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SEDIMENTATION ANALYSIS OF NEW GERMANY LAKE

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and

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Prepared For

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EXECUTIVE SUMMARY

In response to a request by the Department of Natural Resources, Maryland Park Service and Engineering and Construction, Maryland Geological Survey (MGS) was charged to study the sedimentation of New Germany Lake located in Garrett County in the State of Maryland.

Sediment cores were collected from the lake, sediment accumulation volumes were determined and physical and chemical characteristics of the sediment were analyzed.

Sediment cores were collected in October 2008. The cores were analyzed and a sediment accumulation thickness ranging from 0.56 meters to 1.16 meters [1.8 to 3.8 feet] was observed throughout the cores. The calculated amount of sediment accumulated since the construction of New Germany Lake is currently a maximum of 33,191 cubic meters [43,412 cubic yards] within the confines of the current shoreline.

Four cores were analyzed for historical patterns in lead and zinc. Three of these cores displayed patterns that suggest only a portion of the sediment has been deposited since the construction of the New Germany Lake Dam and the remaining sediment is from the original Swauger’s Mill dam.

An elemental analysis was performed on thirty sub-samples from the sediments in the collected cores. The only elements which showed enrichment above national screening levels were aluminum, iron, and barium. However, the elevated levels of these elements are most likely due to the analysis methods which were used.

Three samples were analyzed for priority pollutants using EPA 8270 methods. These samples all reported results below the detection limits for the laboratory equipment.

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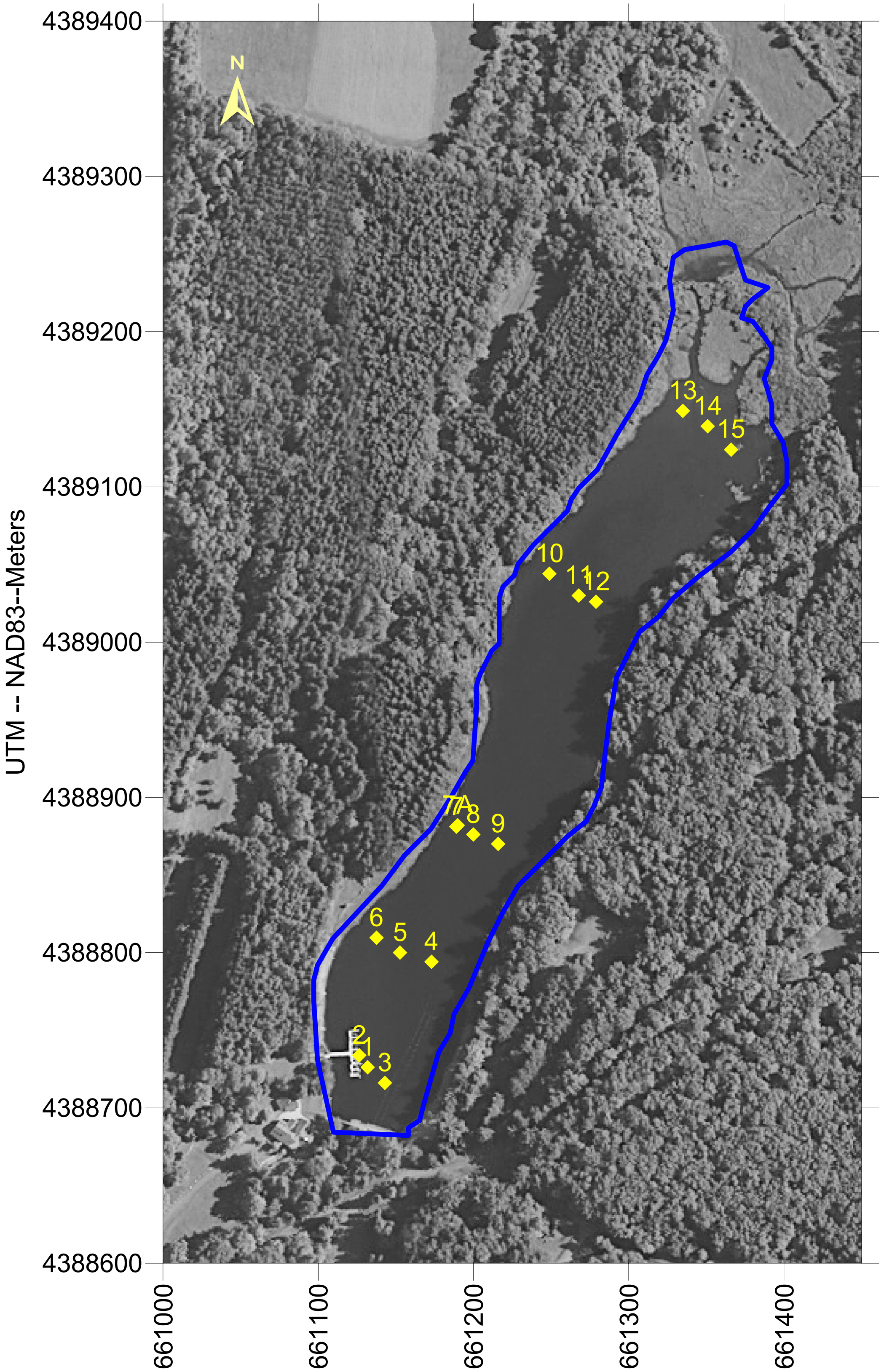

Figure 1. New Germany Lake. Aerial Photography is from 2007 NAIP imagery. Blue Shoreline is digitized from USGS 1946 Topography Maps. Yellow Symbols indicate sediment cores collected in this study.

SITE DESCRIPTION

New Germany Lake is a manmade twelve acre impoundment on Poplar Lick Run in New Germany, Maryland. Upstream and downstream reaches of the contributing and surrounding waterways suggest that this site was once a channelized stream approximately 3.0 to 4.6 meters [10-15 feet] in width and 0.3 to 0.6 meters [1-2 feet] in depth. Around 1837-1847, a milldam and resulting millpond were constructed at what appears to be the same site as the current dam (USGS 1899, 1904, 1938 topographic maps). That dam was lower in height than the current dam; however, it still created a pond of approximately 9 acres (USGS 1899, 1904 topographic maps). Poplar Lick Run enters the lake at the north, and continues southward to the Savage River upon exiting the lake at the dam located on the south end of the lake. The marsh located at the north end of the lake is likely caused by the impoundment and was not originally found in that area (MGS, 1902). Without bathymetry and accurate topography from that time, it is impossible to determine the original depth of this initial impoundment. In the 1933-1935 timeframe, a new earthen dam was constructed which raised the level of the lake to its current height. The lake was very rarely lowered after its final construction in the 1930s. In 2008, DNR performed some safety upgrades and maintenance on the dam which did not alter the water level of the lake. While performing these upgrades, it was noted that the drain pipe for the dam was still clearly above the sediment level. While no evidence has been collected that documents the growth of the headwaters marsh, a cursory observation shows a dendritic stream network with spatially equal amounts of water as there was "land". The streams in this marsh appear to be fed as much by springs as from surface water, and the channels are 0.75 to 0.90 meters [2.5-3 feet] deep with coarse grained sediments throughout. Except for the manmade beach area, the shorelines of the lake do not appear to be marked by much erosion.

