been investigated for contamination. As of this writing, no remediation is planned for these areas.**

1.2 Vertical Extent of contamination

The former site owner (Howard Slotnick of Ardmar Realty; HES Phase I Report, p.19) reported that the former quarry was mined over 100 feet deep. Recent environmental testing by HES shows that the southern hole is 85 feet deep in one location. Depth to bedrock is unknown elsewhere. The depth of the northern hole has not been verified. Information in various HES reports (HES 2013a, 2014, 2015) indicates that no soil borings were drilled to bedrock in the northern quarry hole. One well, MW-9, was completed in bedrock at a depth of approximately 38 feet below grade (ftbg). This well, situated near the southern edge of the northern quarry hole, does not reflect the true depth of the hole.

It is estimated, based on the size of the former quarry holes, and the probable depth of the quarries of ~90-100 feet, that the volume of the dumped wastes is likely in excess of 500,000 cubic yards.



Key to symbols:

- SS-10 Surface soil sample
- •GB-10 Soil boring (2013)
- TB-11 Soil boring (2015)
- MW-9 Monitoring well
- VP-7 Soil vapor point
- VP-16 Soil vapor point

Figure 1. Site Plan of 109-125 Marbledale Road

Adapted from HydroEnvironmental Solutions (2016) Remedial Investigation Report, Figure 3.

Note that locations of soil borings installed in 2013 are approximate.

2.0 Site History

From the early 1950s to the mid-1970s the two quarry holes were filled with chemical wastes, fly ash, cinders, automotive wastes, air conditioners, and other un-identified materials. A detailed description of disposal activities over this time period is provided in **Appendix C**, Affidavit of J. Marinello, and **Appendix D**, Letter of Sheila Clarke to the Mayor and Village Trustees of Tuckahoe. It has been reported that fires were very common at the site, and that the Eastchester Fire Department was routinely called to put them out.

The list of waste contributors includes the following. Known or suspected waste materials are shown in parentheses.

- Eastchester municipal incinerator (ash and burned debris)
- Tuckahoe Ice (a source of Freon)
- General Diaper (cleaning chemicals)
- Burroughs-Wellcome (pharmaceuticals, manufacturing by-products, laboratory wastes, solvents, incinerator ash)
- US Vitamins (suspected pharmaceuticals, manufacturing by-products, laboratory wastes)
- Lee Oil and Chemicals (petroleum products; other chemicals)
- Contractors from Westchester County, Connecticut, New York City, and other areas (asbestos, building materials, unknown chemicals, etc.)
- Local businesses, including electronics, chemical manufacturers, and printing (solvents, inks, dyes, unknown chemicals)

The draft RI report claims that "In or about 1958, the quarry closed and the new owner entered into a lease agreement with the Village of Tuckahoe to 'fill' the former quarry." However, aerial photographs, as well as Marinello's testimony, indicate that filling began prior to 1954.

Subsequent activities at or immediately adjacent to the site include storage of automobiles, auto repair, and storage of telephone company trucks and equipment. As noted in the RI report: "In or about 1978, the current owner [Ardmar Realty] purchased the Site and began using it for auto parking. In or about 1989, the Site was also used by a tenant for auto repair and car storage. An auto sales and service facility was subsequently established at 125 Marbledale Road, which is surrounded by the central portion of the subject Site."

In or about 2004, over 300 tons of contaminated soil was removed from the eastern side of the site. This soil was contaminated with a petroleum-based product.

*2.1 **Environmental issues identified at the BCP Site***

HES, the developer's consultant, identified the following "Recognized Environmental Conditions" or RECs, at the site (Phase I ESA; HES, 2013a):

REC-1 – The presence of a significant amount of waste and fill on Site within the former open pit marble mines represents a REC because HES'[s] prior Phase II ESA [Environmental Site

Assessment] work demonstrated that the fill soils are impacted with metals and PAHs [polycyclic aromatic hydrocarbons].

REC-2 – The former use of the property for petroleum bulk storage represents a REC because release(s) from tanks were documented in 2003 and cleaned up, but changes in the NYSDEC standards have led to residual contamination on-Site in excess of applicable standards.

REC-3 – The presence of drums and containers on the property and the improper storage of these containers represents a REC because there is a significant risk that these containers may have released their contents to the environmental media beneath the Site.

REC-4 – The documented presence of the use, and release, of petroleum and/or hazardous substances from numerous adjacent sites surrounding the Site, especially those along Marbledale Road, represents a REC because a significant number of these are located at a higher elevation than the Site and this contamination may have impacted the environmental conditions of the Site.

3.0 Review of existing environmental investigations

Several investigations of the site have been undertaken by HES on behalf of Bilwin Development Associates (the "Applicant"). The first of these was a Phase II Environmental Assessment which began in the fall of 2013. This was followed by a Supplemental (aka "Additional") Phase II Environmental Assessment which was undertaken in 2014. Further site investigations were conducted in 2015, leading to the Remedial Investigation Report. This document, which currently exists in Draft form, is being revised for approval under the Brownfield Cleanup Program.

Aside from minor sampling performed for removal of an underground storage tank in 2004, we are not aware of any prior investigations of this site.

3.1 *Soil investigations*

3.1(a) Subsurface soil investigations

The current RI Report (HES 2016; p.14) provided this general description of the fill material found at the former landfill:

"Fill materials consist of cinders, ash, concrete, construction and demolition debris, metal (car parts) and miscellaneous debris that was historically disposed at the Site. Fill ranges from eight feet to nearly 90 feet in thickness across the former quarry Site, and a thin mantle of till overlying bedrock was encountered with depth in areas outside the backfilled quarry." Section 9.1.4. of the RI Report mentions also "refuse including rubber and foam, mattress parts, etc."

HES collected soil boring samples at 24 locations (GB-1 through GB-24) for the Phase II investigations. Soils were also collected when three monitoring wells were installed in 2013. An additional 13 soil borings were performed for the RI Report in 2015. From these 40 borings, a total of 308 soil samples were recovered from the sub-surface. These were characterized visually (e.g. "Fill, consisting of SILTY LOAM and weathered rock...") and also characterized for odors. Odors, where detected, ranged from "minor petroleum odor" to "strong petroleum odor," and included non-petroleum odors such as "burnt" and "organic" and "swampy."

A visual depiction of soil borings collected by HES in all areas of the site is provided in **Appendix C**. Borings collected in the southern quarry hole, including odor information, is shown in Figure C-1. A similar summary of soil borings in the north hole is shown in Figure C-2. Soil borings collected in the central and outer areas of the site are shown in Figure C-3, respectively.

The great majority of samples were collected from depths of 0-20 feet below grade. Apparently the equipment used for the Phase II investigation was not powerful enough to advance deeper into the landfill. Only one boring within the landfill proper was advanced deep enough to come in contact with the underlying marble bedrock. This boring, TB-6, extended to a depth of 85 feet, and showed extensive petroleum contamination, as evidenced by petroleum hydrocarbon odors and high PID readings at depths of 42-80 feet below grade (ftbg).

Over 300 soil samples were collected during the soil boring investigation, but most were not submitted for chemical analyses. Instead, only selected samples from each boring were submitted to the laboratory. This is further discussed for each part of the landfill below. I have divided the site into three regions:

1. the southern quarry hole
2. the northern quarry hole
3. areas outside the quarry holes, including the central part between the two holes, and areas on the perimeter of the two holes.

Region 1: Southern Quarry Hole

In Table 1, the Southern Quarry Hole section of the site has been divided into depth intervals or layers to demonstrate where chemical testing has and has not been performed. These layers were based on the depth of the borings; they do not correspond to any historical information. The average depth of the southern hole is assumed to be 85 feet, based one boring which encountered bedrock (TB-6). The actual average depth is unknown at this time.

Table 1. Summary of chemical tests performed on samples from the Southern Quarry Hole

Depth Interval (ft below grade)	Number of soil borings	Number of chemical analyses	
		Organic compounds	Metals & PCBs
0 - 12 feet	19	12	10
12 - 30 feet	12	5	6
30 -51 feet	5	3	2
51 - 85 feet	1	0	0

A total of 161 samples were collected and visually examined. Much of the material in this part of the landfill was characterized as “Fill,” “Ash,” “Silt,” or “Sand” with many occurrences of discarded items such as glass, brick, wood, plastic, and concrete.

0 - 12 foot interval: The top layer of the southern quarry hole is reasonably well-characterized: 10 samples were analyzed for PCBs and metals; 12 were analyzed for a full suite of volatile and semi-volatile organic chemicals. Samples were collected from a total of 19 borings, most of which went up to or past the 12-ft depth. HES reported many odors, the most common being “burnt odor.” Petroleum odors (‘slight’ & ‘strong’ hydrocarbon) were reported in two of the borings (see **Appendix C**, Figure C-1).

12 - 30 foot interval: The next layer of the landfill—an 18-foot interval—has fewer chemical analyses: 5 organic and 6 metals/PCBs. Reported odors included “burnt” (5 samples); ‘slight’ petroleum hydrocarbon (2 samples) and ‘strong’ petroleum hydrocarbon (1 sample). A “strong solvent smell" was reported in one sample. Unfortunately this sample was not analyzed for organic chemical contamination despite the odor.

30 – 51 foot interval: The next layer of the landfill—a 21-foot interval—has even fewer chemical analyses: 3 organic and 2 metals/PCBs. All of these analyses are from samples near the top of this layer; there are no chemical analyses of soils below a depth of 34 feet. Reported odors included 'slight' petroleum (4 samples) and 'strong' petroleum (2 samples).

51 – 85 foot interval: The next layer of the landfill—a 34-foot interval—was penetrated by a single soil boring (TB-6). Based on odors reported, soils in this part of the landfill are extensively contaminated by petroleum. A continuous 30-foot stretch of this boring was reported with odors ranging from 'slight' petroleum hydrocarbon (12 ft) to 'moderate' petroleum (10 ft) to 'strong' petroleum hydrocarbon (8 ft).
The strong petroleum odors were corroborated by very high Photo Ionization Detector (PID) readings. [The PID is a device which detects general presence of vapors in air. It is non-specific, so—unfortunately—PID readings cannot identify individual contaminants. However, it is useful as a general indicator of volatile compounds like those found in gasoline.]
The highest PID readings seen anywhere in the landfill were observed at test boring TB-6 at a depth of 56 to 60 ftbg: concentrations ranged from 230 ppm to 287 ppm. For comparison, PID readings in uncontaminated air are typically 0-1 ppm. The combination of odors and high PID readings shows clear evidence of contamination, yet no soils from this boring were analyzed for organic or other chemicals.

In summary, the soils in the southern quarry hole have only been partially investigated. The upper 12-feet is reasonably well-characterized, but chemical analysis of soils below 12-ft depth is sparse. A total of 8 samples between 12- and 34-foot depths were analyzed for the usual suite of organic and other chemicals. The deepest part of the landfill, extending from 34 to 85+ feet, has been investigated with two borings, one extending to 51 feet, the other to 85 feet. The deeper boring shows clear evidence of petroleum contamination—the greatest amount found in any part of the site. Yet, none of the samples collected at these depths were chemically analyzed.

Region 2: Northern Quarry Hole

This analysis divides the Northern Quarry Hole into the same depth intervals or layers as the southern hole. Chemical testing is summarized in Table 2. As in the southern quarry hole, much of the material in this part of the landfill was characterized as "Fill," "Ash," "Silt," or "Sand" with many occurrences of discarded items. A total of 83 samples were collected and visually examined. The borings are depicted in **Appendix C**, Figure C-2.

Table 2. Summary of chemical tests performed on samples from the Northern Quarry Hole.

Depth Interval (ft below grade)	Number of soil borings	Number of chemical analyses	
		Organic compounds	Metals & PCBs
0 - 12 feet	9	6	7
12 - 30 feet	7	3	3
30 -51 feet	3	2	0
51 - 85 feet	0	0	0

0 - 12 foot interval: The top layer of the northern quarry hole not as well-characterized as the southern hole: Only 7 samples were analyzed for PCBs and metals; 6 were analyzed for a full suite of volatile and semi-volatile organic chemicals. Samples were collected from a total of 9 borings, all of which went up to or past the 12-ft depth. HES reported strong petroleum odors in one of the borings (see Figure C-2).

12 - 30 foot interval: The next layer of the landfill—an 18-foot interval—has even fewer chemical analyses: 3 samples tested for the organic suite of chemicals and 3 for metals/PCBs. Reported odors included "burnt" (2 samples); slight petroleum (4 samples) and "swampy" (3 samples).

30 – 51 foot interval: The next layer of the landfill—a 21-foot interval—has a single sample, collected at a depth of 36-37 ftbg, which was analyzed for the organic suite of chemicals. No samples were analyzed for metals or PCBs. No petroleum odors were noted in any of the samples from this layer.

51 – 85(?) foot interval: The bottom-most layer of the landfill—at depths exceeding 51 feet—was not investigated at all. There is no information on what is buried there, or the presence or absence of odors, or any chemical testing. The actual depth of the northern hole is unknown since no borings penetrated beyond 51 ftbg, and the marble bedrock was not encountered in the central part of the hole.

In summary, the soils in the northern quarry hole have only been partially investigated. The upper 12-feet could be better characterized. Chemical analysis of soils below the 12-ft depth is sparse at best. A total of 4 samples between 12- and 38-foot depths were analyzed for the usual suite of organic and other chemicals. The deepest parts of the landfill, extending from 34 to 85+ feet, have not been investigated at all.

Region 3: Areas Outside the Quarry Holes

A total of twelve borings were retrieved from areas that appear to be outside the quarry holes:

- east of the southern hole: TB-2, TB-3, GB-1, GB-6
- east of the northern hole: GB-17, GB-18, GB-19, GB-20
- between the quarry holes: MW-2, GB-15, GB-16
- west of the northern hole: GB-8

A total of 63 samples were collected and visually examined. Despite being outside the quarry holes, most of the material encountered in these borings was characterized as "Fill." Five of the borings were less than 8-ft deep; the deepest boring was MW-2, which extended to 32-ft. No "burnt" or solvent odors were encountered in these soils, but limited petroleum odors were encountered in two borings (TB-2, TB-3). A complete overview of all soil samples in shown in Figure C-3.)

Chemical analyses were performed on 8 samples from the 0-12-foot interval. Chemical analysis of soils below 12-ft depth is very limited. A total of 3 samples between 12- and 32-foot depths were analyzed for the usual suite of organic and other chemicals; only two were analyzed for PCBs and metals. The depth of affected soils in these areas is highly variable. In some areas the bedrock is close to the surface, but in others (e.g. MW-2) it is unclear from the boring log whether bedrock was encountered.

3.1(b) Surface soil investigations

In addition to collecting a total of over 300 sub-surface soil samples, HES collected 11 shallow soil samples. These went to a depth of only 2 inches, so they represent soils that are the most easily disturbed or eroded. Humans and animals walking on the site are most easily exposed to these soils. These were all analyzed for volatile and semi-volatile organic chemicals, PCBs and metals.

3.1(c) Contaminants found in the soil

Chemical analysis of soils shows contamination by a wide variety of organic compounds, PCBs, and toxic metals. New York State has established Soil Cleanup Objectives (SCOs) for many, but not all, of these substances. Soil Cleanup Objectives (SCO) are the cleanup goals that NYS DEC has established to indicate acceptable levels of soil contamination on re-developed brownfield sites.[1] The objectives depend on the final use of the property:

Unrestricted use soil cleanup objectives: will require no use restrictions on the site for the protection of public health, groundwater and ecological resources due to the presence of contaminants in the soil.

Restricted use soil cleanup objectives: are designed to protect public health only, at varying levels depending on whether the site is considered "residential," "commercial," or "industrial."

Metals contamination in both shallow and sub-surface soil is compared to SCOs in Table 3. A summary of both organic and inorganic (metals, cyanide) contamination in shallow and sub-surface soil contamination was provided by HCS as Table 8 in the RI Report. It is included here

---

[1] Note: The soil cleanup objectives do not account for:

1. volatile contaminants which can appear in soil vapors, which could then cause health problems via vapor intrusion into buildings.
2. soil-borne contaminants which can lead to contamination of surface water and surface water sediments.

as Table 4. It should be noted that this table is not comprehensive; samples collected during the Phase II investigations are not included in this summary. Despite the incomplete nature of the data, Tables 3 and 4 demonstrate that many of the toxic chemicals in the soil on the Site exceed DEC soil cleanup standards for unrestricted use; some exceed soil cleanup standards for restricted uses as well.

Table 3. Summary of soils data for metals, metalloids, and total cyanide.
An X indicates that at least one sample exceeded the NYS Soil Cleanup Criteria (SCO) shown. In most cases, there are multiple exceedances.

		Exceedances		Maximum concentrations	
	Unrestricted use SCO, ppm	**Surface soil (0-2")**	**Sub-surface soils**	**Surface soil (0-2")**	**Sub-surface soils**
Arsenic	13		**X**	4.5	**25.1**
Barium	350		**X**	207	**1,120**
Beryllium	7.2			0.52	0.61
Cadmium	2.5		**X**	**0.42**	**3.25**
Chromium*	30		**X**	28.5	**84.7**
Copper	50	**X**	**X**	**64.5**	**150**
Lead	63	**X**	**X**	**181**	**589**
Manganese	1,600			514	721
Total Mercury	0.18	**X**	**X**	**0.24**	**0.57**
Nickel	30		**X**	28	**62**
Selenium	3.9	unknown	unknown	No data	No data
Silver	2	unknown	**X**	No data	**6.45**
Zinc	109	**X**	**X**	**212**	**5,500**
Total Cyanide	27	unknown		No data	9.8

* trivalent state assumed

Table 4. Summary of Soils Data (from RI investigation only). Source: Table 8 of Draft Remedial Investigation Report (HES, Jan. 14, 2016). See definitions of Soil Cleanup Objectives below.