There are four known anthropogenic activities on the lake which may have influence over the sediments found in the impoundment. Timbering operations were prevalent throughout the area surrounding Poplar Lick Run prior to, during, and after the construction of the dam. Additionally, a majority of the land located immediately west of New Germany Lake was being used for agriculture. These operations would have increased the flow of sediment into the drainage basins. There also was a sawmill located approximately 400 meters [437 yards] upstream from the current lake's headwaters. This sawmill was in operation beginning sometime around 1800 and ceased operations in the 1950s. Evidence of sawdust was in the reconnaissance cores collected in September 2008. Finally, the lake has been used as a recreational facility since 1935. The largest sediment impact from this activity is the import of sand to the current and historical manmade beach areas.

GEOLOGIC BACKGROUND

New Germany Lake occupies a basin developed in the Pocono Formation. The lake’s western shore roughly traces the contact between the Pocono and the Greenbrier Formations, at the base of Meadow Mountain. Further upslope on Meadow Mountain, above the Greenbrier Formation, are exposures of the Mauch Chunk Formation, capped by the Allegheny Formation and Pottsville Group. The sedimentary sources to the New Germany Lake watershed are primarily confined to these four geologic units.

The lake is surrounded on the north, east and south sides by soils developed in the Pocono Formation, which consists of sandstone, siltstone, shale and some conglomerate. The Pocono typically weathers to a grayish, sandy soil to a sandy loam, containing fragments of sandstone and conglomerate cobbles. Pocono soils usually range from 0.38 to 0.61 meters [15-24 inches] in depth and stone fragments and boulders are common locally. The Greenbrier and Mauch Chunk Formations are similar in composition, consisting of shale and sandstone, although the Greenbrier is more calcareous, containing a limestone member. Along hill slopes these shales and limestones weather to a heavy red loam or clay with abundant sandstone boulders. Heavy, yellow and brown clay soils develop in valleys underlain by the Greenbrier and Mauch Chunk Formations. Because these formations lay upslope from the lake valley, they would be expected to contribute red and yellow clays, sand, and rock fragments to the lake's sediment burden. Similar materials would be expected to be derived from the Allegheny Formation and Pottsville Group which make up the western hilltops along the lake. (MGS, 1902)

STUDY OBJECTIVES

The objectives for this study were:

1) Determine the sediment accumulation within the New Germany State Park Lake.
2) Document the physical and elemental characteristics of the sediment.
3) Identify any priority pollutants which may be contained in the sediment.

METHODOLOGY

Core Collection

Cores were collected along five transects of the lake and one core on the downstream river bank. The lake cores were spaced so that one core corresponded to the center of each transect and the two other cores corresponding to the halfway points between the shorelines and the the centerpoint of each transect. Coring locations are shown and documented in Figure 1 and Appendix A. Sediment cores were collected in aluminum liners attached to a vibracore head supplemented with 113 kilograms [250 pounds] of added weight. Cores were driven to refusal, capped, labeled, and retrieved. Horizontal control was provided through a Thales Navigation ProMark 3 GPS supplemented with satellite based augmentation system (SBAS) differential corrections providing a real-time horizontal accuracy of 2-5 meters [6-15 feet]. Horizontal positions were recorded in the Universal Transverse Mercator (UTM) system based upon the North American Datum of 1983 (NAD83). Core logs include depth of water, total depth driven, and GPS coordinates of each core. All cores were collected between October 6, 2008 and October 10, 2008.

Sediment Documentation and Sampling

Cores were drained, split, and documented within 24 hours of collection. Each core was drained of water to the sediment-water interface and then cut in half lengthwise to expose the collected sediments. The sediments were characterized and documented in sediment logs and photographs. These sediment logs are in Appendix B. The photographs are maintained separately by the Maryland Geological Survey. The cores were sub-sampled for further laboratory analysis with sampling intervals annotated on the core logs and on the sample collection bags. Samples collected for physical property analyses and elemental analyses were collected at discrete intervals within the cores where physical changes were identified. Samples collected for priority pollutants were collected equally along the length of the deposited sediment. All samples were kept in a cooler to maintain a temperature between 8-14° C [46-57° F] .

Physical Property Analyses

Selected sub-samples were analyzed for water content, bulk density, and grain size (gravel, sand, silt, clay contents). Analyses were performed as soon as possible after sample collection, and all samples were refrigerated in sealed Whirl-Pak™ plastic bags prior to analysis.

In preparation for grain size analysis, sediment samples underwent a cleaning process to remove soluble salts, carbonates, and organic matter. These constituents may interfere with the dispersal of individual sediment particles and, thereby, affect the subsequent separation of the sand and mud fractions. All sediment samples were treated first with a 10% solution of hydrochloric acid (HCl) to remove carbonate material, such as shells, and then with a 6% or 15% solution of hydrogen peroxide (H_2O_2) to remove organic material. A 0.26% solution of the dispersant sodium hexametaphosphate ($(NaPO_3)_6$) was then added to ensure that individual grains did not clump, or flocculate, during pipette analysis.

For each sample, the coarse fraction was separated from the mud fraction by wet-sieving through a 4-phi mesh sieve (0.0625 mm, U.S. Standard Sieve #230). The sand fraction (i.e., particles > 0.0625 mm) was dried and weighed. The mud fraction (i.e., sediment passing through the #230 sieve) was analyzed using a pipette technique to determine the proportions of silt and clay (Krumbein and Pettijohn, 1938). The mud fraction was suspended in a 1000-ml cylinder in a solution of 0.26% sodium hexametaphosphate. The suspension was agitated and, at specified times thereafter, 20 ml pipette withdrawals were made. The rationale behind this process is that larger particles settle faster than smaller ones. By calculating the settling velocities of different sized particles, withdrawal times can be determined. At the time of withdrawal, all particles larger than a specified size have settled past the point of withdrawal. Sampling times were calculated to permit the determination of the total amount of silt and clay (4 phi) and clay-sized (8 phi) particles in the suspension. Withdrawn samples were dried at 60°C and weighed.

From the dry weights, the percentages of gravel, sand, silt, and clay were calculated for each sample and classified according to Shepard's (1954) nomenclature, or, if sample contained gravel, according to Folk's (1954) nomenclature. Shepard’s classification, which is widely used in sediment studies, is based on the relative percentages of the sand, silt and clay components of the sediment. Sediments are classified as one of 10 classes according to Shepard's ternary diagram (Figure 2). Folk's classification of sediments is based on textural composition of gravel, sand and mud (silt + clay) fractions and consists of 15 classes. (Figure 3).

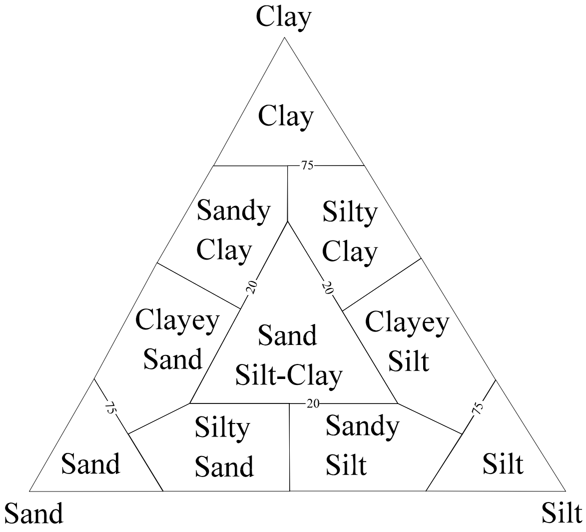

Figure 2. Shepard's (1954) classification of sediment types.

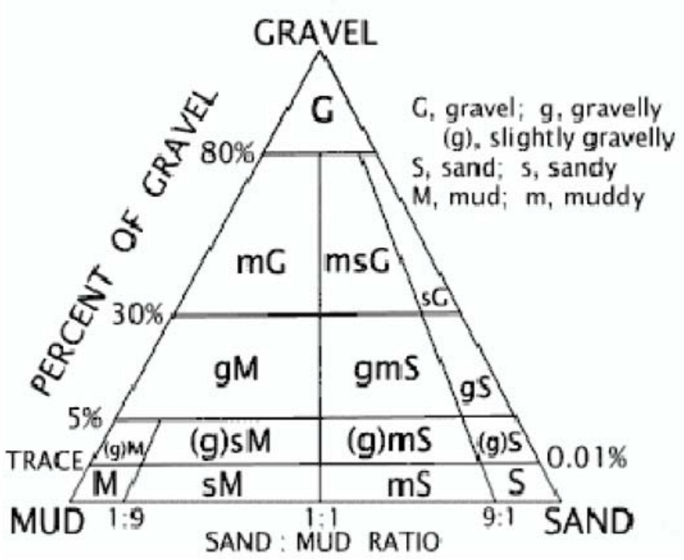

Figure 3. Folk's (1954) classification of sediments.

Elemental Analyses

Activation Laboratories, Ltd. (Actlabs) of Ancaster, Ontario, Canada, analyzed the sediment samples for 48 elements. Concentrations of the elements were determined by one or both of two methods: Instrumental Neutron Activation Analysis (INAA) and a Total Digestion – ICP Analysis. For the Total Digestion method, Actlabs used a four-acid, "near total" digestion process, followed by analysis of the digestate by inductively coupled plasma emission spectroscopy (ICP-OES). The four-acid digestion employed perchloric ($HClO_4$), hydrochloric (HCl), nitric (HNO_3), and hydrofluoric (HF) acids. The digestion method is similar to EPA Method 3052 used for total decomposition of samples.

Quality assurance was checked using the method of bracketing standards (Van Loon, 1980). The standard reference materials (SRMs), similar to the sediments being analyzed, were included every 8 samples and submitted to Actlabs as blind unknowns. Actlabs' results of the analyses of the SRMs are listed in Appendix F.

The authors point out that the analytical method used in this study for the elemental determinations is not appropriate for regulatory applications that require the use of leachate preparations (*i.e*., EPA Methods 3050, 3051, 1311, 1312, 1310, 1320, 1330, 3031, or 3040). This method is appropriate for those applications requiring a total decomposition for research purposes (*i.e.*, geological studies, mass balances, analysis of Standard Reference Materials) or in response to a regulation that requires total sample decomposition.

Priority Pollutant Analyses

Three collected core samples were homogenized and they were analyzed using EPA 8270 standards for priority pollutants. These samples were collected, stored in acid-washed glass containers with Teflon lid liners, and analyzed by the Maryland Department of Health and Mental Hygiene Laboratories in Baltimore, Maryland.

RESULTS AND DISCUSSION

Sediment Accumulation

Sixteen cores were collected from New Germany Lake and one core was collected from the downstream river bank. The core logs, photographs, physical properties, and elemental properties were used to determine the core depth of various layers including historical soil, coarse grained deposits, accumulated fine grained sediments, and a dominant organic layer.

Identification of these selected layers was chosen to aid in the determination of accumulated sediment within the lake. The historical soil layer is defined through the dominant soil types and geology found in the local vicinity and confirmed through the collection of the downstream riverbank core. This layer is visibly and textually identifiable through its dark red sandy soil structure with included gravel, cobbles and rock conglomerates. There are no embedded organic materials and the water content is below twenty percent. Eight of the cores penetrated to the depth of the historic soil level. The coarse grained deposit layer is clearly identifiable through its physical characteristics. This layer is predominately yellow or grey in color consisting of a high percentage of sand and occasionally including organic material. This layer is believed to be a subaerial deposit formed by the weathering of the uphill sediments and their subsequent deposition on the valley floor through wind and rain events prior to any water inundation. This layer was observed in fifteen of the cores. The accumulated fine grained sediment layers, identified as soft mud and firm mud, are the materials which have collected since an impoundment of waters created a subaqueous sedimentary environment. The impoundment slowed the flow of waters and decreased the energy in the environment allowing the fine grain particles to fall out of the water column and collect on the bottom of the lake. These layers are clearly identified through the sediment's physical properties demonstrated by an increase in clay and silt percentages and an increase in water content due to its subaqueous formation. Furthermore, this layer is identified through the occasionally observed striations from episodic depositional events. Organic material is found throughout this layer. These sedimentary deposits were found in all of the cores within the lake. The last layer which was identified is a layer which was extremely high in organic material. In several cores, this layer included sawdust that was most likely deposited by a storm event relocating material from an upstream sawmill. In other cores this layer was a dense leaf mat or a heavy accumulation of sticks. Identification of this layer was found in fifteen of the sixteen cores from the lake.

A description of the selected facies in the collected cores is best visually summarized in the graphs in Appendix C. Figure C-1 is a bar graph which depicts the location of these layers from the sediment surface throughout the depth of the collected cores. Figure C-2 is a bar graph which depicts the location of these layers from the surface of the lake which aligns all of the layers to the same vertical plane. Table C-1 presents the interpreted data from the cores.

A majority of the cores collected follow clear definable patterns of sedimentation. From the lake bottom downwards, the topmost sediments are mostly silts and clays with organic material deposited throughout. The sediments generally become more consolidated with depth. These silts and clays are the sediments which have collected since the initial impoundment of the waters. Below the silts and clays is a thin layer of coarse sand, ranging from 2-33cm [1-12 inches] in thickness. This layer of coarse sand is likely the deposits created by wind and rain erosion of the upslope soils which were mobilized and deposited into the valley prior to the creation of any pond or lake. Below the layer of coarse sand is the historical soil horizon.