Substances in excess of Soil Cleanup Objectives are highlighted in yellow.

Analyte		NYSDEC BCP SCOs			Shallow Soil (11 samples)		Subsurface Soil (27 samples)	
		NY-Restricted	NY-Residential Restricted	NY-UnRestricted	Frequency of Detection	Range of Detected Concentrations	Frequency of Detection	Range of Detected Concentrations
Volatiles (TCL) By SW8260C								
Acetone	ug/Kg	100,000	100,000	50	4	6.9-370	14	20-250
Benzene	ug/Kg	2,900	4,800	60			6	5.9-1,800
Carbon Disulfide	ug/Kg						5	1.2-6.9
Dichlorodifluoromethane	ug/Kg						5	8-420
Ethylbenzene	ug/Kg	30,000	41,000	1,000			5	23-1,200
Isopropylbenzene	ug/Kg						3	27-6,900
m&p-Xylene	ug/Kg				1	78	9	21-4,500
Methyl ethyl ketone	ug/Kg	100,000	100,000	120			7	11-110
Methylcyclohexane	ug/Kg						4	4.1-9,200
o-Xylene	ug/Kg						7	5.1-92
Toluene	ug/Kg	100,000	100,000	700			6	49-1,000
Total Xylenes	ug/Kg		100,000	260			7	13.5-4,500
Trichloroethene	ug/Kg	10,000	21,000	470			1	330
Trichlorofluoromethane	ug/Kg						2	46-75
Semivolatiles By SW8270D								
1,1-Biphenyl	ug/Kg						8	170-6,500
3&4-Methylphenol (m&p-cresol)	ug/Kg						7	420-1,200
Acenaphthene	ug/Kg	100,000	100,000	20,000			2	350-790
Acenaphthylene	ug/Kg	100,000	100,000	100,000	4	130-210	1	810
Anthracene	ug/Kg	100,000	100,000	100,000	6	140-320	9	300-2,200
Benz(a)anthracene	ug/Kg	1,000	1,000	1,000	10	170-1,900	19	540-5,900
Benzaldehyde	ug/Kg						1	620
Benzo(a)pyrene	ug/Kg	1,000	1,000	1,000	10	240-1,900	18	260-5,800
Benzo(b)fluoranthene	ug/Kg	1,000	1,000	1,000	10	340-2,900	21	350-7,700
Benzo(ghi)perylene	ug/Kg	100,000	100,000	100,000	10	160-540	8	140-2,900
Benzo(k)fluoranthene	ug/Kg	1,000	3,900	800	9	140-990	12	240-2,500
Bis(2-ethylhexyl)phthalate	ug/Kg				2	110-260	16	240-32,000
Chrysene	ug/Kg	1,000	3,900	1,000	10	190-1,600	21	300-6,000
Dibenz(a,h)anthracene	ug/Kg	330	330	330	2	130-160	2	390-790
Dibenzofuran	ug/Kg			7,000			4	250-1,400
Fluoranthene	ug/Kg	100,000	100,000	100,000	10	140-2,900	23	450-9,200
Fluorene	ug/Kg	100,000	100,000	30,000			6	140-1,800
Indeno(1,2,3-cd)pyrene	ug/Kg	500	500	500	10	130-520	9	140-2,700
Naphthalene	ug/Kg	100,000	100,000	12,000			8	330-7,400
Phenanthrene	ug/Kg	100,000	100,000	100,000	9	140-940	23	220-10,000
Pyrene	ug/Kg	100,000	100,000	100,000	9	160-2,300	23	410-7,400
PCBs By SW8082A								
PCB-1248	ug/Kg	1,000		100			1	1,300
PCB-1260	ug/Kg	1,000		100	2	56-71	3	130-1,100
Metals, Total								
Aluminum	mg/Kg				12	741-16,500	27	3,670-24,900
Arsenic	mg/Kg	16	16	13	11	1.2-4.5	27	0.9-25.1
Barium	mg/Kg	350	400	350	12	4.3-207	27	17-1,120
Beryllium	mg/Kg	14	72	7.2	11	0.2-0.52	17	0.25-0.61
Cadmium	mg/Kg	2.5	4.3	2.5	2	0.22-0.42	13	0.16-3.25
Calcium	mg/Kg				12	126-80,700	27	5,090-168,000
Chromium	mg/Kg			30	12	3.9-28.5	27	7.23-84.7
Cobalt	mg/Kg				12	0.67-12.3	27	2.68-12.9
Copper	mg/kg	270	270	50	12	2.19-64.5	27	4.26-150
Iron	mg/Kg				12	1,960-27,500	27	5,030-73,300
Lead	mg/Kg	400	400	63	12	1.3-181	27	5.13-589
Magnesium	mg/Kg				12	226-44,300	27	3,580-83,800
Manganese	mg/Kg	2,000	2,000	1,600	12	28.3-514	27	130-721
Mercury	mg/Kg	0.81	0.81	0.18	9	0.03-0.24	21	0.03-0.57
Nickel	mg/Kg	140	310	30	12	1.02-28.2	27	5.77-62
Potassium	mg/Kg				12	129-4490	27	353-5,300
Silver	mg/Kg	36	180	2			8	0.84-6.45
Sodium	mg/Kg				12	14-748	27	31.9-3,960
Vanadium	mg/Kg				12	3.7-47.9	27	8.82-80.5
Zinc	mg/Kg	2,200	10,000	109	12	4.3-212	27	36.9-5,500
Miscellaneous/Inorganics								
Total Cyanide	mg/Kg						9	0.443-9.82

Soil chemical contamination is described in greater detail below. For the purposes of this discussion, comparisons will be made to New York's "Unrestricted Use" Soil Clean-up Objectives.

1. Metals
   A wide variety of toxic metals are found at the site in both surface soils and sub-surface soils. As summarized in Table 3. SCOs were exceeded in surface and/or sub-surface soils, for arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc. As noted by HES, "The results of subsurface soil sampling for metals indicate that metals are pervasive and common throughout the fill material at varying depths."

2. Chlorinated solvents: Methylene chloride; trichloroethylene(TCE); and chloroform are found sporadically in soil samples throughout the site. Highest concentrations include 1,400 ppb of chloroform in GB-9 and 1,100 ppb of methylene chloride in GB-7. Both of these exceed the SCOs of 370 ppb and 50 ppb, respectively. Other chlorinated solvents, like trichloroethylene, were generally at low concentrations.

3. Non-chlorinated solvents: Acetone is widespread in site soils, both in shallow soils (4 – 370 ppb) and sub-soils (20 – 1,100 ppb). The SCO for acetone is 50 ppb. Methyl ethyl ketone was detected often but was consistently below the SCO.

4. Petroleum Hydrocarbons: These compounds, including benzene, toluene, xylenes, ethylbenzene, and substituted benzenes are found widely in sub-soils throughout the site. This is consistent with the observation of petroleum odors in many of the soil borings. Compounds exceeding SCOs include the following:

   - **benzene:** up to 1,800 ppb SCO = 60 ppb
   - **toluene:** up to 1,000 ppb SCO = 700 ppb
   - **total xylenes:** up to 4,500 ppb SCO = 260 ppb
   - **ethylbenzene:** up to 1,200 ppb SCO = 1,000 ppb

   Related compounds found in site soils include trimethyl benzenes, isopropyl benzene, and methylcyclohexane. SCOs have not been developed for all of these compounds. All of these hydrocarbons are partially soluble in water, and therefore can leach into groundwater.

5. Polycyclic aromatic hydrocarbons (PAHs)
   This category of compounds represents 16-18 multi-ringed compounds, many of which are carcinogenic. They are found in coal, and in petroleum products such as gasoline, diesel, asphalt, and fuel oils. They are also formed during combustion, so they are also present in ash and cinders. PAHs are found throughout the site, both in shallow soils (10 of 11 samples) and sub-soils (23 of 27 samples collected for the RI; many of the Phase II samples contained PAHs as well).

SCOs are set for individual PAHs. These were exceeded in numerous locations. See Table 4 for details.

6. Polychlorinated biphenyls (PCBs)
PCBs are found at relatively low concentrations in several samples. The SCO of 100 ppb for unrestricted use and/or the SCO of 1,000 ppb was exceeded in several samples, including GB-17 (400 ppb), TB-4 (1,100 ppb), TB-7 (1,300 ppb) and TB-10 (160 ppb). It is worth noting that Aroclors 1248 and 1260 were found at differing locations, which indicates differing sources of PCBs. Aroclor 1260 was typically used in electrical transformers, while 1248 was historically found in hydraulic fluids.

* * *

.

*3.2 **Groundwater investigations***

Groundwater was initially sampled at two temporary wells installed in May 2013 (GB-11, GB-12). In the fall of 2013, three permanent monitoring wells were installed (MW-1, MW-2, MW-3) and sampled. An additional six monitoring wells were installed in the spring of 2015 (MW-4 through MW-9). All nine wells were sampled in May 2015 for a suite of volatile and semi-volatile organic compounds, as well as PCBs. Monitoring wells were sampled by NYSDEC in December 2015 for volatile and semi-volatile organic compounds, PCBs, and metals.

As of this writing, no further groundwater testing is planned. However, as discussed in Section 3.2 (b) Groundwater flow , there are serious concerns about the adequacy of the entire design and scope of the groundwater monitoring program at the BCP Site. For example, the movement of contaminated groundwater off-site is unknown at this time.

It should also be noted that several classes of toxic compounds which are suspected to be in the landfill—namely polychlorinated dioxins and furans, and pharmaceutical compounds—have ***not been investigated***. There are good reasons to believe that these substances are present, as discussed in Section 4, Data Gaps. Further limitations of the groundwater sampling are discussed below.

3.2 (a) Contaminants found in site groundwater

The initial round of groundwater sampling monitoring wells MW-1, MW-2, and MW-3 was described as follows:
"The groundwater collected from monitor wells designated MW-1 and MW-3 were visibly impacted by previous site use based on field observations. **The groundwater was noted to be black with a noticeable "sweet odor." The "sweet odor" may be attributed to the presence of solvent breakdown compounds…"** (Additional Phase II ESA, p. 18; emphasis added)
Further sampling and analysis of groundwater by NYSDEC in December 2015 showed total organic carbon levels as high as 113 mg/L—a level which is comparable to dilute untreated sewage. Based on this, **it may be concluded that the groundwater at the site is grossly polluted with a variety of organic substances.**

Chemical contamination of the groundwater is summarized below. Comparisons are made to New York's Ambient Water Quality Standards for Groundwater. The data, incomplete as they are, show specific toxic organic compounds such as trichloroethylene, PCBs, PAHs, and benzene which frequently exceed NYS ambient groundwater standards.

1. Chlorinated solvents:

Tetrachloroethene (a.k.a. perchloroethylene) and trichloroethene were found at very high levels in monitoring well MW-8, when sampled in both May and December 2015. (See summary chart below.) Concentrations of this compound, commonly used as a dry cleaning fluid and degreasing solvent, increased from 480 to 1,700 µg/L over the span of seven months. These levels exceed the groundwater standard of 5 µg/L by factors of ~100 to ~340. MW-9 also contained tetrachloroethene somewhat above 5 µg/L in May 2015. MW-8 and MW-9 were completed in bedrock, and therefore represent a different flow regime from most of the other monitoring wells (see discussion below). Other wells generally had low or non-detected levels.

All concentrations in µg/L.	NYSDEC Ambient Water Quality Std	MW-8		MW-9	
Compound		May 21-22, 2015	Dec. 16, 2015	May 21-22, 2015	Dec. 16, 2015
Tetrachloroethene	5 µg/L	480	1,700	8.1	<5
Trichloroethene	5 µg/L	47	38.5	<1	<5

2. Petroleum Hydrocarbons:

A variety of petroleum hydrocarbons have been found throughout the site groundwater, including benzene, toluene, xylenes, and other related compounds. This is consistent with the widespread occurrence of these compounds in site soils. Groundwater concentrations frequently exceeded NYS ambient standards, but were generally not far above them.

3. PAH (polycyclic aromatic hydrocarbon) compounds:

PAH (polycyclic aromatic hydrocarbon) compounds are found throughout the site groundwater. They were frequently far above the NYS groundwater standards. Both temporary wells sampled in May 2013 showed relatively high concentrations of these compounds. The results are shown in Table 5.

Further sampling conducted in the fall of 2013, and again in May and December 2015 confirmed these results. All nine wells sampled in May 2015 had at least one PAH compound above these standards; in most cases, 5-6 compounds were well above the 0.002 ppb standards. Sampling in December 2015 confirmed the presence of many PAH compounds well above NYS groundwater standards.

Table 5. Results of groundwater sampling conducted on May 6, 2013 for polycyclic aromatic hydrocarbons. Bold results indicate a violation of NYS Ambient Standards for groundwater. (ND = not detected; no standards have been developed for three compounds)

Sample I.D.	GB-11 GW	GB-12 GW	NYSDEC Ambient Water Quality Standards
Lab I.D. No.	BD68598	BD68599	
Depth (ftbg)	10.1	7.6	
Sample Date	05/06/2013	05/06/2013	
SEMI-VOLATILE ORGANIC COMPOUNDS (SVOCs)			
2-Methylnaphthalene	4.6	**7.5**	**4.7**
Acenaphthene	4.3	13	**20**
Acenaphthylene	1.5	ND	**--**
Anthracene	6.3	12	**50**
Benz(a)anthracene	**15**	**19**	**0.002**
Benzo(a)pyrene	**15**	**17**	**ND**
Benzo(b)fluoranthene	**20**	**22**	**0.002**
Benzo(ghi)perylene	9.8	9.7	**--**
Benzo(k)fluoranthene	**6.6**	**7.5**	**0.002**
Chrysene	**16**	**18**	**0.002**
Dibenz(a,h)anthracene	2.7	2.7	**--**
Fluoranthene	35	59	**50**
Fluorene	3.9	17	**50**
Indeno(1,2,3-cd)pyrene	**8**	**9**	**0.002**
Naphthalene	3.9	**16**	**10**
Phenanthrene	21	**61**	**50**
Pyrene	20	45	**50**

4. Polychlorinated Biphenyls (PCBs) and Pesticides

PCBs and a variety of chlorinated pesticides have been found in the site groundwater. These compounds were not reported in 2013, when the first three wells were installed, but were tested in samples collected from all nine monitoring wells in May 2015, and again in December 2015. These tests showed the following pesticides:

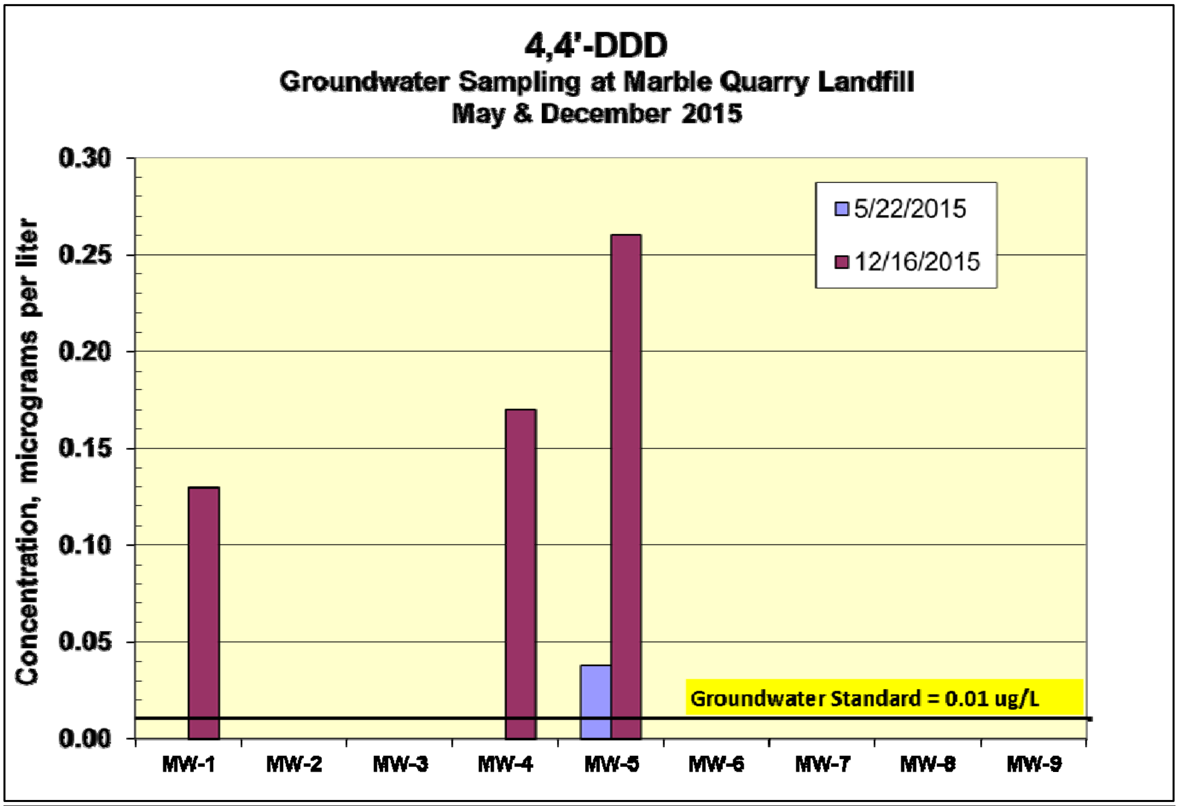
- Two breakdown products of the pesticide DDT were found three wells in May 2015, and four wells in December 2015. As shown in Figure 2A, all detected concentrations were far above the ambient groundwater standard of 0.01 µg/L.

- The pesticide dieldrin was found at 0.12 µg/L in MW-5, three times the ambient groundwater standard of 0.004 µg/L. It was not detected elsewhere, but high detection limits may have obscured the presence of this pesticide.
- Hexachlorocyclohexanes (HCCHs) represent a family of related compounds, including the pesticide lindane. All are toxic. Alpha-HCCH was found at 0.46 µg/L, which is 46 times the ambient groundwater standard of 0.01 µg/L. Lindane was found at 0.11 µg/L in MW-5, above the ambient groundwater standard of 0.05 µg/L. Other forms of HCCH were found at much lower levels in MW-2.
- Several other pesticides were found in site groundwater, including gamma-chlordane (0.11 µg/L), endrin aldehyde).018 – 0.032 µg/L, and heptachlor epoxide (0.012 µg/L).

PCBs were found above groundwater standards in samples from two wells in May 2015: MW-1 and MW-7 (see Figure 2B.). Both samples were quantified as Aroclor 1260, which indicates electrical transformer oil as the probable source. No PCBs were reported in the December samples, but high laboratory reporting limits (~0.5 µg/L) may have made it impossible to find PCBs.

5. <u>Phenol</u>

The compound phenol, which has an ambient groundwater standard of 1 µg/L, was found above this standard in several groundwater samples in May and December 2015. (See Figure 2B.) Concentrations in May ranged as high 100 µg/L (in MW-9), but only 1.2 µg/L in December. The reason for the wide discrepancy in results is unknown.



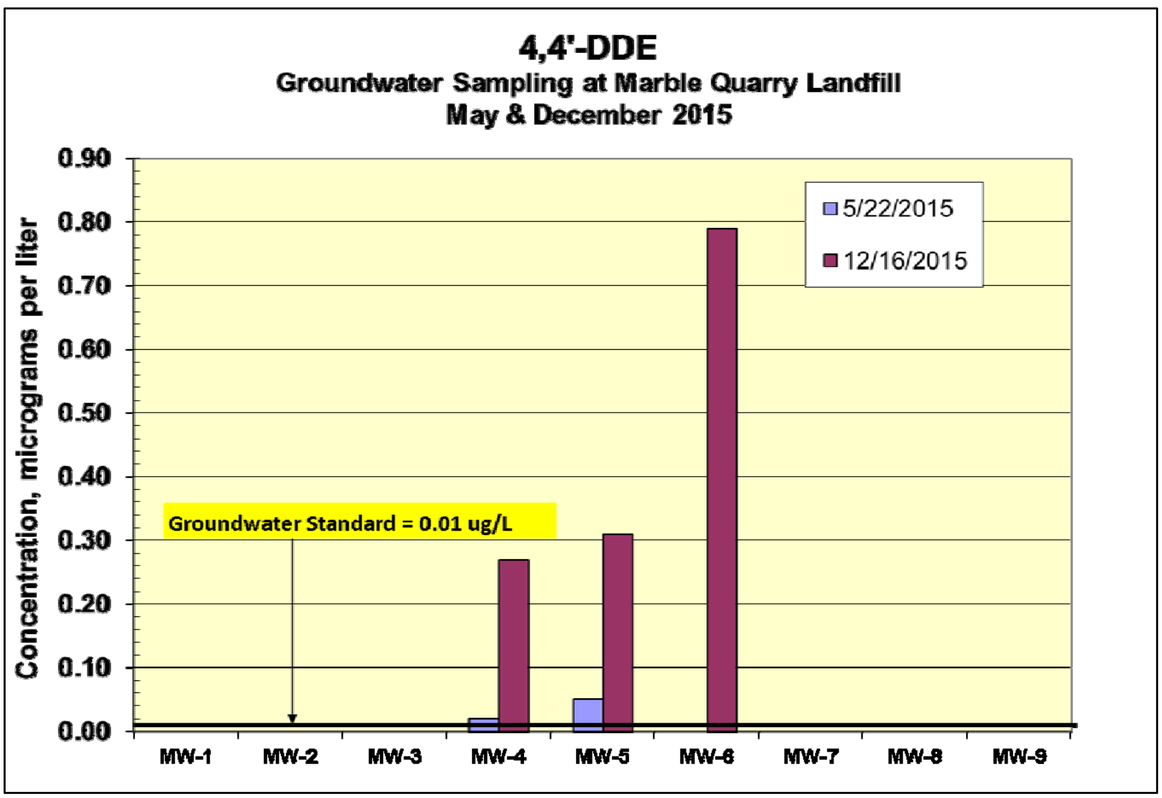
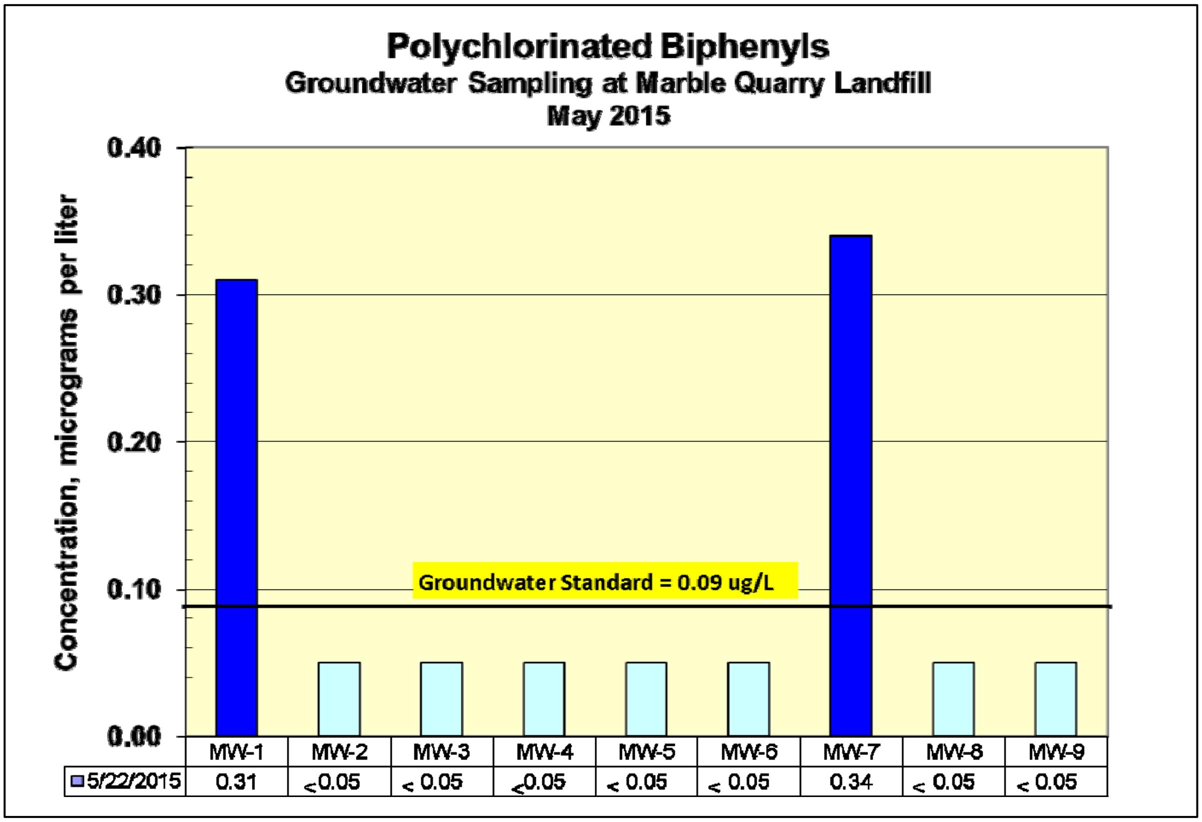


Figure 2A. Groundwater results for 4,4'-DDD and 4,4'-DDE compared to NYS ambient water standards.



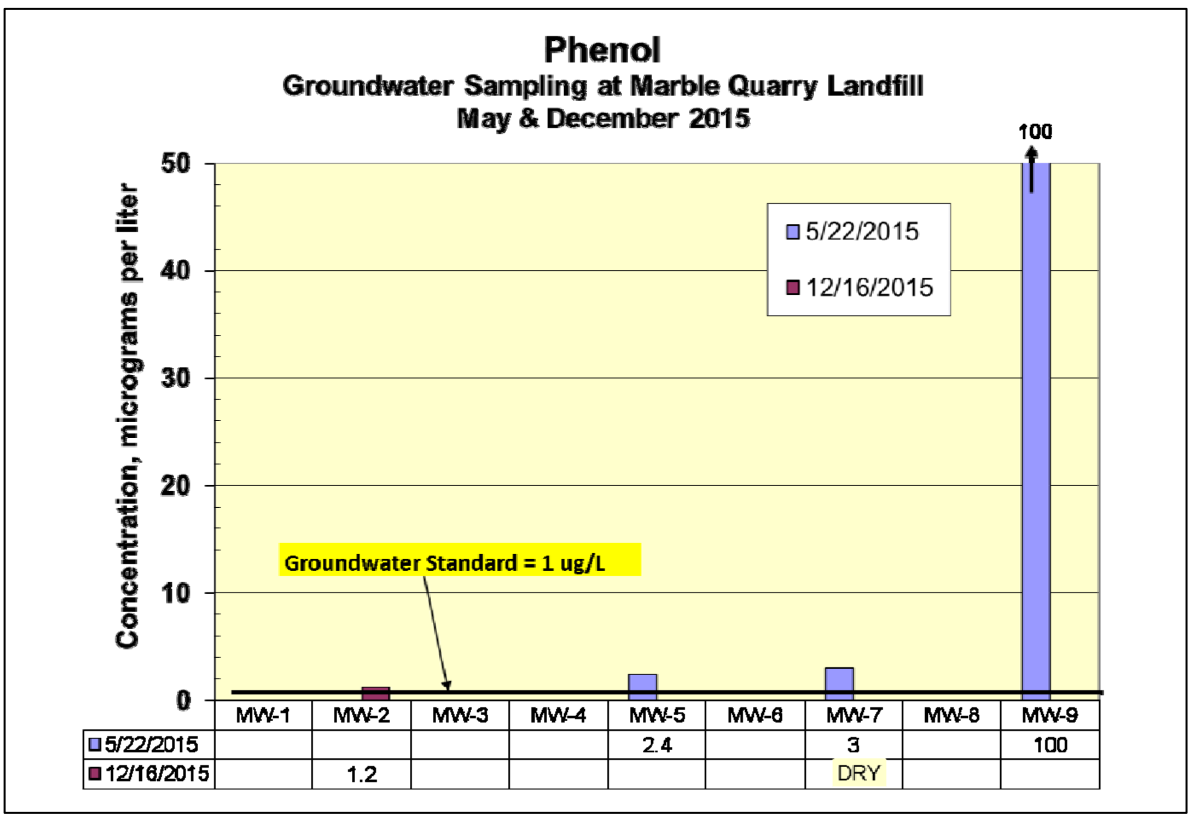


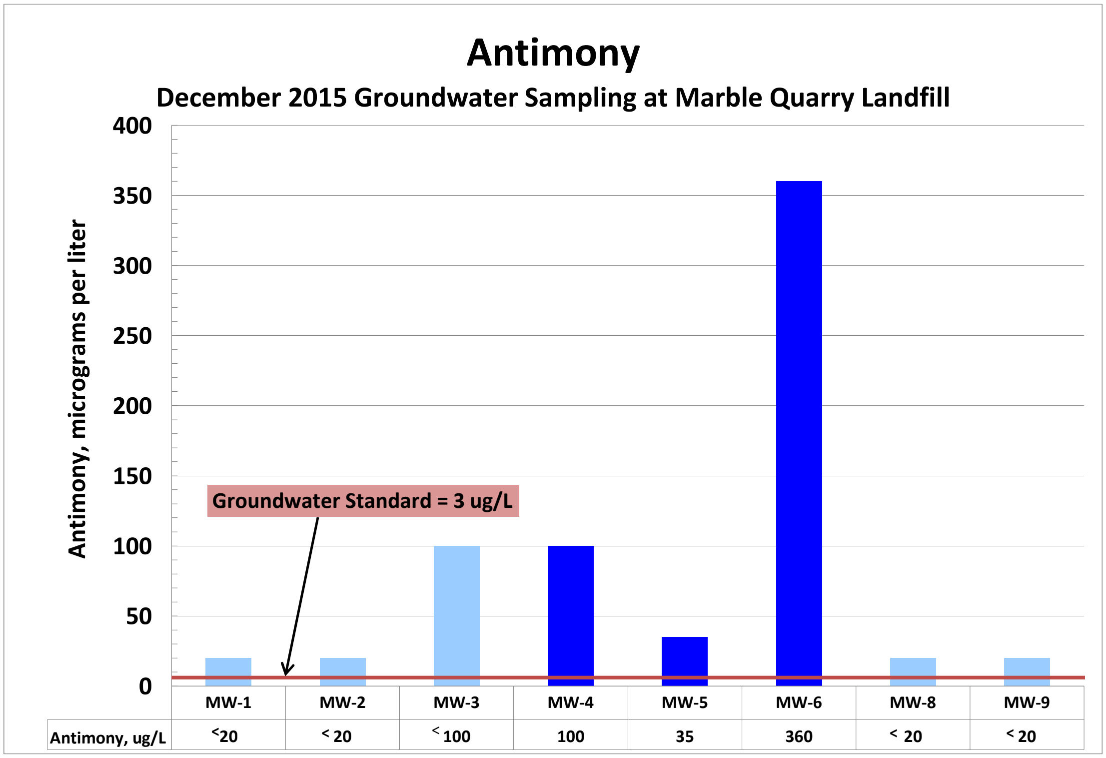
Figure 2B. Groundwater results for PCBs and phenol compared to NYS ambient water standards.

6. <u>Metals</u>

Groundwater was not tested for metals until a round of samples was collected by the NYSDEC on December 16, 2015. Samples were collected from eight wells (MW-1 through MW-6, MW-8, and MW-9); the well MW-7 was dry so no sample could be collected. Analytical results (Test America, 2016) show that many of the samples were highly contaminated with a wide variety of heavy metals, as well as arsenic. Data were compared with NY State Ambient Water Quality Standards for groundwater, most of which are based on protection of human health. These comparisons are shown in Figures 2C through 2G.

In general, MW-3, MW-4, MW-5, and MW-6 were the most heavily contaminated. The graphs on the following pages show the following:

- The level of antimony in MW-6 was 120 times the NYS standard of 3 µg/L. Antimony exceeded 3 µg/L in MW-4 (33x) and MW-5 (12x). The detection limit for antimony was above 3 µg/L, so it is possible that groundwater in the other wells exceeded this limit.
- Arsenic exceeded the standard of 25 µg/L in MW-3, -4, -5, and -6 (up to 11 times)
- Barium exceeded the standard of 1000 µg/L in MW-3, -4, -5, and -6 (up to 5.4 times)
- Cadmium exceeded the standard of 5 µg/L in MW-4, -5, and -6 (up to 12 times)
- Chromium exceeded the standard of 25 µg/L in MW-3, -4, -5, and -6 (up to 21 times)
- Copper exceeded the standard of 200 µg/L in MW-3, -4, -5, and -6 (up to 28 times)
- Mercury exceeded the standard of 0.7 µg/L in MW-3, -4, -5, and -6 (up to 23 times)
- Nickel exceeded the standard of 100 µg/L in MW-3, -4, -5, and -6 (up to 12 times)
- Lead concentrations were extremely high in MW-3, -4, -5, and -6, ranging from 5,500 to 34,500 µg/L; groundwater in these four wells exceeded the standard of 25 µg/L by factors of 220 to 1,380 times. MW-1 also exceeded the standard, but only by a factor of about two.