Cores 8, 12 and 13 demonstrate a clear sedimentary pattern in recent sediments; however, at depth the sediments appear to have been reworked. From the lake bottom downwards, the topmost sediments are mostly silts and clays with organic material deposited in layers. These sediments become more consolidated with depth. Below the silts and clays there is a deposit of coarse grained material which varies greatly in thickness from at least 8-55 cm [3-22 inches]. The coarse grained materials are characterized by predominantly medium to coarse sands with pockets of organic material and mud lenses. The organic material and mud lenses are most likely due to these cores being near the headwaters of the initial millpond or even in the floodplain or meanders located upstream of the millpond or in the case of Core 8, it may have been in the historic stream channel. In all cases this deposit would be subject to reworking from storm events. The lack of fine sediments suggests that these coarse grained deposits were mobilized under high energy events which indicate that these are alluvium deposits.

A very dense organic layer was detected in all cores with the exception of core 5. This organic layer is likely a distinct event or series of events which occurred within the drainage basin. There is not enough data to draw any conclusions from this layer.

The accumulated sediment is spatially variable, dominantly dependent on the pre-existing topography of the valley and the current bathymetry of the lake. In general, there is an 81 cm [range: 67-93 cm] [31 inches] sediment deposition at the southerly end of the lake slightly decreasing to a 68 cm [range: 56-92 cm] [26 inches] sediment deposition in the middle of the lake and increasing to a 88 cm [range: 56-106 cm][34 inches] sediment deposition at the north end of the lake. The increase in sediment deposition at the north end of the lake also is identified with an increase in silt content of the deposited sediments. This is anticipated as silts need more energy to stay suspended in the water column than clay particles and therefore they deposit to a greater extent closer to the headwaters. This increase is also an indication of the natural pro-delta formation extending the headwaters marsh and decreasing the length of the lake.

Aerial imagery from 2007 maps the spatial area of New Germany Lake to be 41,700 square meters (10.3 acres). Using this area, the lake was divided into thirds, measuring upstream from the dam, and areas and volumes were calculated. While it is likely that the accumulated sediment varies spatially and tapers to a much thinner deposit near the shorelines, this calculation does not extrapolate those changes as the extent of deposit and rate of change is unknown. The calculations use the average accumulated sediment thickness within the area multiplying it by the planar area of the current lake. This will yield an overestimate of the actual accumulated sediment volume in each area; however, it will underestimate the total volume of sediment collected as it does not factor in the sediment which has collected in the headwaters of the lake. Table 1 below presents this data. The total accumulated sediment in New Germany Lake within the current shoreline is 33,191 cubic meters [43,412 cubic yards].

Section	Distance from Dam (Meters)	Average Accumulated Sediment (Meters)	Area (Square Meters)	Calculated Accumulated Sediment Volume (Cubic Meters)
South	0-125	0.81 [0.67-0.93]	9500	7695
Middle	125-306	0.68 [0.56-0.92]	14200	9656
North	306-530	0.88 [0.56-1.16]	18000	15840
Total	0-530	------	41700	33191

Table 1. Sediment accumulation within New Germany Lake.

Elemental Analyses

Analytical results are presented in Table F-2.

Because the samples were analyzed using a total decomposition method (four-acid digestion), the concentration values should not be compared to threshold limits in the NOAA SQuirTs (Screening Quick Reference Tables) (Buchman, 2008). The values listed in the NOAA tables are based on EPA methods which allow partial decomposition of sediment samples and thus reflects that portion of any element that may become biologically available/mobile under extreme environmental conditions. For example, the NOAA tables list background levels in soil/sediments for aluminum (Al) as 0.26% which reflects the average aluminum (Al) biologically available. However, our results for aluminum (Al) range from 2.85% - 7.17%, reflecting total recovery of the element by our digestions method. Aluminum (Al) is a major component of most minerals found in native rock and soils. In addition to aluminum (Al), iron (Fe) and barium (Ba) exceed the SQuirTs background levels by an order of magnitude. Concentrations of the other elements that are listed in SQuirTs are near the background levels.

Table F-4 presents a correlation matrix for elemental concentrations and textural components (Water content, bulk density, gravel, sand, silt and clay). Most elements are significantly correlated with one or more textural components, reflecting some textural control over the relative abundance of these elements. For example, many elements show a significantly strong inverse relationship with sand indicating that these elements are found in the mud (silt+ clay) fraction of the sediments. Hafnium (Hf) and Uranium (U) show the least significant correlations with the other parameters measured.

Because of the wide range of sediment types analyzed, comparisons of absolute metal concentrations between the sediments are very difficult due to variation in textural characteristics. Likewise, assessing down core changes in elements is further complicated since there is a significant downcore change in the textural character of the sediments (example: Core 4, Table G-1).

To reduce the effect of grain size, metal concentrations may be discussed in terms of enrichment factors (EF). The use of enrichment factors also allows for comparisons of sediments from different environments and the comparisons of sediments whose trace metal contents were obtained by different analytical techniques (Cantillo, 1982; Hill and others, 1990; Sinex and Helz, 1981). Once metal data are "normalized" with respect to textural differences, trends in the spatial distribution of metals are easier to realize and interpret.

Enrichment factor is defined as:

$$EF_{(X)} = \frac{(X\ /N\ )_{sample}}{(X\ /N\ )_{reference}}$$

where:

$EF_{(x)}$ is the enrichment factor for the metal X;
$X/N_{(sample)}$ is the ratio of the concentrations of metal X to major metal N (Fe or Al) in the sample;
$X/N_{(reference)}$ is the ratio of the concentrations of metal X to major metal N (Fe or Al) in a reference material, such as an average crustal rock.

Both aluminum (Al) and iron (Fe) were chosen as the element for normalizing because anthropogenic sources for these metals are small compared to natural sources (Helz, 1976). Average continental crust is used as the reference material (Taylor, 1964). Taylor's averages have been used in other studies involving various sedimentary environments, including fresh water reservoirs (Ortt et al., 1999; Sinex and Helz, 1981; Wells et al., 2007).

EF values calculated using aluminum as the normalizing element are similar to those values using iron as the normalizing elements (Table 2). EF values of one or less indicate no or under-enrichment of that element with respect to continental crust rock. In both sets of EFs, most elements show no or little enrichment (i.e. EF < 2). However, several elements are greatly enriched with respect to the reference material. The enrichment of zinc (Zn) and lead (Pb) is due, in part, to anthropogenic sources; both of these elements have a regional atmospheric source component related to man activities. The enrichment of both elements decreases with depth identifying that concentrations of these metals have changed over time (Figure 4). Other elements having high EF values include arsenic (As), cesium (Cs), hafnium (Hf), antimony (Sb), uranium (U) and lutetium (Lu). The high enrichment may reflect a natural regional abundance of the elements as they do not exhibit any significant downcore change. For example, a source of hafnium (Hf) is zircon, a mineral found in the parent rock of the study area.