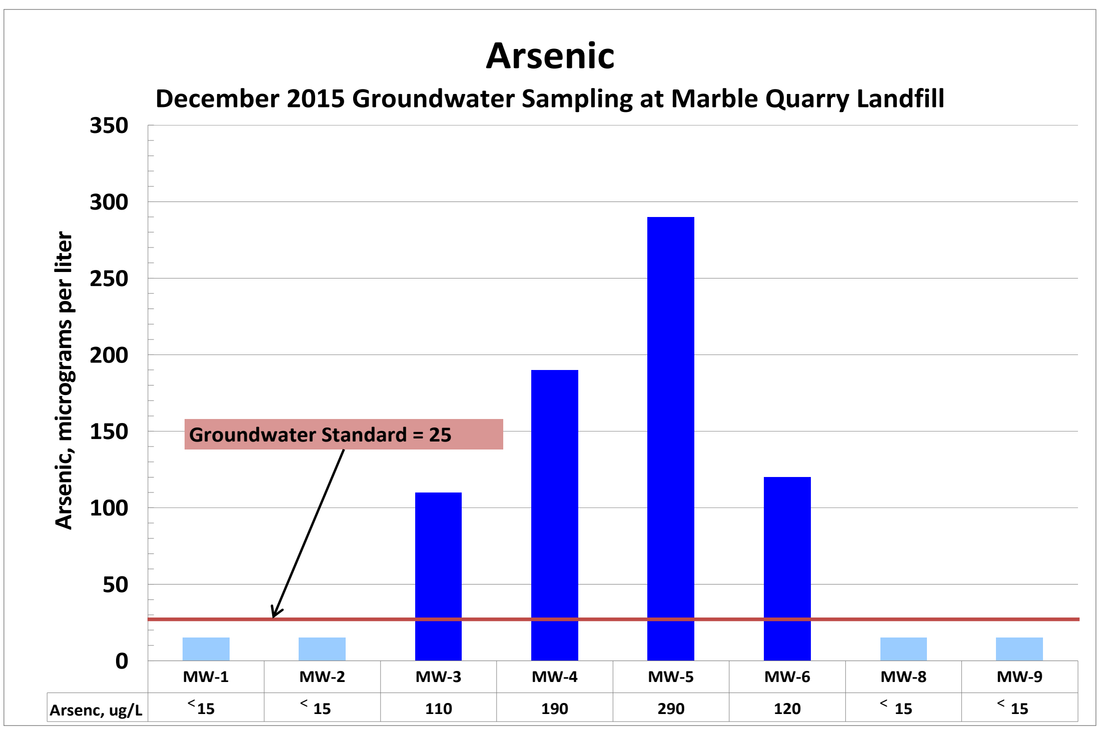
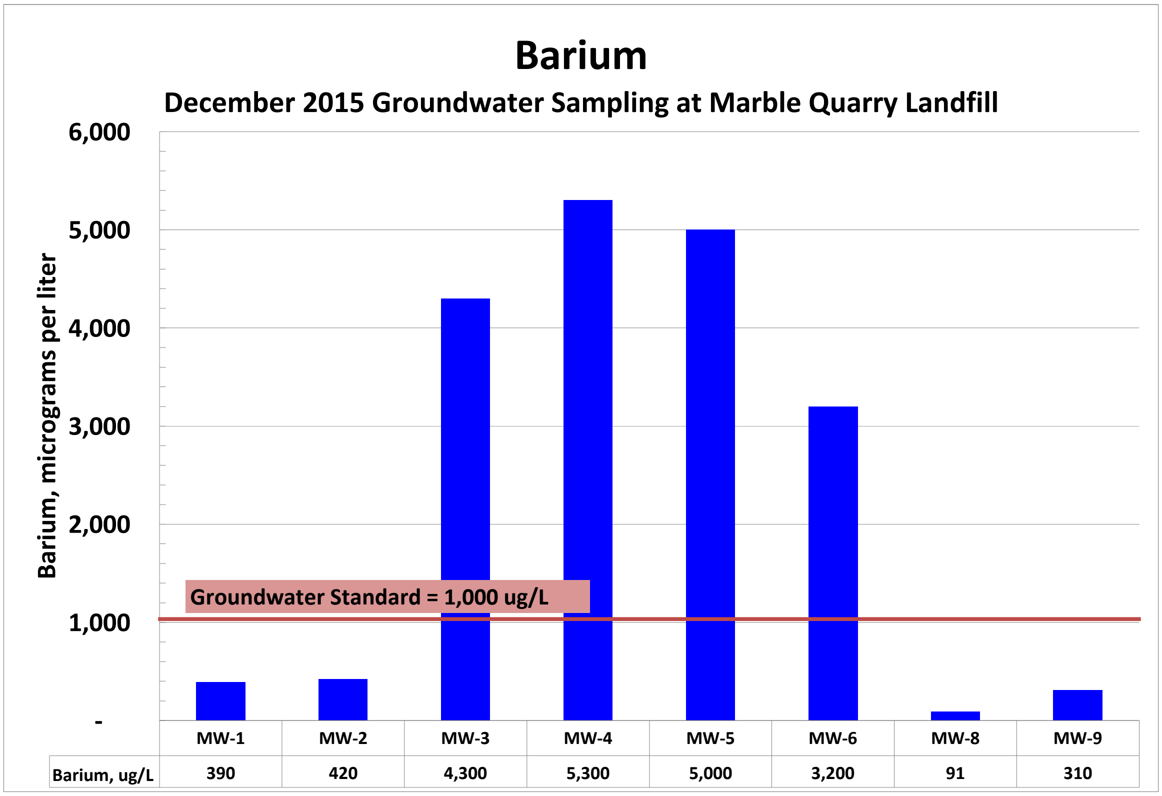


Figure 2C. Groundwater results for antimony and arsenic compared to NYS ambient water standards.



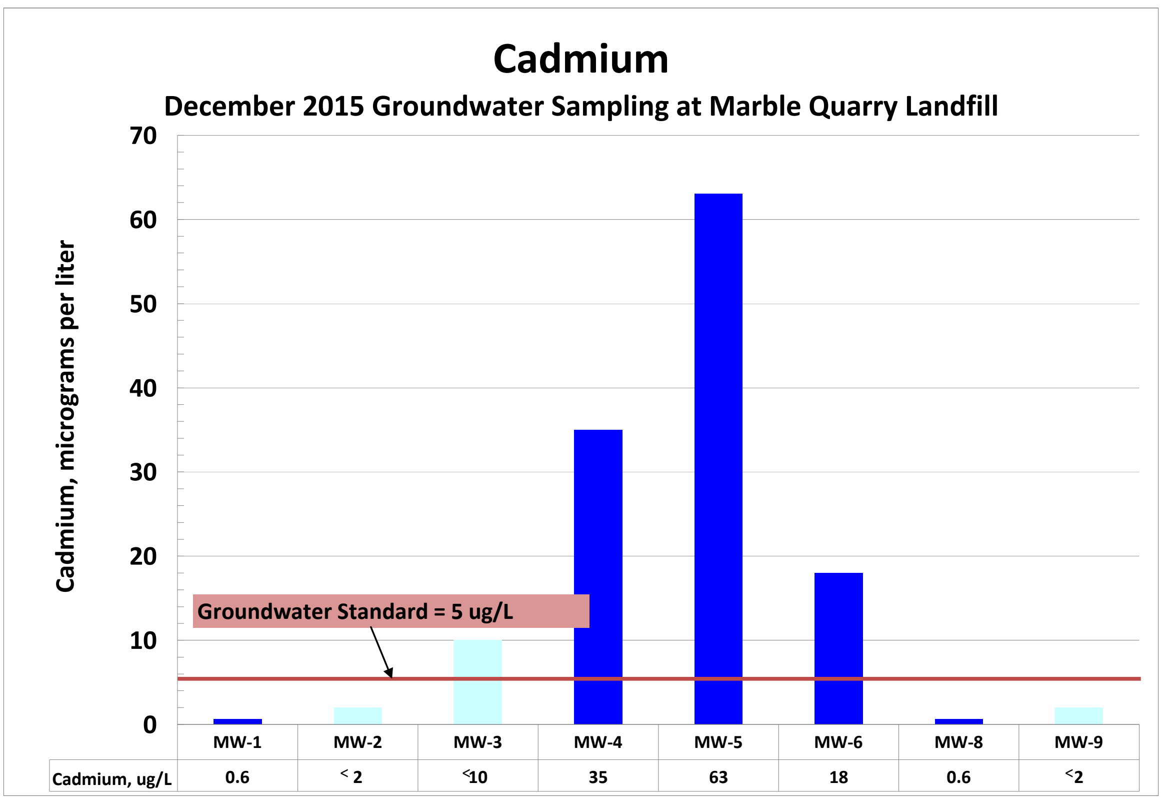
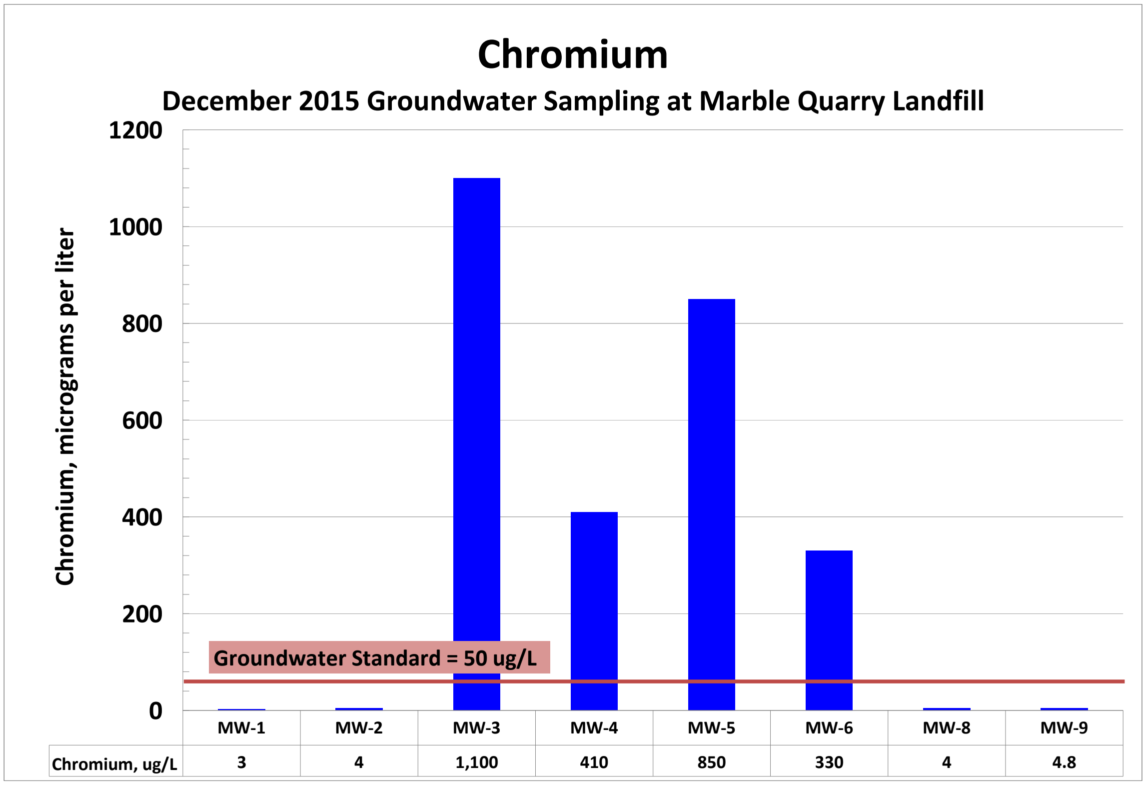


Figure 2D. Groundwater results for barium and cadmium compared to NYS ambient water standards.



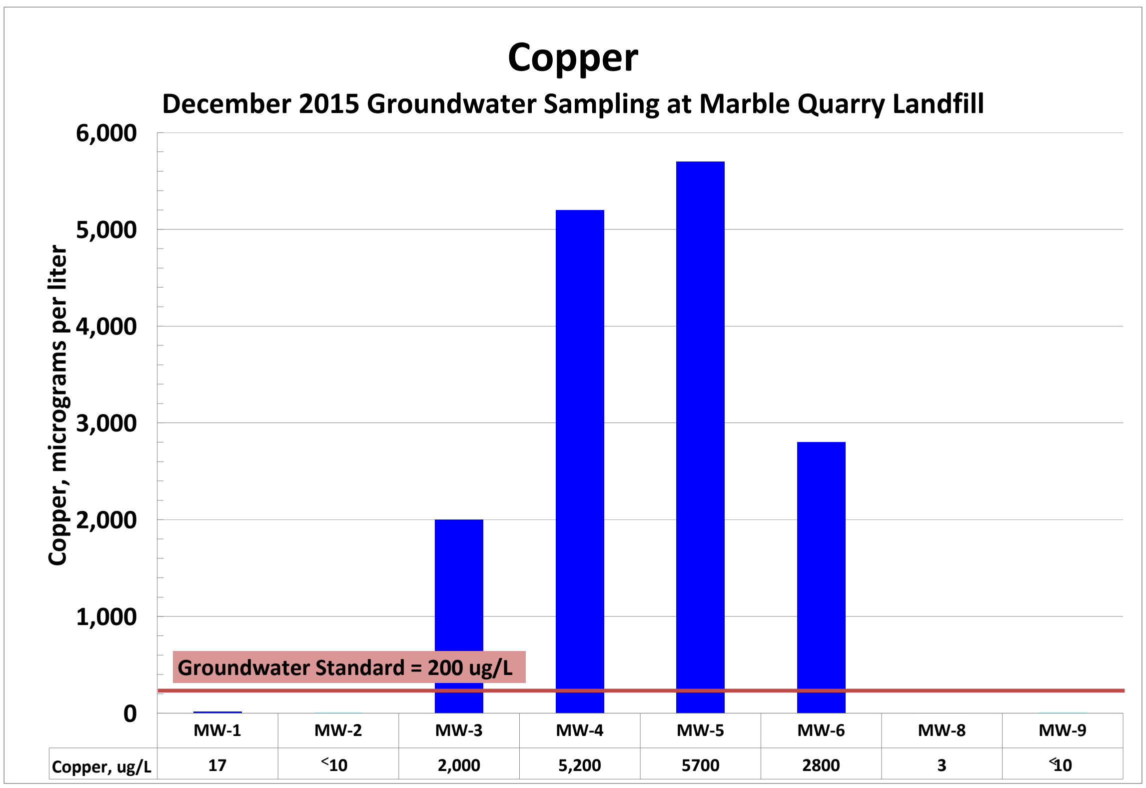


Figure 2E. Groundwater results for chromium and copper compared to NYS ambient water standards.

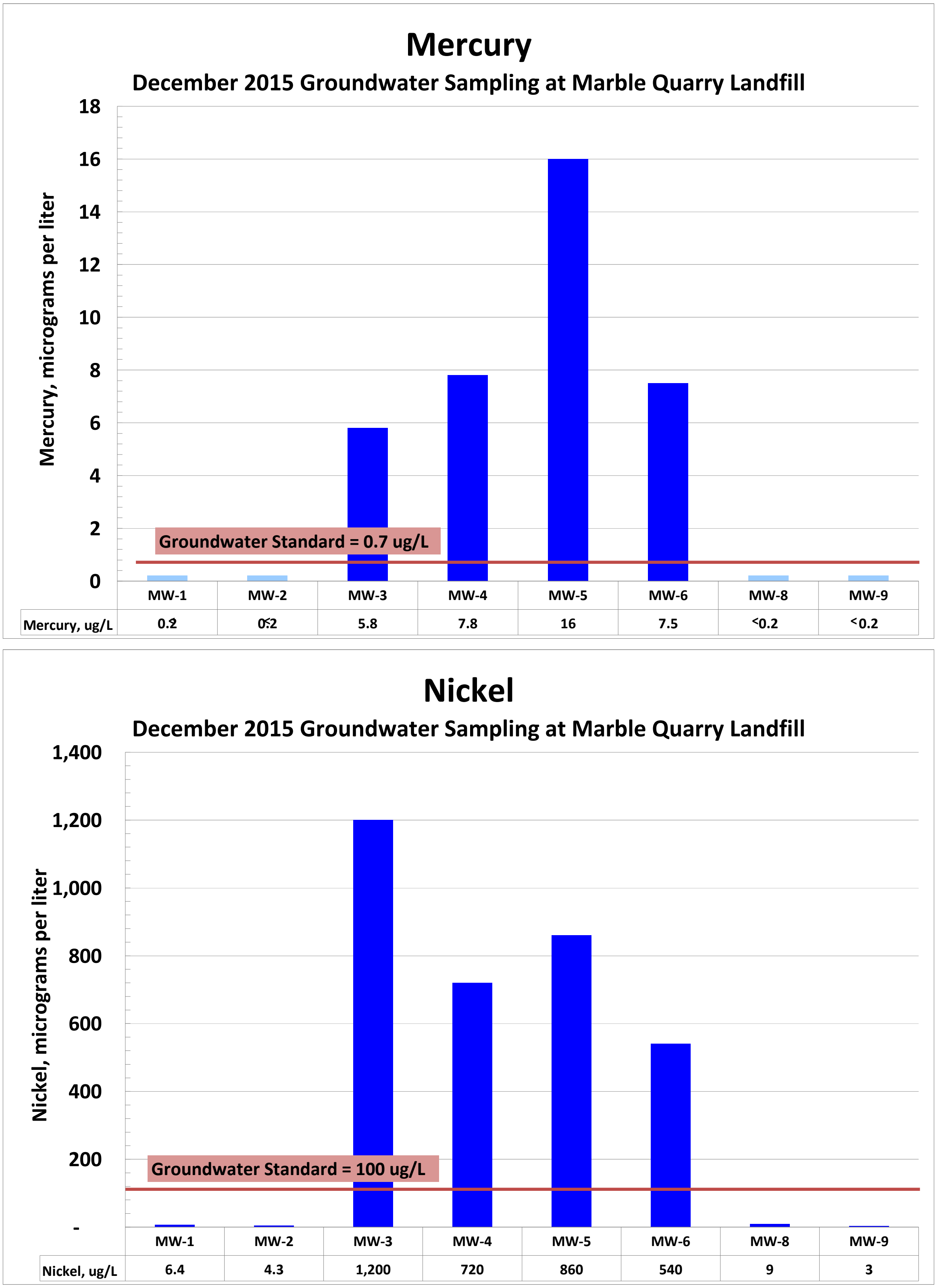


Figure 2F. Groundwater results for mercury and nickel compared to NYS ambient water standards.

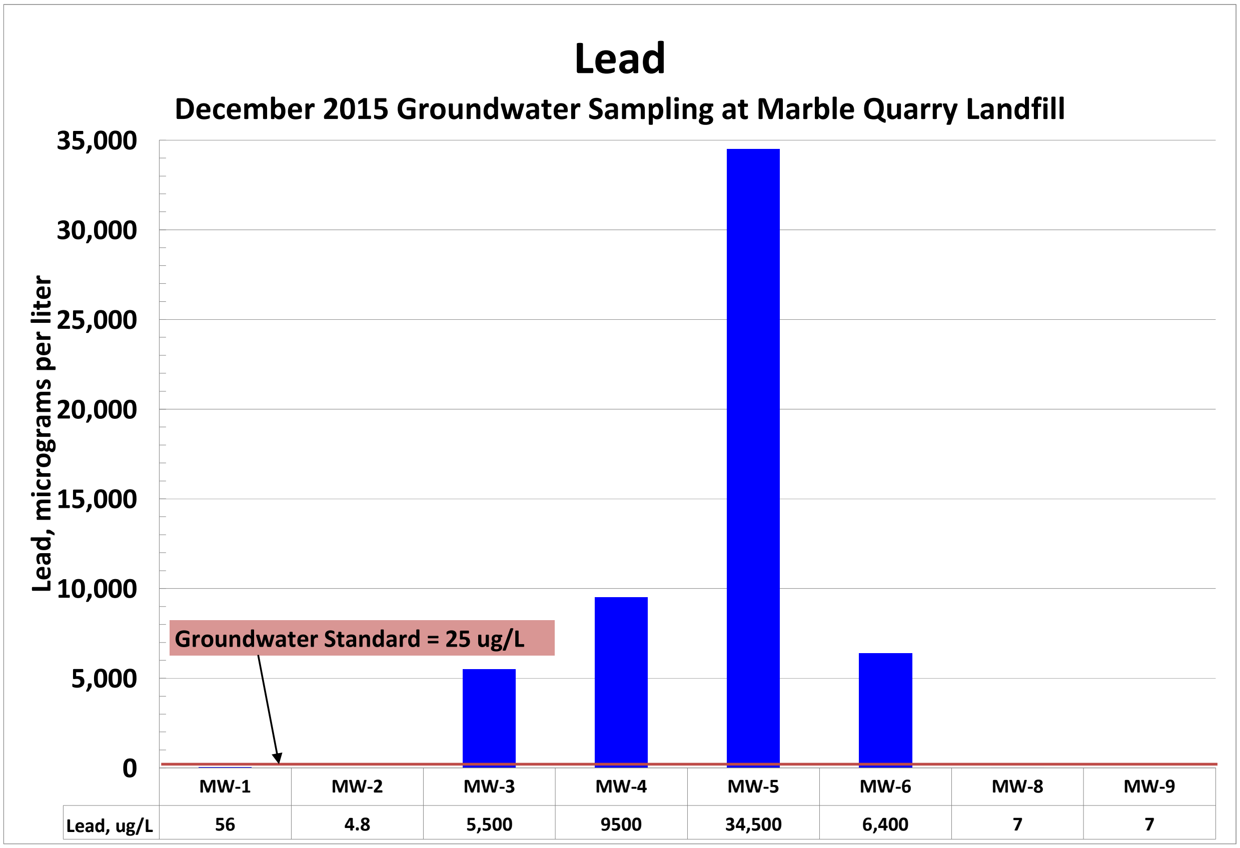


Figure 2G. Groundwater results for lead compared to NYS ambient water standards

3.2 (b) Groundwater flow

It is recognized that the likely overall groundwater flow path is to the south/southwest of the Site toward Bronxville and the Bronx River. As noted by HES is the Phase II Report (p. 7):

"Groundwater is assumed to flow to the south-southwest toward the Bronx River within the unconsolidated material and the fractured bedrock beneath the site; however, the overall flow characteristic of the site suggests that any contaminant[-]impacted groundwater would migrate away from the site in the groundwater to the south-southwest toward the Bronx River. **Contaminants are expected to migrate horizontally on top of or in the bedrock**." (emphasis added)

Thus, it is acknowledged that contaminated groundwater is moving off-site.

However, the local flow of groundwater through the site is poorly understood. Groundwater flow is generally characterized by measuring groundwater elevations and drawing contours based on those data. HES noted that "collected groundwater levels from the nine (9) wells could not be contoured due to extreme variability across the Site." (current RI Report, January 14, 2006; p. 42)

It is highly significant that the water table exhibits great variability in elevation, dropping from a typical elevation of 128-132 feet[2] in the northern portion of the site to 112-113 feet in the southern portion. This represents a vertical drop of approximately 19 feet over a horizontal distance of roughly 200 feet—a very atypical groundwater gradient. A chart of elevations measured in May 2015 is presented in Table 6 and shown in Figure 3.

Table 6. Groundwater elevations observed in monitoring wells, November-December 2103, and May 2015. (Sources: RI Report, dated Jan. 14, 2016, and Supplemental Phase II ESA)

			Water table elevation, referenced to sea level *				
Well No.	Completed in:	Ground elev.	11/20/2013	12/12/2013	5/11/2015	5/18/2015	5/21/2015
MW-1	Soil/fill	134.15	103.87	102.95	113.15	112.46	111.73
MW-2	bedrock	147.85	104.29	114.95	118.31	118.1	117.76
MW-3	Soil/fill	150.97	125.32	127.83	132.67	131.9	131.26
MW-4	Soil/fill	132.93			112.83	112.09	111.84
MW-5	Soil/fill	138.56			113.19	112.33	111.96
MW-6	Soil/fill	135.7			113.12	112.34	112.2
MW-7	Soil/fill	146.74			113.48	112.82	112.23
MW-8	bedrock	149.22			128.35	127.84	127.57
MW-9	bedrock	150.21			132.34	131.76	131.61

*Notes: Elevations are referenced to National Geodetic Vertical Datum of 1988. Elevations for 2013 derived from reported depth-to-groundwater.

HES further concluded that there are two regimes of groundwater: one that is trapped within the site fill, and another that flows beneath the site through the bedrock. According to the RI Report (Table 2), monitoring wells MW-2, MW-8, and MW-9 were completed in bedrock, while the remaining six wells are in site soils/fill material. The geologic log for MW-2 confirms that it extended to a depth of 55 ftbg, and suggests that marble bedrock was encountered at 31 ftbg.

The current RI Report (HES, 2016; p. 42) notes: "Groundwater monitoring on multiple dates indicates that there appears to be **two separate groundwater flow regimes, one in the fill material and one in the fractured bedrock**." (emphasis added)

One might expect that the existence of two flow regimes would help to explain the highly variable elevations. However, this is not the case: the four northernmost wells have markedly higher groundwater elevations than those located in the southern portion of the site, as illustrated in Figure 3. In May 2015, a severe gradient existed across the three wells completed in bedrock. Also, there is significant variability over time within some wells: the groundwater elevation in MW-2 increased by ~11 feet over a 22-day period in 2013.

[2] Referenced to mean sea level, NAVD-1988.

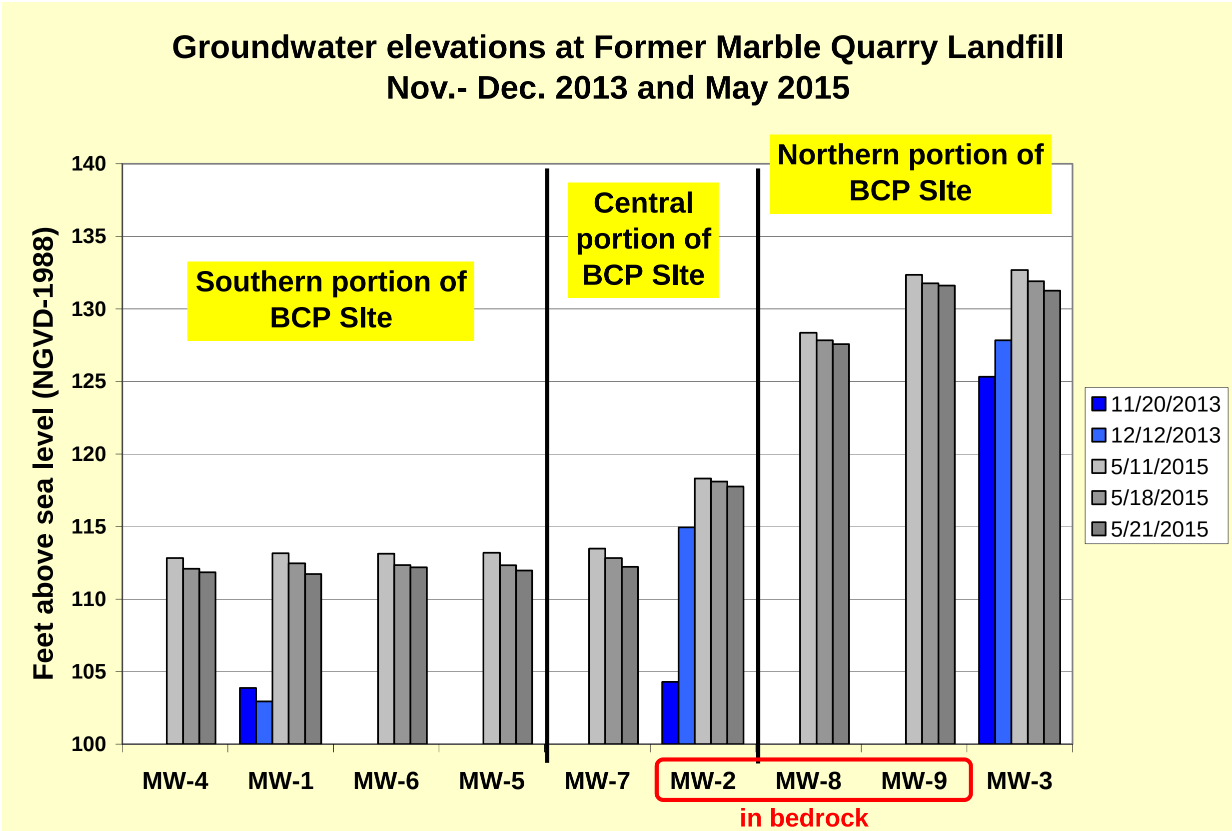


Figure 3. A comparison of groundwater elevations observed at the BCP Site, 2013 - 2015. Monitoring wells are ordered left-to-right, approximately south to north, with MW-4 at the southern edge, and MW-3 near the north end of the Site.

Overall, there is no consistency among the three bedrock wells, nor among the six wells completed in the fill material. Clearly, the Applicant has not collected sufficient groundwater information specific to each aquifer to enable construction of groundwater flow maps.

Further, there is evidence that the underlying bedrock (the Inwood Marble) exhibits karst geology. Karst is formed when over time flowing groundwater dissolves soluble bedrock, creating drainage systems that can rapidly transport groundwater over long distances. Tuckahoe and the surrounding region exhibit some classic karst features: sinking streams and sinkholes. A review of local topographic maps shows two streams sinking into the Inwood Marble via sinkholes 4 miles north of the project site in the Hartsdale area (HydroQuest, 2015a and 2015b). These features indicate rapid groundwater flow along conduit portions of karst aquifers – quite likely over distances of miles. The Bronxville High School, located one mile south of the site, sits in the path of this groundwater (HydroQuest, 2015b).

Further south of the project site, geologic mapping and lithologic descriptions acknowledge the karstic nature of the Inwood Marble (U.S. Geological Survey; Miscellaneous Investigation Series Map I-2003; Bedrock and Engineering Geologic Maps of Bronx County and Parts of New York and Queens Counties, New York by Charles A. Baskerville, 1992):

> "*Inwood Marble encountered along the Bronx shore of the Harlem River south of the Alexander Hamilton Bridge (I-95) to Bronx Kill is deeply weathered and karstic to depths of nearly 200 ft below top of rock in some locations (Frank Irving, New York State Department of Transportation, personal commun., 1987).*"

Karst aquifers are comprised of both conduit and non-conduit segments. Non-conduit portions behave hydrogeologically similar to fractured bedrock aquifers with laminar, Darcian, groundwater flow. Conduit portions of karst aquifers are characterized by non-laminar, rapid, groundwater flow where little or no dilution of contaminants occurs. Delineation of conduit flow paths and down-gradient receptors in karst settings requires characterization via tracer testing. Monitoring wells are often not appropriate because they seldom encounter the rapid flow portions of karst aquifers. (HydroQuest, 2015b).

In conclusion, the movement of contaminated groundwater off-site is largely unknown. In all likelihood, three flow vectors are present: within the fill, a fractured (non-conduit) bedrock aquifer, and a karstic (conduit) portion of the underlying carbonate aquifer. Contaminated groundwater is known to exist within the fill, but the rate of its movement and its flow path have not been empirically determined. Moreover, the applicant has failed to characterize the conduit and non-conduit portions of the carbonate aquifer underlying the site. These are the most significant flow vectors. Groundwater flow paths, the degree of off-site contamination, and the down-gradient receptors of contaminated groundwater and/or volatile vapors, if any, have not been determined.

3.3 Soil Vapor Investigations

In the summer of 2015, HES, installed 18 soil vapor monitoring points across the site. The sampling points are shown on Figure 1. These points were sampled for a wide variety of volatile compounds according to EPA Method TO-15. This testing showed the presence of a wide variety of volatile organic compounds in soil vapors, some at alarmingly high concentrations. A summary of the findings is provided in the current RI Report (HES, 2016; p 21):

"…widespread and numerous soil vapor detections were observed at all eighteen soil vapor sampling points. The maximum VOC concentrations detected from the 18 soil vapor samples collected across the Site included dichlorodifluoromethane at a concentration of 173,000 µg/m^3 (micrograms per cubic meter) in VP-15, 1,2-dichlorotetrafluoroethene at a concentration of 344,000 µg/m^3 in VP-15, and trichlorofluoromethane at a concentration of 198,000 µg/m^3 in VP-16. In addition, VOCs associated with petroleum hydrocarbons including benzene, toluene, ethylbenzene, and total xylenes (BTEX compounds) were detected, and are pervasive throughout the Site. VOCs associated with solvents including 1,1,2,2-tetrachloroethane and 1,1-dichloroethene were detected at most soil vapor sampling points."

The report concludes:
"… the collective soil vapor results indicate that the historic disposal of waste material has impacted the soil vapor across the Site and provisions will need to be incorporated into any

proposed building, including a soil vapor barrier and vapor mitigation system such as an active, negative air pressure sub-slab depressurization system (SSDS), to mitigate the potential for vapor migration through and into on-Site structures."

Soil vapor data are summarized in Table 5. Compounds are grouped into the following categories:

1. **Chlorinated Volatile Organic Compounds**
2. **Petroleum hydrocarbons**
3. **Chorofluorocarbons (Freons)**
4. **Ketones**
5. **Other volatile compounds**

This table illustrates, in greater detail, how pervasive these compounds are within the former landfill. Chorofluorocarbons (Freons) are found in every sample collected, with maximum concentrations reaching ***several hundred milligrams*** per cubic meter. The widespread occurrence of the these compounds indicates that there are **active sources such as old refrigeration or air conditioning equipment, and/or corroding tanks of Freon, which are releasing these chemicals into the overlying soils.**

Chlorinated VOCs, such as trichloroethene, tetrachloroethene (perchloroethylene), carbon tetrachloride, and methylene chloride were commonly found, with individual concentrations as high as 459 $\mu g/m^3$. This indicates past disposal of these common laboratory and industrial solvents at the site. Other chlorinated compounds are widespread, including 1,3-dichlorobenzene (found at 16 of the 18 points) and chloroform (11 of the 18 points). 1,3-dichlorobenzene is used as a fumigant and insecticide. Chloroform is a common laboratory reagent, and is also used in pesticide formulations, and as a solvent in various industrial applications. It should be noted that all of the aforementioned chlorinated VOCs are denser than water, so if large amounts were dumped at the former quarry site, they would form a dense non-aqueous phase liquid (DNAPL) which would tend to sink to the lowest confining layer.

Petroleum hydrocarbons are also widespread in the soil vapors. Benzene, toluene, *m-, p-, and o-* xylene isomers, ethylbenzene, 1,2,4-trimethylbenzene, cyclohexane, hexane, and heptane are found throughout the site in all or nearly all of the sample points. Cyclohexane was found at the highest concentration of 5,210 $\mu g/m^3$. This is completely consistent with the soil investigations which found these compounds in many soil samples. Many of these compounds were found in the groundwater as well. These reflect the contamination of the site with past spills, leakage from parked vehicles, and probable dumping of gasoline, motor oils, fuel oil, and/or diesel fuel.

Compounds not typically associated with these petroleum products were also found at the site: propylene and styrene. There may have been other sources of these compounds.
Other solvents found at the site fall in the category of ketones. Acetone, up to 370 $\mu g/m^3$, is widespread in soil vapors. This compound has also been found throughout the site in surface soils, sub-surface soils, and in the groundwater. Other ketones commonly found in the soil vapors include 4-Methyl-2-pentanone (MIBK) and methyl ethyl ketone (MEK). All of these

compounds are common solvents used in laboratories, and numerous industrial and commercial applications.

An assortment of other compounds was found in soil vapors, including carbon disulfide (up to 59 $\mu g/m^3$), ethyl and isopropyl alcohols (up to 2,150 $\mu g/m^3$), and tetrahydrofuran (up to 15 $\mu g/m^3$). All of these are common laboratory chemicals. The alcohols were found in all 18 vapor monitoring points. These might have originated in medical or pharmaceutical wastes, or in a wide variety of commercial products such as adhesives, paints, inks, etc.

Table 7. List of compounds found in soil vapors at Marble Quarry Landfill, based on one round of sampling (May 18, 2015).

1. Chlorinated Volatile Organic Compounds	Maximum concen-tration (µg/m^3)	# detected (out of 18 locations)	Percentage of locations where detected	Health Effects associated with chronic exposure (where known)
1,1,1-Trichloroethane	106	5	28%	causes liver damage in mice and ventricular arrhythmias in humans.
1,1-Dichloroethane	4.1	3	17%	classified as a Group B2, probable human carcinogen
1,3-Dichlorobenzene	51	16	89%	causes cough, drowsiness, nausea, sore throat.
carbon tetrachloride	6.7	6	33%	primary effects in humans are on the liver, kidneys, and central nervous system (CNS); classified as a Group B2, probable human carcinogen.
chloroform	151	11	61%	has effects on the liver, including hepatitis and jaundice, and central nervous system effects, such as depression and irritability. Linked to an increase in kidney and liver tumors. Classified as a Group B2, probable human carcinogen.
cis-1,2-dichloroethene	27.2	5	28%	causes cough, drowsiness, nausea, sore throat..
methylene chloride (dichloromethane)	44.8	12	67%	affects the central nervous system-dizziness, confusion; possible carcinogen
tetrachloroethene	259	18	100%	impaired cognitive and motor neurobehavioral performance; may also cause adverse effects in the kidney, liver, immune system and hematologic system, and on development and reproduction; probable human carcinogen
trans-1,2-dichloroethene	11.5	3	17%	moderately toxic by ingestion, inhalation and skin contact
trichloroethene	459	17	94%	probable human carcinogen (especially kidney, liver, cervix, and lymphatic system)
vinyl chloride	94	8	44%	known human carcinogen

Note: Compounds detected in only one sample are not listed in Table 5. These are: isopropylbenzene (5.6 µg/m3), chloromethane (1.3 µg/m3), and bromodichloromethane (6.3 µg/m3).