	Mean EF using			Mean EF using	
Element	**Fe**	**Al**	**Element**	**Fe**	**Al**
P	0.62	0.53	**Sb**	10.64	9.86
Cr	1.05	0.85	**Rb**	1.86	1.44
Cu	0.52	0.42	**Sc**	0.76	0.61
Fe	--	1.02	**Sr**	0.30	0.24
Mn	0.50	0.49	**Ti**	0.94	0.79
Ni	0.69	0.56	**Th**	1.91	1.53
Pb	3.46	2.92	**U**	3.10	2.43
Zn	2.62	2.04	**V**	0.78	0.70
Al	1.24	--	**Y**	1.48	1.16
As	9.13	9.23	**La**	2.31	1.79
Ba	2.18	1.61	**Ce**	1.88	1.48
Co	0.87	0.72	**Nd**	1.70	1.23
Cs	2.99	2.16	**Sm**	1.44	1.13
Eu	1.83	1.42	**Yb**	1.70	1.31
Hf	6.77	5.25	**Lu**	2.66	2.08
Mg	0.24	0.19			

Table 2. Comparison of EF values using Fe and Al, respectively, as the normalizing metal. Values shown for each element are an average of all samples.

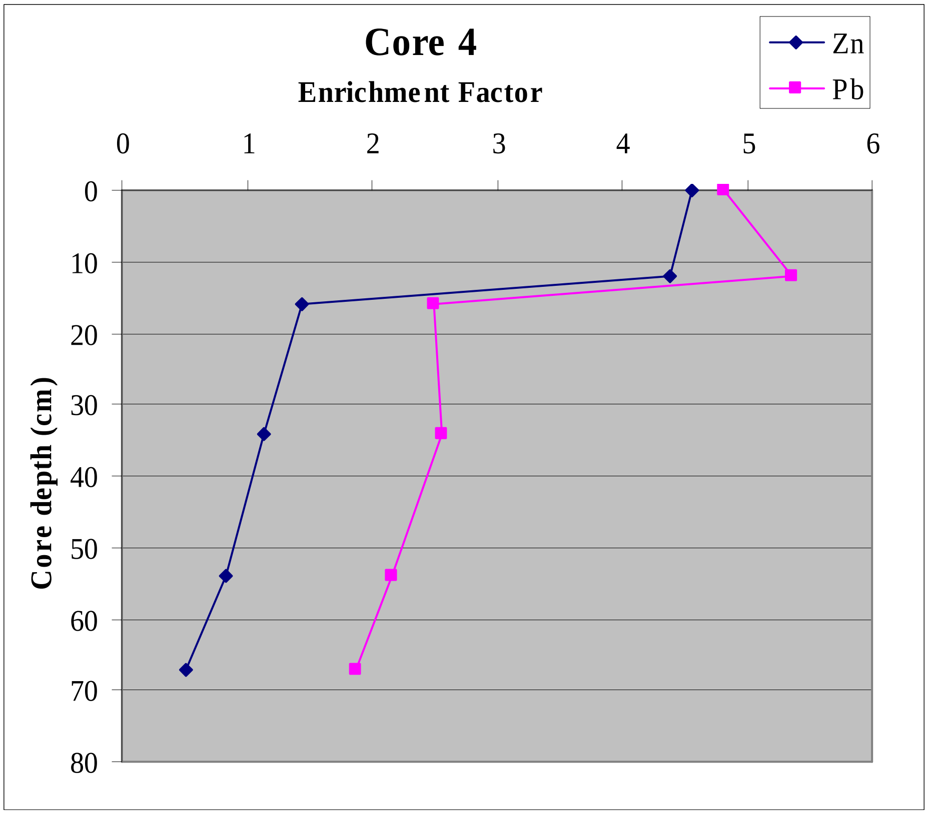

Figure 4. Plot of EF (nomalized using Fe) for Zn and Pb in core 4.

The downcore plot of lead (Pb) and zinc (Zn) in Core 4 also allows a general conclusion regarding the sediment history in that core. Both lead (Pb) and zinc (Zn) environmental levels increased dramatically in the early 1900s due to the industrial use of these metals and increased atmospheric levels due primarily to coal-powered factories and power plants and automotive exhaust. A peak in lead (Pb) concentrations during the mid-1970s is also a continental pattern observed in sediments caused by the removal of alkyl-lead from gasoline. (Owens and Cornwell, 1995) The lead (Pb) and zinc (Zn) profiles in Core 4 (Figure 4) demonstrate this trend with a significant increase in both lead (Pb) and zinc (Zn) levels between the samples collected at 16-34cm depth and 12-16cm depth. A peak in the lead (Pb) data is also displayed in the 12-16cm depth sample. While the sampling intervals used for this study are too gross for determining the exact chronology of the sediments in this core, it can be generalized that sediments deeper than 25cm [range: 16-34cm] [10 inches] are older than the early 1900s, and they are from the original Swauger's millpond. Conversely, the sediments shallower then 25 cm [range: 16-34cm] [10 inches] have been deposited since the early 1900s, and they are mostly from post-1935 dam construction.

Priority Pollutants (Semi-Volatile Organics) Analyses

Samples from cores 1, 11, and 15 were created using sediment collected along the length of the core. These samples were submitted to DHMH for EPA 8270 analyses. The report identified only pesticides from this submission (Appendix D). A second set of the same samples was submitted to DHMH for EPA 8270 analyses (Appendix E). These samples were processed using the EPA 8270 method with the exception that the holding time between collection of the samples and the analysis of the samples was exceeded. All results showed that the levels of all of the analyzed pollutants were below detection limits.

Delta Growth Analysis

Maps and aerial images from 1899, 1904, 1938, 1944, 1962, 1995, and 2007 were analyzed to document the change in the northern boundary of New Germany Lake. This area is subject to a faster sedimentation rate as it is the area where there is the greatest decrease in energy. Unfortunately, the scales, datums, and quality of the maps and images differ enough that absolute measurements are difficult to compare; however, the general trend can be observed. A point was selected where Poplar Lick Run intersects the south side of Twin Churches Road. From that point, distances were measured to the shoreline of the northern most portion of New Germany Lake. (Table 3)

Year	Document	Scale	Distance Measured (Meters)
1899	USGS Topo	1:62,500	330
1904	USGS Topo	1:62,500	342
1938	USGS Topo	1:62,500	349
1938	Imagery	1:20,000	202
1944	USGS Topo	1:24,000	207
1962	Imagery	1:20,000	211
1995	Imagery	1 Meter	238
2007	Imagery	1 Meter	238

Table 3. Measurement of Northern Lake Boundary migration.

The three measurements from the 1899, 1904, and 1938 topographic maps yield a southerly migration of 19 meters [62 feet] over a 39 year period. It is unknown when the actual field surveys were performed for these maps; however, the 1938 topographic map shows the New Germany Lake at its pre-1933-1935 construction extent. These measurements provide a rough calculation of 0.5 meter/year [1.6 feet/year] growth of the headwaters delta.