Table 5. (continued) List of compounds found in soil vapors at Marble Quarry Landfill …

2. Petroleum hydrocarbons				
benzene	236	15	83%	Known human carcinogen (Class A: leukemia)
toluene	1190	17	94%	Causes irritation of the upper respiratory tract and eyes, sore throat, dizziness, and headache.
m- and p- xylenes	390	18	100%	Impaired motor coordination
o-xylene	238	18	100%	Impaired motor coordination
ethylbenzene	76.4	18	100%	Developmental toxicity
1,2,4-trimethylbenzene	6.7	14	78%	
1,3,5.Trimethylbenzene	2.1	4	22%	
4-ethyltoluene	1.6	2	11%	
4.Isopropyltoluene	2.45	6	33%	
cyclohexane	1320	14	78%	Low acute toxicity.
heptane	163	17	94%	
hexane	5210	18	100%	
propylene	428	2	11%	
styrene	6	5	28%	
3. Chorofluorocarbons (Freons)				
1,2.Dichlorotetrafluoroethane	344,000	17	94%	
Dichlorodifluoromethane	173,000	18	100%	
Trichlorofluoromethane	198,000	18	100%	
Trichlorotrifluoroethane	174	11	61%	
4. Ketones				
acetone	370	12	67%	Nephropathy
4-Methyl-2-pentanone (MIBK)	15	8	44%	Causes nausea, headache, burning in the eyes, weakness, insomnia, intestinal pain, and slight enlargement of the liver in humans.
methyl ethyl ketone (MEK)	101	15	83%	
5. Other volatile compunds				
carbon disulfide	59	14	78%	Peripheral nervous system dysfunction
ethanol	2,150	18	100%	
ethylacetate	3	6	33%	
isopropanol	1,390	18	100%	
Methyl *tert*butyl ether(MTBE)	7	6	33%	
tetrahydrofuran	15	13	72%	Confirmed animal carcinogen

3.3 (a) Comparison of soil vapors with indoor air guidelines

The NYS Department of Health has issued specific guidelines for a small number of hazardous chemicals in soil vapors which can enter buildings: methylene chloride, tetrachloroethylene, trichloroethylene (TCE), PCBs, and dioxin-equivalents (see table 6 below).

Based on just one round of soil vapor sampling, **there is a very strong likelihood that the occupants of buildings adjacent to the site are being adversely affected by vapors from the site**. Sampling point VP-18 had a very high level of TCE (459 $\mu g/m^3$). This is over 200 times the NYSDOH specific guideline value of 2 $\mu g/m^3$. VP-18 is between 131 and 173 Marbledale Road. VP-6, located only ~90 feet from 21 Verdi Ave., had extraordinarily high levels of the Freons 1,2-dichlorotetrafluoroethane (142,000 $\mu g/m^3$), dichlorodifluoromethane (107,000 $\mu g/m^3$), and trichlorofluoromethane (6,180 $\mu g/m^3$). It also contained TCE above the DOH guidance value.

The health impacts of TCE are widely known and include, among other things, central nervous system depression, likely toxicity to kidneys and other organs and probably human carcinogenicity. Many of the other volatile organics found in the vapor samples cause health problems as well.

The levels of PCBs and dioxin-equivalents in soil vapors are unknown. While both of these compound groups are considered "non-volatile," the volatility of both is greatly enhanced by the presence of water. Given the known presence of PCBs at the site, and the suspected presence of chlorinated dioxins and furan, future soil vapor sampling should certainly include these parameters.

Table 8. Comparison of Soil Vapor Sampling (May 2015) at the Former Marble Quarry Landfill with NYSDOH Indoor Air Guidelines.

Note: TEQ = toxicity equivalent quotient, a method used to sum toxicities of PCDDs and PCDFs

Substance	Air Guideline Value, ($\mu g/m^3$)	Maximum soil vapor concentration found ($\mu g/m^3$)	Number of soil vapor samples above AGV
methylene chloride (dichloromethane)	60	44.8	0
tetrachloroethene	30	259	4
trichloroethene	2	459	6
Polychlorinated biphenyls	1	**??**	not tested
Dioxin equivalents, as TEQ	0.00001	**??**	not tested

4.0 Data gaps

4.1 Untested parts of the landfill

Large sections of the Former Marble Quarry Landfill have not been investigated. As noted in Section 2 (a), none of the areas outside the BCP Site have been investigated for contamination. Thus, approximately one-half of the area occupied by the former landfill has not been investigated to any extent. As shown in the figure in Appendix B, **about one-third of the southern quarry hole and three-quarters of the northern quarry hole lie *outside the BCP Site.*** There have been no surface soil samples, sub-surface soil samples, groundwater samples, or soil vapor samples collected in these areas. **This represents a major data gap.**

The extent of contamination in the subsurface is poorly defined, even within the confines of the BCP Site. This represents another major data gap. The portion of the southern quarry hole that falls inside the BCP Site has been investigated to a greater degree than the northern hole, but it is still poorly characterized. A total of 161 samples were collected from the southern hole. Of these 161 samples, 20 were tested for organic chemicals (e.g. petroleum hydrocarbons and solvents), and 18 were tested for inorganic substances (e.g. arsenic, barium, lead, and other metals). All of the samples tested were collected in the top 34 feet of the landfill surface. The deepest part of the landfill, extending from 34 to 85+ feet, was investigated with two borings, one extending to 51 feet, the other to 85 feet. The deeper boring shows clear evidence of petroleum contamination—the greatest amount found in any part of the site. Yet, none of the samples collected at these depths were chemically analyzed.

In the northern part of the landfill, the extent of contamination in the sub-surface is even less well-understood. A total of 83 samples have been collected from the northern quarry hole that falls inside the BCP Site. Of these 83 samples, only 11 were tested for organic chemicals, and 10 were tested for inorganic substances. All of the samples tested were collected in the top 36 feet of the landfill surface. The deepest parts of the landfill, extending from 40 to 85+ feet, have not been investigated at all. There is no information whatsoever about the soils and fill material in the bottom 50-60% of the northern part landfill.

There is no basis for assuming that the data collected to date are representative of the entire landfill. The landfill was filled progressively over time. Aerial photography shows that the northern lobe of the quarry was filled first, followed by the central and southern parts of the quarry. The historical record, limited as it is, suggests that the composition of the waste materials changed over time, as the customers who brought wastes to the landfill changed over time. Probably the most consistent source of waste materials was the incinerator located a few miles to the north in Eastchester, NY. However, the mix of waste materials provided by other customers, including various private contractors, local automotive repair, construction, electronics, medical suppliers, printing, and other businesses, and a major pharmaceutical company, undoubtedly changed over the 25-30-year lifespan of the landfill.

4.2 Buried drums, tanks, vehicles, and other objects

It is reasonable to expect that wastes dumped at the landfill may have included drums, bottles, tanks, and/or other containers of chemicals. The recurrence of fires at the site suggests that flammable liquids were probably spilled onto the ground during dumping. Another indicator is the prevalence of high concentration of Freon gasses in the soil vapors throughout the site. Since these compounds are gasses at ambient temperatures, there must be active sources releasing them into the site fill material. This implies that there is old refrigeration or air conditioning equipment, and/or corroding tanks of Freon buried in the site.

The presence of large buried metal objects can be determined through magnetometer surveys and other methods. Another, more direct method is to dig test pits. None of these techniques has been employed at the Former Marble Quarry landfill.

4.3 Groundwater

The movement of contaminated groundwater off-site is largely unknown. In all likelihood, three flow vectors are present: within the fill, a fractured (non-conduit) bedrock aquifer, and a karstic (conduit) portion of the underlying carbonate aquifer. Contaminated groundwater is known to exist within the fill, but the rate of its movement has not been determined. Moreover, the applicant has failed to characterize the conduit and non-conduit portions of the carbonate aquifer underlying the site.

4.4 Polychlorinated dioxins and furans

To date, no environmental media have been tested for the presence of two families of compounds known as polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). These compounds are, in general, highly toxic, the most toxic member being 2,3,7,8-tetrachloro-*p*-dibenzodioxin. Due to widely varying toxicities, the total toxicity is expressed in terms of a single TEQ (toxicity equivalence quotient) value.

These compounds are formed during combustion reactions, and are often found in incinerator ash. Figure 3 shows TCDDs +TCDFs in ash samples from a modern trash incinerator located in Onondaga County, NY. It can be expected that ash which was dumped into the Former Marble Quarry landfill, which originated from an old-design garbage incinerator lacking modern combustion controls, probably contains much higher concentrations of TCDDs and TCDFs. The landfill was also reportedly the site of many fires when dumping was on-going. Again, these fires no doubt created additional TCDDs and TCDFs. The magnitude of TCDDs/TCDF concentrations remaining at the landfill can only be guessed at, since the nature of the burning materials is completely unknown.

Figure 4 shows TCDDs +TCDFs in incinerator ash in comparison to clean-up levels recommended by USEPA. New York State has not established a soil clean-up level for these highly toxic substances.

The sub-surface investigations document the presence of large amounts of ash at the site. Boring logs collected throughout the site indicate "fly ash" and "cinders" in numerous locations. For example, at MW-1, located in the southern portion of the site, cinders and fly ash are encountered between 5 and 12 fbg, and 25-27 fbg. Ash was found at many locations in both the southern and northern landfill holes during the Phase II investigations. As noted in Section 3.1, HES also reported a "burnt odor" in many of the soil borings.

Therefore, it is very reasonable to expect that dioxins and furans are present at the site at elevated concentrations—high enough to pose a risk to humans and animals. These compounds should certainly be investigated in the future, especially in soil vapors and groundwater, since these are the major pathways for off-site exposure. There is no way to know what levels of dioxin and furan contamination exist at the Site without conducting such tests.

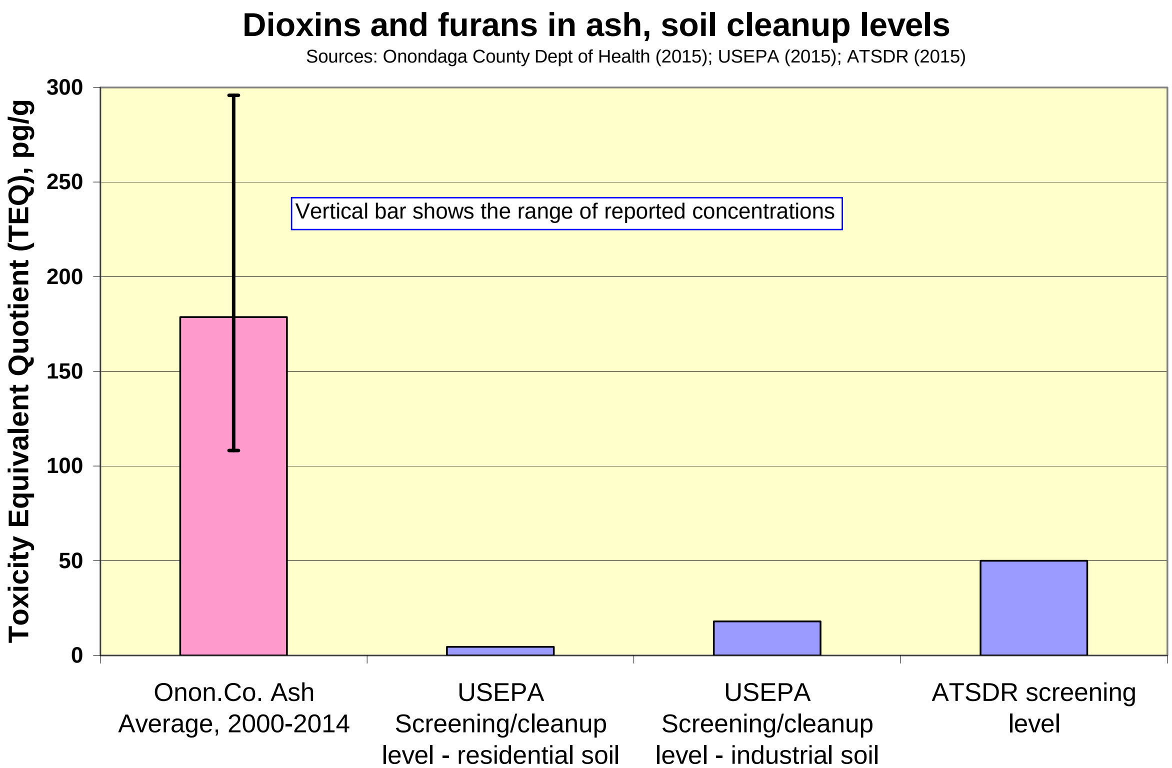


Figure 4. Polychlorinated dioxins (PCDDs) and furans (TCDFs) in ash from the Onondaga County Resource Recovery Facility, compared with soil clean-up and screening levels.

4.5 Radioactivity

Radioactivity has not been tested at the site. There are at least two reasons to suspect that radiological material is present at the Former Marble Quarry Landfill:

1) A local industry, MediRay, produces shielding for radioactive application. It is expected that this industry, which is situated next to the site on Marbledale Rd., handled radioactive materials which could easily have been dumped at the site.

2) Laboratory wastes from the pharmaceutical industry were reportedly dumped at the site. Radioactive tracers such as C-14 and P-32 are often employed in bio-medical research.

5.0 <u>Proposed Remediation of the BCP Site</u>

The Brownfield Cleanup Program specifies that “A Volunteer in the Brownfield Cleanup Program must evaluate and implement an effective remedy to address the contamination on-site as well as prevent further migration of contamination to off-site properties.” The developer of the BCP Site is considered a “Volunteer” who is not liable for past disposal of hazardous waste or discharge of petroleum at the site, but who is taking on site investigation and remediation for the purposes of redevelopment.

In its application for Brownfield Cleanup Program funding, Bilwin Development Associates has proposed a remedial program consisting of capping the BCP Site, *i.e.* the parcels that it controls and on which it proposes to develop the hotel and the restaurant. The cap is an impermeable layer that would prevent infiltration of water into the soil under the BCP Site. It would consist of the hotel and restaurant structures, and the parking lot servicing them. The remediation will include venting of the fumes from the hotel and restaurant, to avoid health impacts to guests, patrons and workers in those buildings.

The proposed cleanup would leave most of the contaminated soil in place on the BCP Site, only removing the soil to the extent necessary to grade the land for project development. The vast majority of the dumped waste material would remain in place.

There is no cleanup proposed for any of the areas of the former quarry landfill located off the BCP site. The lack of any remediation at the portions of the former landfill outside the BCP site would continue the threat that the buried chemicals pose to the environment and the public. Additionally, capping the BCP site without removal of contaminated soils and waste materials would make the site a permanent repository of chemical wastes. There is good reason to believe, based on historical accounts, that the site contains containers of chemical wastes. The widespread occurrence of Freon in soil vapors points to leaking refrigeration equipment buried in the landfill.

DEC and the New York State Department of Health are planning to test three buildings adjacent to the former landfill for toxic air contamination in early 2016. As of this writing, no other properties—residential or commercial—are being considered for testing, despite close proximity to areas known to have heavily contaminated soil vapors. For example, the neighborhood of single family homes atop the ridge immediately to the west of the BCP site has not been considered for testing. Properties which lie adjacent to the quarry holes north and south of the BCP site are unlikely to be considered for testing under the current program, since they do not border the BCP site. Moreover, the DEC/Department of Health has yet to determine whether to require venting of any nearby homes and businesses. Thus, the suspected indoor air contamination in neighborhood buildings will continue to pose a risk to residents and others well into the future.

The issue of contaminated groundwater moving off-site is not addressed. While the cap would abate the problem of rain filtering into the contaminated soils, the natural flow of groundwater through the site will continue to transport the pollutants to off-site locations. Given the complete lack of off-site groundwater monitoring, there is no solid basis to evaluate the movement of contaminants—including lead, mercury, chromium, tetrachloroethene and trichloroethene—into areas down-gradient (to the south) of the site. Clearly, the BCP objective to "prevent further migration of contamination to off-site properties" is not being met.

6.0 <u>Conclusions</u>

6.1 Summary

Based on historical records, including eyewitness accounts, the Former Marble Quarry Landfill includes substantial toxic contamination. It was used extensively by the Village of Tuckahoe and industries to dispose of a wide variety of wastes, including many hazardous chemical contaminants in concentrations that pose a health threat. There is, and has been, no effective containment of the chemicals on the site; the landfill has no liner and sits on top of fractured bedrock. It is also clear that nearby buildings are subject to potentially dangerous fumes.

The site investigation and proposed remediation under the Brownfield Cleanup Program has neither adequately assessed the scope of the potential hazard nor contemplated an effective remedial program. The assessment falls short in the extent of the area examined for contamination, and in the assessment of groundwater migration from the site. The remediation only includes a cap for part of the former landfill, and would leave the contamination almost entirely in place. There is no remedial proposal for any of the substantial portion of the former landfill that is outside the parcels controlled by the developer.

6.2 Recommendations for future actions

The following actions are recommended before proceeding any further towards development of the Former Marble Quarry Landfill:

- Conduct a comprehensive investigation of the entire landfill, which includes the complete footprint of both former marble quarry holes. Such an investigation should actively penetrate to the bottom of each quarry hole at multiple locations to define what is there.
- Conduct a magnetometer survey to determine whether buried metal drums, tanks, or other metallic objects are present in the landfill.
- Expand the groundwater investigations to comprehensively sample the bedrock aquifer which is most likely carrying contaminants away from the site, underneath buildings to

the south, and ultimately to the Bronx River. Monitoring wells should be installed down-gradient of the southern quarry hole.

- Conduct a comprehensive karst investigation in accordance with ASTM standard D 5717 – 95 which provides guidance for investigations of karst and fractured bedrock aquifers, or an updated equivalent. This investigation should identify and locate offsite and down-gradient sinkholes, sinking streams, springs, and caves that exist between the waste site and the Bronx River. Water quality monitoring should be conducted at locations likely to be adversely impacted from contaminant migration from the waste site (e.g., Gramatan Spring).
- Conduct sub-slab and associated vapor testing in ***all of the properties which surround the entire landfill site***. Testing should not be limited to a few parcels on the west side of Marbledale Road.
- When conducting any vapor testing, include polychlorinated biphenyls (PCBs) and dioxins and furans (PCDDs/PCDFs) to determine whether air guidelines established by the NYS Department of Health are exceeded.
- Conduct a focused survey of radioactivity (gross alpha emitters and beta-emitters) to determine whether radioactive substances are present at the Site.
- Include metals, pharmaceutical compounds and TCDDs/TCDFs when performing future rounds of groundwater and soil sampling.

7.0 References

American Society for Testing and Materials (ASTM) (1995; rev. 1998) *Standard Guide for Design of Ground-Water Monitoring Systems in Karst and Fractured-Rock Aquifers*. , 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

Bilwin Development Affiliates, LLC. (2014) Brownfield Cleanup Program Application. Dated Feb. 11, 2014

HydroEnvironmental Solutions, Inc. (2013a) Phase II Environmental Site Assessment Report, prepared by HydroEnvironmental Solutions, Inc. for Bilwin Development Affiliates, LLC. (June 13, 2013) [Included as Appendix 2 in the Additional Phase II ESA Report]

HydroEnvironmental Solutions, Inc. (2013b) Phase I Environmental Site Assessment 109-125 Marbledale Road, Tuckahoe, New York
(September 6, 2013) 97 pp

HydroEnvironmental Solutions, Inc. (2014) Additional Phase II ESA Report, 109- 125 Marbledale Road, Tuckahoe, New York (January 30, 2014) 700 pp.

HydroEnvironmental Solutions, Inc. (2015) *Draft* Remedial Investigation Report, 109-125 Marbledale Road, Tuckahoe, New York; Brownfield Cleanup Program Site # C360143 (September 16, 2015) 658 pp

HydroEnvironmental Solutions, Inc. (2016) Remedial Investigation Report, 109-125 Marbledale Roadtuckahoe, New York; Brownfield Cleanup Program Site # C360143 (January 14, 2016) 1867 pp

HydroQuest (2015a) "Hydrogeologic Considerations Relative to the Proposed Conditioned Negative Declaration for the 109-125 Marbledale Road Brownfield Development; Tuckahoe, New York." Letter-report to A.M. Ciaramella, Chairwoman,Village of Tuckahoe Planning Board and Bill Williams, Village of Tuckahoe Building Inspector, dated Sept. 15, 2015

HydroQuest (2015b) "Addendum To HydroQuest Report Of September 15, 2015: Additional Karst Aquifer Discussion." To Village of Tuckahoe Planning Board, Building Inspector, Planning Commission; Mayor of Tuckahoe; NYS Department of Environmental Conservation; NYS Department of Health, dated October 20, 2015

Test America Buffalo (2016) *Analytical Report*, prepared for New York State D.E.C.: Former Marble Quarry Landfill #C360143. Test America Inc., Amherst, NY. Dated January 7, 2106. (71pp)

APPENDICES

APPENDIX A: **Comparison of historical aerial photos of Tuckahoe, NY, 1940-1966**

Page A-1: November 1940

Both the southern and northern holes of the quarry are filled with water

Page A-2: March 1947.

Both the southern and northern holes of the quarry are filled with water, although the water level appears low in the southern lobe, with much of the quarry walls on the eastern side exposed.

Page A-3:
Left : January 8, 1954
Right: March 23, 1964
By 1954, the northern quarry hole is filled in, but the southern hole still contains water.
By 1964, the northern hole has become a parking are. Much of the southern quarry has been filled in, but not completely. Shadows shows that the southern hole is still below the surrounding land surface. There appears to be much debris on site.

Page A-4: January 12, 1966
The northern hole is much the same as in 1964, a parking area. The southern hole is still below the surrounding land surface, but appears to be more filled in compared to 1964.

Image taken November 19, 1940


Image taken March 31, 1947

Image taken Jan.1954

Image taken March 1964


Aerial photo, dated January 12, 1966

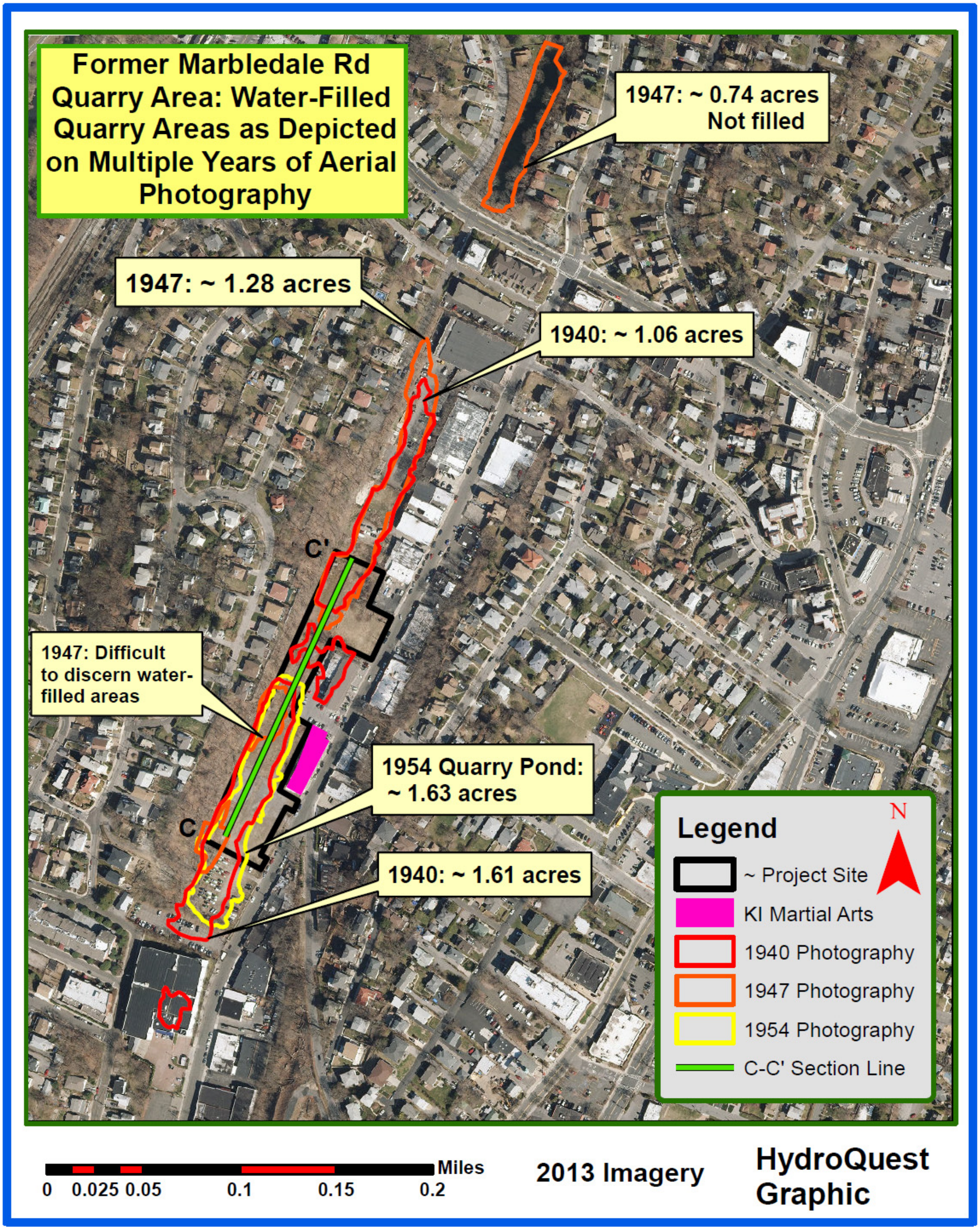
Sources:

1. Westchester County's Historical Aerial Photograph Collection
http://giswww.westchestergov.com/HistoricalAerial/index.htm

2. EDR reports, Phase I Environmental Site Assessment for Former Marble Quarry Landfill

Appendix B: Former Marble Quarry Areas, relative to Current Conditions

(Prepared by P. Rubin, HydroQuest)



Appendix C

Affidavit of J. Marinello
(November 12, 2015)

November 12, 2015

To the Department of Environmental Conservation, the Village of Tuckahoe Planning Board, and the Village of Tuckahoe Board of Trustees,

Please place this letter in the record.

I have resided in the Village of Tuckahoe for 84 years.
The only exception was when I served in the Korean War from 1951 to 1954.

From 1960 – 1983, I was the Chairman of the Tuckahoe Board of Police Commissioners.
During those 23 years, I was repeatedly elected as the Chairmen by a bi-partisan group.

I am a lifetime member of the Tuckahoe Veterans of Foreign Wars Post 2285
I have also served on the board of directors of the VFW Post 2285.
I am also lifetime member of the Knights Columbus.

Since 1954, when I returned from Korean War, I have continually, publicly, raised concerns about the hazardous conditions of the Marbledale Road Quarry Dump.
I have publicly stated, on the record, at many Village meetings, that the toxic and hazardous waste in the Quarry Dump poises serious health threats to our community.
When I returned from the Korean War in 1954, I got off the train, and put my duffle bag on my shoulder, and began walking home. I turned onto Circuit Avenue, the street where I was born. As I was walking up, I could not believe the foul air and the stench. I could not believe that anyone could live there.
I asked my father what was going on, my father said that they were filling the quarry with waste.
I asked what the community was doing about it, and my father said that we were told to keep our mouths shut.
Despite my father's instruction, I began to approach the owners of the property, Trap Rock Corporation and the Woodbine Corporation, and local officials.
It became clear that the horrible dumping was taking place because the local politicians and officials allowed it.
For approximately 27 years, I witnessed an immense amount of industrial and toxic dumping in the quarry.
I witnessed repeated spontaneous combustion of the site.
There were Eastchester Fire Trucks parked in front of the Quarry because of the constant fires.
As they kept filling the quarry with toxic debris, ash, and all sorts of containers of combustible chemicals, the area would ignite.

I had many conversations with the health department. We, in the community, called them about the smell, and the smoke, and the horrible air. We complained to the Health Department frequently from the 1950es through the 1970es.
There was a file kept in the Village of Tuckahoe Clerks office. The file contained all of the records of complaints about the Quarry Dump, and information of dumping in the Quarry, and the Board of Health inspection records. I saw the file in the 1970es, and it was over 10" thick. I was allowed to read it, but I was not allowed to copy it. The file contained complaints from residents, information of complaints to the Department of Health, and from Congressmen. The residents were formally complaining about the toxic health dangers of the site.

When I requested the file again, the file containing the information about the Quarry dumping, complaints and inspections, it had disappeared. Over 27 years of history of complaints of the Quarry and inspection documentation. I would like to know where that file is.

The owners of the Quarry Dump were the Woodbine Corp, and the Trap Rock Corp. Trap Rock Corp was owned by Steve and Joe Luciano.
The owners of the Quarry Dump got paid per load.
There was a shed that was manned by 2 people, Jimmy DiMaria, and Paul Regliano.
They were employees of Woodbine and Trap Rock.
Every time a truck pulled up, Mr. DiMaria or Mr. Rogliano had the dumper sign a sheet.
That is how they kept track of the billing, and who was charged for the loads.

I witnessed major and continual dumping by:
1) The Town of Eastchester, all municipal and industrial garbage, this included a lot of ash, and debris that didn't burn, from the Town of Eastchester's garbage incinerator.
2) The Village of Bronxville, all municipal and industrial garbage.
3) The Village of Tuckahoe, all municipal and industrial garbage.
4) Burroughs Welcome - a pharmaceutical company, now known as Smith Kleins, they dumped loads of chemicals, un-sellable pharmaceuticals, and pharmaceutical containers into the Quarry Dump.
5) US Vitamins dumped all the chemical research, compounds, and containers into the Quarry Dump.
6) Revlon dumped all chemicals, testing debris, compounds and chemicals into the Quarry Dump.
7) Lee Oil & Chemical Corp dumped oil, waste and barrels of chemicals in the Quarry Dump.
8) General Diaper Corporation washed diapers with chemicals & dumped all discharge and waste into the Quarry Dump.
9) Eastern Metal, metal works manufacturer, dumped chemicals, metals, and waste debris into the Quarry Dump.
Mr. Rocco Idria, of Eastern Metal, wrote a letter to the Village of Tuckahoe detailing many of the pollutants that Eastern Metal had dumped in the Quarry.
10) The Printers on Lake Ave, in the Village, dumped lead, dyes, chemicals and debris for over 27 years.
11) Tuckahoe Ice Corporation dumped all of the Freon barrels, chemicals, and work product debris into the Quarry Dump.
12) Woodbine Corporation, dumped black top, road building debris and chemicals, construction chemicals & debris and automotive debris into the Quarry Dump.
13) Trap Rock Corporation, dumped black top, road building debris and chemicals, construction chemicals & debris and automotive debris into the Quarry Dump.
14) Freeman Industries, manufacturer of chemicals and chemical preparations, dumped chemicals and chemical preparations into the Quarry Dump.
15) Kings Electronics company, on Marbledale Rd., made electronic connectors & dumped waste, work byproduct, chemicals, and electrical components into the Quarry Dump.
16) Diesel, fuel tanks, and other chemical storage tanks were located along the Quarry, and leaked and dumped into the Quarry Dump.
17) Pine Sol distributorship dumped waste and debris into the Quarry Dump.
18) Conlin & Company, Building Supply Corp, delivered Coal, fertilizer and building materials. They dumped debris and ash into the Quarry Dump.

November 12, 2015

I have also witnessed a great amount of loss of life, over 200 people in this immediate area, died of cancer.
The contamination in the Quarry Dump seeps and travels.
This current hotel project has not correctly represented the toxic contents of the Quarry Dump.
This hotel project does not have the public interest in mind.

In the 1950es, the local politicians, and local business owners valued money over the health and beauty of our community. They turned our shining marble quarry into a dangerous toxic foul smelling dump. Now, all these years later, we are in the same situation. Business owners and local politicians value their money over the health and welfare of our community. They do not have the public interest in mind.
This is one of the most contaminated pieces of property in Westchester County.
It is very dangerous to underestimate, and misrepresent, what is in there.

There are too many unanswered questions about this project.
About 10 years ago I sent a detailed description of what I had witnessed dumped into the Quarry to the D.E.C.
Where is that information?
What will happen to the rest of the contaminated Quarry Dump?
The hotel project site is not the entire dump.
And, the toxic gasses that will be pumped into our air by venting the toxic site through the hotel?
There isn't any data showing what those toxic gasses are, and how they settle in, and impact, our community.

The proposed Hotel is huge, why have we not seen any renderings in context of the site and the ridge?
At the current size, the top of the hotel will pass the top of the ridge.
Why does it need to be so large?
Why can it not be something that is more in scale with the area?

And, the buffer zone? After the Quarry Dump was closed, and the property was subdivided, there was a 150' buffer zone. I was assured that the buffer zone would never change. But, now the buffer zone has been reduced to 25'.

I only wish that Tuckahoe could be valued and protected. There is more money to be made by proper care of a community, then by forcing a giant building onto toxic site. Our neighbors in other communities protect and value the welfare of their residents, and community. In those communities the property values are high, and those communities are confident that their welfare is valued and protected.

Joseph Marinello, Jr.
4 Coolidge St.
Tuckahoe, NY 10707

Joseph Marinello Jr

CLIVE GRIFFITHS
Notary Public, State of New york
No. 01GR6215323
Qualified in Westchester Cou
Commission Expires December 28, 2014

11/16/15 Clive Griffiths

Appendix D

Letter of Sheila Clarke, submitted to the Mayor and Village Trustees of Tuckahoe
(December 18, 2011)

January 9, 2012

Board of Trustees Meeting
Called to Order at 8PM

PRESENT:	
TRUSTEE	Giordano
TRUSTEE	Quigley
TRUSTEE	Luisi
TRUSTEE	Hayes- ABSENT
MAYOR	Ecklond

The meeting opened with the Salute to the Flag and Pledge of Allegiance.

PRESENTATIONS:

Special Presentation by Donald Gunther, Isaah Gunther, and Maria McHugh-Sayegh for Children Understanding Cultural Differences. Both Donald Gunther and Maria McHugh-Sayegh spoke about the program and made mention of their first fundraiser event set for January 29, 2012 at 8:00AM at the Quarry.

Trustee Giordano motioned to approve the minutes of the regular meeting of December 12, 2011; motion was seconded by Trustee Luisi and upon roll call, motion was carried by a vote of 4 – 0.

CORRESPONDENCE

Clerk Susan Ciamarra read a letter to the Mayor and the Board from Sheila Clarke voicing health concerns regarding proper testing procedures on the property behind 181 Marbledale Road.