The five measurements since the construction of the new dam yield a 36 meter [118 feet] southerly migration over a 69 year period. This calculates to an average 0.5 meter/year growth [1.6 feet/year] of the headwaters delta.

CONCLUSIONS AND RECOMMENDATIONS

Sediment Accumulation

New Germany Lake has accumulated a maximum of 33,191 cubic meters [43,412 cubic yards] of sediment within its current acreage. These sediments range from 0.56-1.16 meters [1.8- 3.8 feet] in thickness throughout the majority of the lake with the most sediment accumulating in the northern portion of the lake. Additionally, the delta formed in the headwaters of the lake has shown a history of growth at 0.5 meters per year [1.6 feet/year].

Sediment Physical Properties and Chemical Properties

The accumulated sediment is generally a silty-clay. Towards the southern portion of the lake, there is an abnormally higher amount of sand in the sediment which is likely to be from the historical and current man-made beaches. Towards the northern portion of the lake, silt dominates over the clay percentages and changes the sediment classification to clayey-silt.

Chemical analyses document that the sediments are fairly consistent with average crustal standards. There is an elevation of rare earth metals; however, these metals do not reach any levels for national screening criteria. The elevation of these metals is likely due to localized geologic composition.

Priority Pollutants (Semi-Volatile Organics) Pollution

No forms of sediment pollution were identified. While the second analysis of priority pollutants using EPA 8270 methods was outside of the holding period, there were no pollutants detected via the analysis. Additional research with Maryland Department of the Environment confirmed that there are no known pollutants identified within the area surrounding the park.

Recommendations

No further studies are recommended to document sediment accumulation within New Germany Lake.

Should studies of this type be extended to other small-watershed lakes similar to this study area, it is recommended to take additional samples throughout the cores and analyze them for both physical characteristics and chemical composition. The additional samples would document downcore changes and assist in interpretation of the cores.

ACKNOWLEDGEMENTS

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Appendix A

Core Locations

	UTM--NAD83--Meters		Water Depth	Water Depth
Core	Easting	Northing	FT	Meters
1	661132	4388726	6.9	2.09
2	661127	4388734	6.6	2.01
3	661143	4388716	7.0	2.13
4	661173	4388794	4.9	1.49
5	661153	4388800	6.7	2.04
6	661138	4388810	5.4	1.65
7	661189	4388881	3.8	1.16
7A	661190	4388882	4.0	1.22
8	661200	4388876	5.1	1.55
9	661216	4388870	5.1	1.55
10	661249	4389044	2.5	0.76
11	661268	4389030	2.8	0.85
12	661279	4389026	2.5	0.76
13	661335	4389149	1.1	0.34
14	661351	4389139	1.4	0.43
15	661366	4389124	1.5	0.46
16	661110	4388545	0.0	0.00

Table A-1. Locations and Water Depths of collected cores.

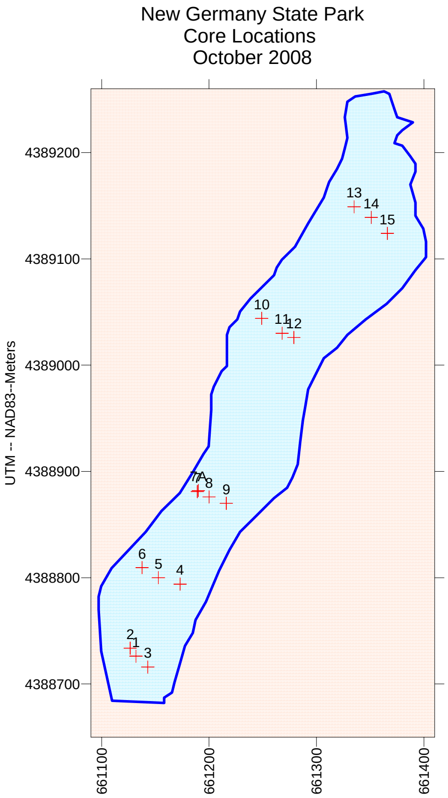


Figure A-1. Map depicting the location of the collected cores. Shoreline is approximate from 1944 USGS topographic map.

Appendix B

Core Logs

P 1 of 1

GRAPHIC LOG

PROJECT: NGSP
CORE ID: Core 1
DATE COLLECTED: 10/7/08
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: 104 cm (cm)
DATE OPENED: 10/7/08

NOTES:

Depth (cm)

v. soft, watery
v. slightly silty mud
5Y 3/2
10
20
sl. firmer, sl. more grit mud.

28 cm

30
smooth clay
10YR 4/2
v. firm
40

45 cm

10YR 4/2 w/ sawdust

50
50 cm

clay
5Y 4/1
organics w/ sand

57 cm
5YR 6/1
58 cm
> clay w/ few organics

60
clay, smooth
5YR 5/2
v. firm

68 cm

70
gaseous, clay,
10YR 4/2
sl. less firm than above
80

86 cm

10YR 4/2 w/ organics → sand w/ many roots

88 cm

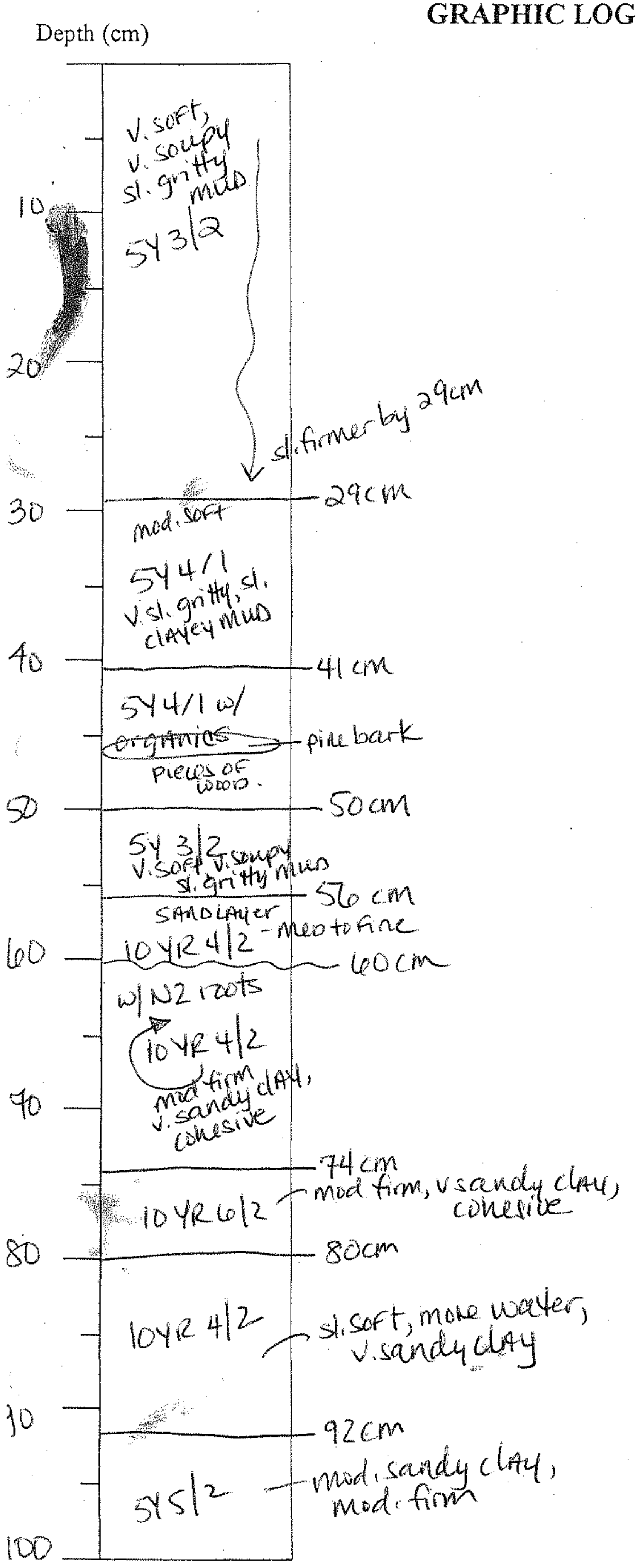
90
10YR 6/2
v. firm ↓
10YR 4/2
100

fine to v fine sand w/ mod. clay content in spots.
* roots from 88-100 cm.
BoC = 104 cm

	Sampled Interval	Grain Size	
	0-28 cm		WP (whirlpack)
	88-100 cm		WP
0-100	composite		~~[illegible]~~ WP

P 1 of 2

GRAPHIC LOG



v. soft, v. soupy sl. gritty mud

5Y 3/2

sl. firmer by 29cm

29cm

mod. soft

5Y 4/1

v. sl. gritty, sl. clayey mud

41 cm

5Y4/1 w/ ~~organics~~ pieces of wood. — pine bark

50cm

5Y 3/2

v. soft, v. soupy sl. gritty mud

56 cm

sand layer

10YR 4/2 - med to fine

60cm

w/ N2 roots

10YR 4/2

mod firm v. sandy clay, cohesive

74 cm

10YR 6/2 — mod. firm, v sandy clay, cohesive

80cm

10YR 4/2 — sl. soft, more water, v. sandy clay

92cm

5Y 5/2 — mod. sandy clay, mod. firm

PROJECT: NGSP

CORE ID: Core 2

DATE COLLECTED: 10/7/08

INITIAL LENGTH: ______ (cm)

COMPACTION: ______ (cm)

FINAL LENGTH: 123.5cm (cm)

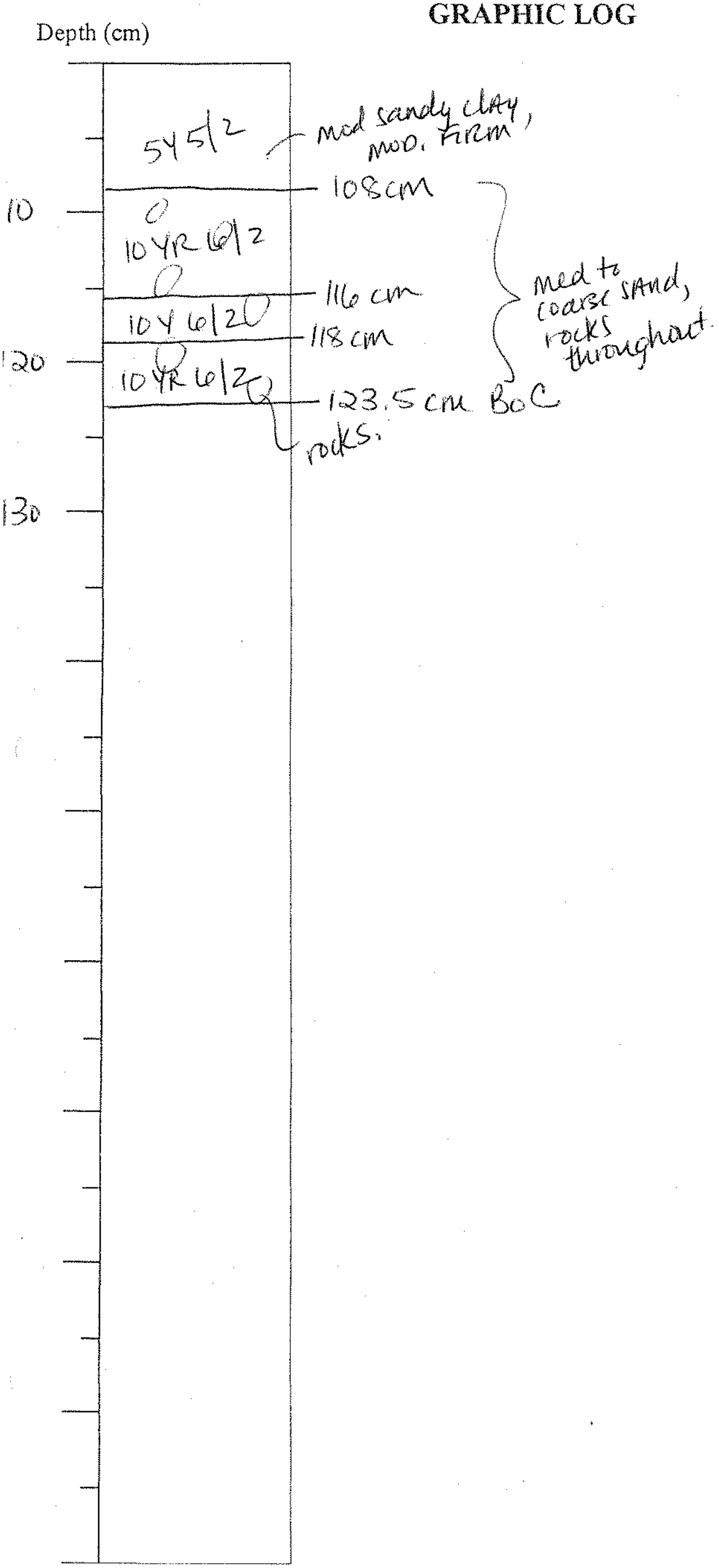
DATE OPENED: 10/7/08

NOTES:

Sampled Interval	Grain Size

P201 a

GRAPHIC LOG



PROJECT: NGSP

CORE ID: Core 2

DATE COLLECTED: 10/7/08

INITIAL LENGTH: ____________(cm)

COMPACTION: ____________(cm)

FINAL LENGTH: 123.5cm (cm)

DATE OPENED: 10/7/08

NOTES: ____________

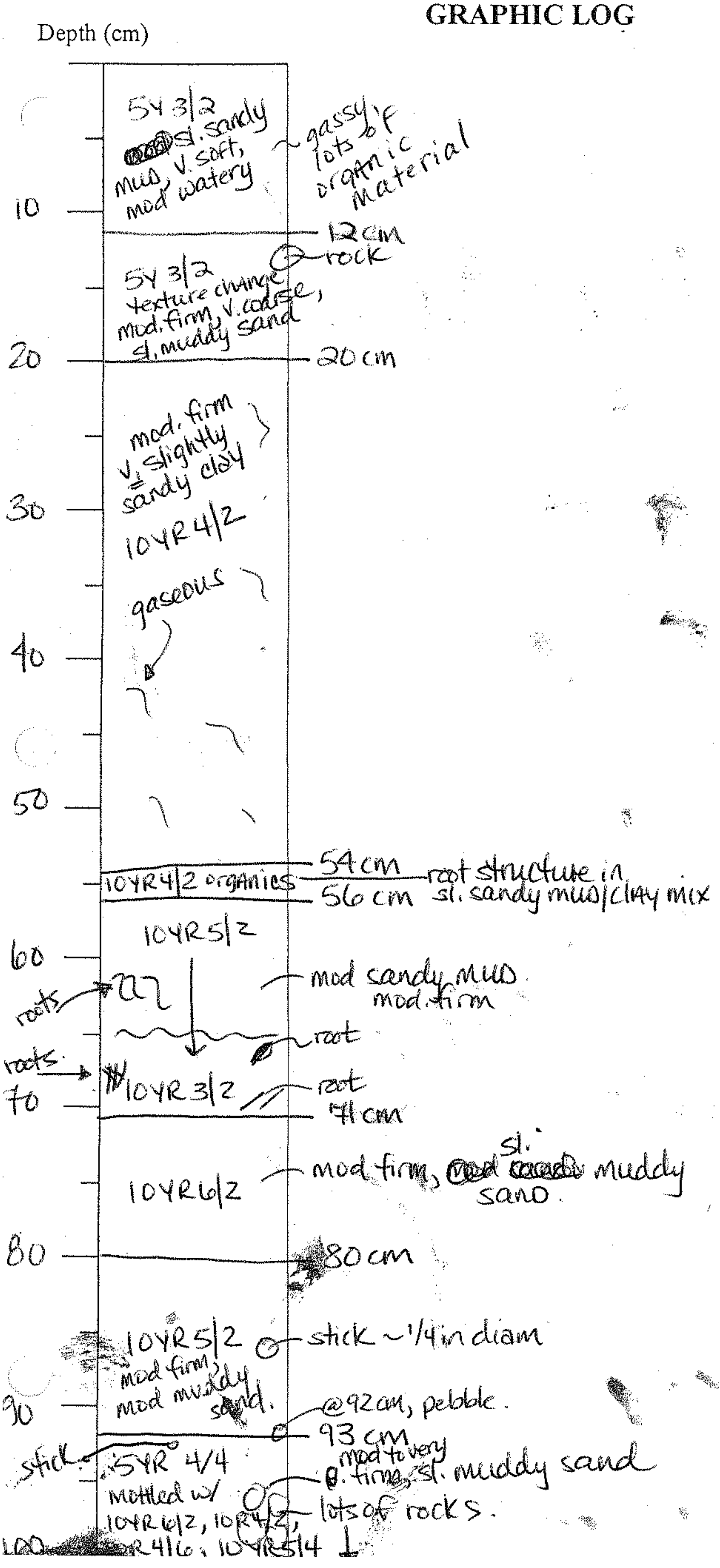
Sampled Interval	Grain Size	
0-29cm		
116-124cm		
116-124	cm	→rocks.
80-92	cm	→clay layer

P1 of 2

GRAPHIC LOG

PROJECT: NGSP
CORE ID: ~~Core~~ 3
DATE COLLECTED: 10/7/08
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: 154.5cm (cm)
DATE OPENED: 10/8/08

NOTES: ______

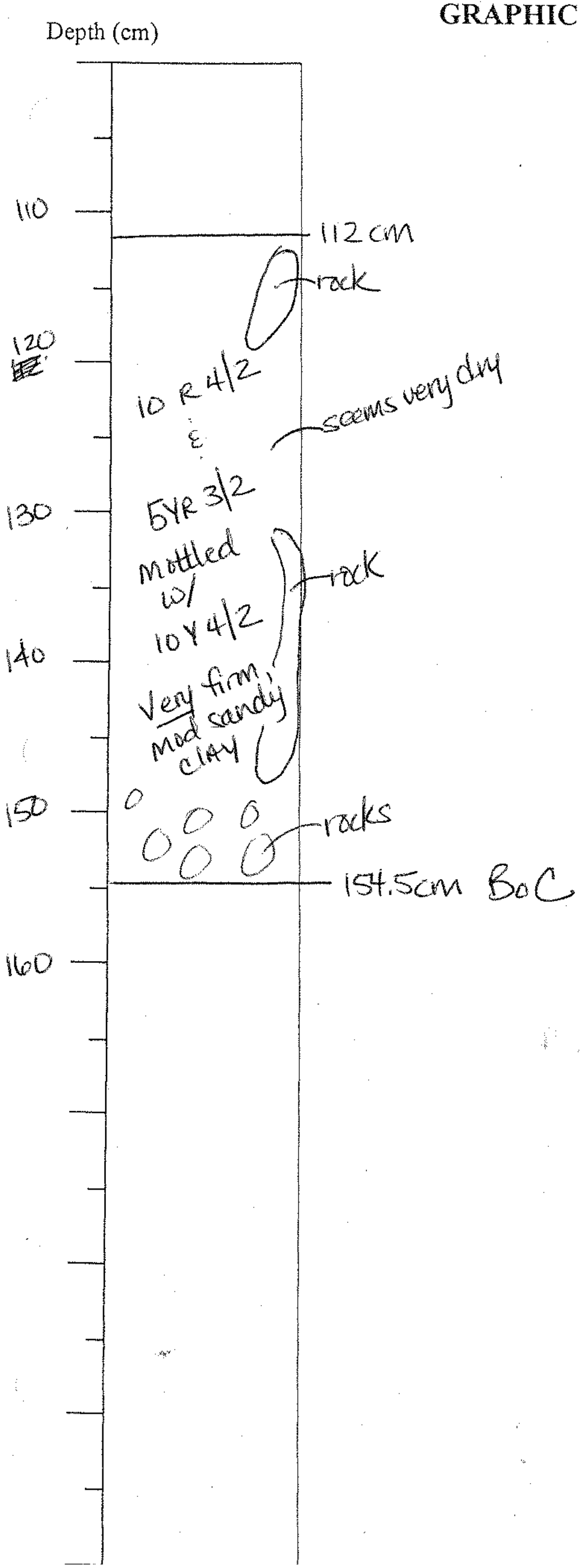


Sampled Interval	Grain Size
0-12	
12-20	
20-54	
54-56	
56-71	
71-80	
80-93	
93-112	
112-154.5	

GRAPHIC LOG

PROJECT: NGSP
CORE ID: CORE 3
DATE COLLECTED: 10/7/08
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: 154.5cm (cm)
DATE OPENED: 10/8/08

NOTES: ______