January 9, 2012 Meting

Correspondence received –

1. **Pertaining to the referral review submitted to the Westchester County Dept. of Planning for the Crestwood Station Plaza project for a Special Permit, Area Variances and Site Plan Approvals; the Fleet Collision Corporation project for special use permit approval and Rocco's Car Wash and Auto Repair for site plan approval, the County has responded with their review and comments. A copy of the response was forwarded to the Building Dept. and Planning Board.**

2. **On December 20, 2011 received an emailed letter addressed to the Chairperson of the Planning Board, from Mark Sweeney of Whiteman, Osterman & Hanna law firm – subject matter - Application of Midora Corp./Glenmark Patners, LLC for amended site plan review and approval for a mixed use development to the located at 146, 150, 160 Main Street & 233 Midland Place, Tuckahoe, NY. Letter was forwarded to the secretary of the building dept. to have it distributed to the Planning Board members.**

3. **A memo dated December 18, 2011, sent by Sheila Clarke, addressed to Mayor Ecklond and Village Trustees. Subject matter "proper testing procedures for future development/new construction on all parcels of property in the Village"- the memo also has an attachment titled "The Tuckahoe Marble Quarry" A tainted Legacy. She requested that it be read at the January 9th 2012 meeting and entered into the minutes. A copy of this memo with the attachment was emailed the Village Attorney, Village Bd and Planning Board members.**

2 Hollywood Avenue
Tuckahoe, NY 10707
December 18, 2011

TO : MAYOR STEVEN ECKLOND AND
VILLAGE TRUSTEES

RE: PROPER TESTING PROCEDURES FOR FUTURE DEVELOPMENT/ NEW CONSTRUCTION ON ALL PARCELS OF PROPERTY IN THE VILLAGE

PLEASE READ AT 12/211 MEETING AND ENTER INTO MINUTES

Dear Mayor and Trustees,

Several months ago it was made known, to the Mayor as well as the Chairman of the Planning Board, that there exists a concern among Parkview HeightsResidents with regard to Testing procedures of property to be built behind 181 Marbledale Rd., but also any development that would disturb the "Land Fill" area (formerly the Marble Quarry).

Our understanding is that a Phase I and Phase II have been completed, read and signed off on. Under SEQRA (State Environmental Quality Review Act) there are proper Phase I and Phase II procedures that are mandated. Therefore, we are asking that a second firm, known to have high quality credentials and expertise in this field, be selected by a village consultant to do the proper testing for a second opinion.

A Phase I is the research and history of how a large and deep open parcel of land had been filled over many years to become a level flat area -" Land Fill." It has been previously noted that the property in question (The Marble Quarry along Marbledale Rd.) had been used as a dump from the1950's to the 1960's some of the 70's and an additional portion from 2003 to 2005.

The Town of Eastchester, Villages of Bronxville and Tuckahoe, were allowed to dump at this site. Contractors from the Bronx, New York City, Jersey and lower Connecticut also dumped. As can be read on the attached flyer, written a few years ago and distributed to residents, it can be noted that many local companies and to name just a few: Tuckahoe Ice (Freon dumped), General Diaper (chemical used in the cleaning of their laundry), Burroughs Welcome, USV, Revlon, and more recently, 2003 to 2005 Harold Pitts, were also dumping.

During the more recent years, from 2003 to 2005, Mr. Pitts, who owned an environmental cleanup company dumped directly behind 181 Marbledale Rd. It was observed and watched by the DEC. Oil tanks, in some cases still leaking, removed from residences and businesses are abandoned and buried behind this building on the vacant land where there is a proposal to build. Mr. Pitts pleaded guilty and ultimately was indicted.

It is well known that over the years, there have been many residents in the Parkview Heights area who have had respiratory illness and many who have suffered from cancer. A coincidence, perhaps, but perhaps not!!

No one objects to construction if it is done with thorough and proper testing by those who are highly qualified in this area. In the past, there have been excellent consultants who were hired to guide the Mayor and Trustees through the very complex process of development of the Revlon Property , now the site of Riverview. We would hope that this Board will have the same level of concern and care for the proper testing on all parcels of the land in the village where there is an interest in building or developing parcels where there exists suspicion of extremely toxic land.

Many young and recently newer residents to the Village are perhaps unaware of this site and others throughout the village that may be of concern.

Respectfully ,

Sheila Clarke

Sheila Clarke

CC: Chairman, Ann Marie Ciaramella, Tuckahoe Planning Board (Please read and enter into the minutes of the December 20th Planning Board Meeting.)

Chairman, Ron Gallo, Tuckahoe Zoning Board

THE TUCKAHOE MARBLE QUARRY: A TAINTED LEGACY

The following is a brief history of the Marbledale Road quarries from the early 1800's to the present time. All facts cited in this history can be verified either by eyewitness testimony or researched documentation. For more information, or verification of any part of this history, please use contact number provided on bottom of the back page.

Starting in the early 1800's, marble was quarried in Tuckahoe that was highly prized for its purity of color and its strength. Tuckahoe marble was used in the construction of buildings locally, as well as in many important structures including the Main Branch of the New York Public Library and the Washington Monument. For over one hundred years the Tuckahoe marble quarries stood as a testament to the laborers and early industry that helped build America. The marble the quarry yielded was a source of local pride for generations of local residents. This great legacy has been tainted by the events that followed in the second half of the last century.

After the quarries closed in the early 1930's they filled with water fed from underground springs and rainwater. The southern portion of Marbledale Road, where the lower quarry was located, continued to develop as an industrial area while the northern portion, north of Fisher Avenue, and the hill area to the west of the lower quarry grew as lovely residential areas.

During the next two decades, both quarries came alive with natural vegetation that, in turn, attracted wildlife such as fox and pheasant. The deep water that filled the quarries was cool and pure and, with the aid of the white marble that lined them, one could see almost to the bottom.

All of this came to an end at the lower quarry in the early 1950's when it was converted to a dumpsite. Ashes from the municipal incinerators of Tuckahoe[1], Bronxville, Eastchester and Pelham were deposited there. The quarry's water was slowly emptied into the nearby storm drains. In addition to ashes, contractors from Westchester, Rockland, New Jersey and New York City dumped their waste, trash and unwanted equipment there. A nearby paper company discarded its inks and solvents, and other local industries such as Revlon, U.S. Vitamins, Burroughs Welcome Pharmaceuticals, and Lee Oil and Chemicals deposited their waste there as well. Eyewitnesses still living in the area today saw diesel engines, fuel tanks, oil drums, and other combustible items left in the quarry. In addition, there was dumping of car and truck batteries, air conditioners and refrigerators.

Residents can still remember the foul odors and smoke that emanated from the dump. Eastchester Fire Department records will show the number of times it was called upon to extinguish the spontaneous fires that regularly erupted there. What was once an oasis of natural beauty that stood as a testament to Tuckahoe's proud history had, by the late 1960's, turned into a smoldering, poisonous wasteland. The owners of the surrounding homes that had once overlooked a natural habitat became neighbors to stench, contamination, and rubble of all forms. They lost their buffer against the now well-established industrial area to the east of the toxic dump, where industries added to the pollution with the use and production of various chemicals and contaminants. Over the ensuing decades, an alarming number of area residents have

[1] It should be noted that for the past several years, residents have tried to obtain information about the dump and landfill operations from Village Hall's records. However, despite the fact that the lower quarry served as Tuckahoe's municipal dumpsite for over 20 years, ***the Village has no record of its operation, or of the landfill operation and sale***.

become ill with respiratory diseases and various forms of cancer. Many have died from these diseases. No official agency, local or otherwise, has investigated to determine what illnesses, if any, may be attributable to the contamination.

During the late 1960's, when residents learned of plans to extend the dump to the upper quarry they came out in force to protest to Tuckahoe Village officials. Thankfully their efforts prevented the terrible conditions of the lower quarry from spreading to their residential area.

By 1973, the dump at the lower quarry was filled and sold. **Last year the DEC ordered a portion of the landfill to be excavated. Some of the oil tanks have been found and removed along with _over 300 tons of contaminated soil_.** In addition, some industries operating on Marbledale Road either are or have been involved with contaminants and dangerous materials:

MediRay, Inc., operations located at 135, 150, 160, and 191 Marbledale Road, handles, stores, and recycles lead medical containers used for the containment of radioactive materials. Some of these radioactive materials are presently stored at 191 Marbledale Road.

King's Electronics, 40 Marbledale Road, operated a parts manufacturing plant from 1951 to 1998 that was responsible for using and on site dumping of **toxic and carcinogenic solvents** that have contaminated the groundwater of the surrounding area. Since 1995 the DEC has been aware of this contamination and in 2002 a voluntary clean up of the immediate area began. Last year, 6 wells were drilled further away from the site of origin, and tests and clean-up are still in progress. The extent of spread has yet to be determined.

Freeman Industries, 100 Marbledale Road, is a manufacturer and distributor of products such as coatings and colorings for the food, pharmaceutical, cosmetic, and flavoring industries. From 1988 through 1998, the DEC, EPA, and local and county officials were involved in toxic spill clean-ups and removal at Freeman. The most serious were in September and August 1998 involving, among other dangerous materials, **picric acid, a highly explosive and very unstable material** that releases very toxic fumes when it decomposes. Roads were closed. Area businesses, residents, and students from the nearby Waverly Early Childhood Center had to be evacuated until the dangerous substances were removed.

Prepared by Active Citizens of Tuckahoe. For more information, call 914-793-4178

Appendix E. Vertical profiles of sub-surface soil borings

Color Key to odors:

No odor detected
Slight odor (not specified)
Strong odor (not specified)
Swampy or septic odor
Slight Hydrocarbon odor
Med Hydrocarbon odor
Strong Hydrocarbon odor
Organic odor
Strong organic odor
Strong solvent odor
Burnt odor

Key for chemical analyses:
OC = volatile and semi-volatile organic compounds
P = polychlorinated biphenyls
M = metals and total cyanide

Figure E-1. Sub-surface Soil Borings in the South Quarry Hole

Depth Interval (ft below grade) from	to	MW-1	TB-1	TB-4	TB-5	TB-6	TB-7	TB-10	GB-2	GB-3	GB-4	GB-5	GB-7	GB-8	GB-9	GB-10	GB-11	GB-12	GB-13	GB-14
0	1				OC									M, P						
1	2				M, P					OC						OC			OC	
2	3													^^^^^					M, P	
3	4													XXX						
4	5					OC,		OC						XXX		^^^^^				
5	6					M,P**		M, P					OC	XXX	OC	XXX		M, P	^^^^^	
6	7					OC	OC							XXX		XXX			XXX	
7	8					M, P	M, P							XXX		XXX			XXX	
8	9													XXX		XXX			XXX	
9	10											M, P		XXX	^^^^^	XXX	OC		XXX	
10	11		OC				OC							XXX	XXX	XXX			XXX	
11	12		M, P				M, P							XXX	XXX	XXX		^^^^^	XXX	^^^^^
12	13				OC								^^^^^	XXX	XXX	XXX		XXX	XXX	XXX
13	14				M, P				M, P					XXX	XXX	XXX	^^^^^	XXX	XXX	XXX
14	15		OC*		^^^^^								XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
15	16		M* P*		XXX								XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
16	17				XXX				^^^^^	^^^^^	^^^^^	^^^^^	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
17	18				XXX				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
18	19		OC*		XXX				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
19	20		M* P*		XXX				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
20	21		OC		XXX				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
21	22		M, P		XXX				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
22	23				XXX				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
23	24				XXX				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
24	25			OC	XXX				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
25	26			M, P	XXX				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
26	27				XXX	OC			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
27	28				XXX	M, P			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
28	29				XXX				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
29	30				XXX		^^^^^		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
30	31			OC	XXX		XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
31	32	OC		M, P	XXX		XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
32	33	^^^^^			XXX		XXX	OC	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
33	34	XXX			XXX		XXX	M, P	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
34	35	XXX		^^^^^	XXX		XXX	^^^^^	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
35	36	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
36	37	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
37	38	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
38	39	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
39	40	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
40	41	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
41	42	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
42	43	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
43	44	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
44	45	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
45	46	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
46	47	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
47	48	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
48	49	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
49	50	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
50	51	XXX		XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
51	52	XXX	^^^^^	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
52	53	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
53	54	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
54	55	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
55	56	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
56	57	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
57	58	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
58	59	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
59	60	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
60	61	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
61	62	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
62	63	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
63	64	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
64	65	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
65	66	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
66	67	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
67	68	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
68	69	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
69	70	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
70	71	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
71	72	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
72	73	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
73	74	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
74	75	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
75	76	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
76	77	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
77	78	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
78	79	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
79	80	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
80	81	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
81	82	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
82	83	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
83	84	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
84	85	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
85		XXX	XXX	XXX	XXX	^^^^^	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX

* Soils from TB-1 14-16' and 18-20' included with 20-22' sample for SVOC, PCB and metals analyses

** Soils from TB-6 4-6' ' included with 6-8' sample for SVOC, PCB and metals analyses

Figure E-2. Sub-surface Soil Borings in the North Quarry Hole

Depth Interval (ft below grade)		MW-3	TB-9	TB-11	TB-12	TB-13	GB-21	GB-22	GB-23	GB-24
from	to									
0	1									
1	2						OC			
2	3		OC				M, P			
3	4		M, P							
4	5			OC	OC	OC				
5	6			M, P	M, P	M, P				M, P
6	7									
7	8		OC							
8	9		M, P							
9	10									
10	11									
11	12							^^^^^	^^^^^	
12	13							XXX	XXX	
13	14							XXX	XXX	^^^^^
14	15							XXX	XXX	XXX
15	16							XXX	XXX	XXX
16	17		^^^^^				^^^^^	XXX	XXX	XXX
17	18		XXX				XXX	XXX	XXX	XXX
18	19		XXX				XXX	XXX	XXX	XXX
19	20		XXX				XXX	XXX	XXX	XXX
20	21		XXX				XXX	XXX	XXX	XXX
21	22		XXX	OC			XXX	XXX	XXX	XXX
22	23		XXX	M, P			XXX	XXX	XXX	XXX
23	24		XXX	^^^^^			XXX	XXX	XXX	XXX
24	25		XXX	XXX			XXX	XXX	XXX	XXX
25	26		XXX	XXX			XXX	XXX	XXX	XXX
26	27		XXX	XXX		OC	XXX	XXX	XXX	XXX
27	28		XXX	XXX		M, P	XXX	XXX	XXX	XXX
28	29		XXX	XXX	OC		XXX	XXX	XXX	XXX
29	30		XXX	XXX	M, P		XXX	XXX	XXX	XXX
30	31		XXX	XXX			XXX	XXX	XXX	XXX
31	32		XXX	XXX			XXX	XXX	XXX	XXX
32	33		XXX	XXX			XXX	XXX	XXX	XXX
33	34		XXX	XXX			XXX	XXX	XXX	XXX
34	35		XXX	XXX			XXX	XXX	XXX	XXX
35	36		XXX	XXX			XXX	XXX	XXX	XXX
36	37	OC	XXX	XXX			XXX	XXX	XXX	XXX
37	38	^^^^^	XXX	XXX			XXX	XXX	XXX	XXX
38	39	XXX	XXX	XXX			XXX	XXX	XXX	XXX
39	40	XXX	XXX	XXX			XXX	XXX	XXX	XXX
40	41	XXX	XXX	XXX			XXX	XXX	XXX	XXX
41	42	XXX	XXX	XXX	^^^^^		XXX	XXX	XXX	XXX
42	43	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX
43	44	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX
44	45	XXX	XXX	XXX	XXX	^^^^^	XXX	XXX	XXX	XXX
45	46	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
46	47	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
47	48	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
48	49	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
49	50	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
50	51	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
51	52	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
52	53	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
53	54	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
54	55	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
55	56	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
56	57	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
57	58	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
58	59	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
59	60	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
60	61	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
61	62	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
62	63	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
63	64	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
64	65	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
65	66	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
66	67	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
67	68	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
68	69	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
69	70	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
70	71	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
71	72	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
72	73	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
73	74	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
74	75	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
75	76	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
76	77	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
77	78	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
78	79	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
79	80	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
80	81	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
81	82	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
82	83	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
83	84	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
84	85	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
85		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX

Figure E-3. Sub-surface Soil Borings Outside Quarry Holes

Depth Interval (ft below		East of South Hole				East of North Hole				NW	Central area		
		TB-2	TB-3	GB-1	GB-6	GB-17	GB-18	GB-19	GB-20	TB-8	MW-2	GB-15	GB-16
from	to												
0	1												
1	2				M, P								
2	3	OC M, P	OC M, P							OC M, P			
3	4												
4	5											M, P	
5	6					OC M, P	^^^^^		^^^^^				
6	7						XXX		XXX			^^^^^	
7	8						XXX		XXX			XXX	
8	9		^^^^^			^^^^^	XXX		XXX			XXX	
9	10		XXX	M, P		XXX	XXX	M, P	XXX			XXX	
10	11		XXX			XXX	XXX		XXX			XXX	
11	12		XXX			XXX	XXX		XXX			XXX	
12	13		XXX		^^^^^	XXX	XXX		XXX			XXX	
13	14		XXX		XXX	XXX	XXX		XXX			XXX	
14	15		XXX		XXX	XXX	XXX		XXX			XXX	
15	16		XXX		XXX	XXX	XXX		XXX			XXX	
16	17		XXX		XXX	XXX	XXX		XXX			XXX	
17	18		XXX	^^^^^	XXX	XXX	XXX		XXX			XXX	^^^^^
18	19	OC M, P	XXX	XXX	XXX	XXX	XXX	^^^^^	XXX			XXX	XXX
19	20		XXX	XXX	XXX	XXX	XXX	XXX	XXX			XXX	XXX
20	21	^^^^^	XXX	XXX	XXX	XXX	XXX	XXX	XXX	OC M, P		XXX	XXX
21	22	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX			XXX	XXX
22	23	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	^^^^^		XXX	XXX
23	24	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX			XXX	XXX
24	25	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		XXX	XXX
25	26	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		XXX	XXX
26	27	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		XXX	XXX
27	28	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		XXX	XXX
28	29	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		XXX	XXX
29	30	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		XXX	XXX
30	31	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		XXX	XXX
31	32	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	OC	XXX	XXX
32	33	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	^^^^^	XXX	XXX
33	34	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
34	35	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
35	36	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
36	37	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
37	38	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
38	39	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
39	40	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
40	41	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
41	42	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
42	43	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
43	44	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
44	45	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
45	46	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
46	47	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
47	48	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
48	49	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
49	50	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
50	51	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX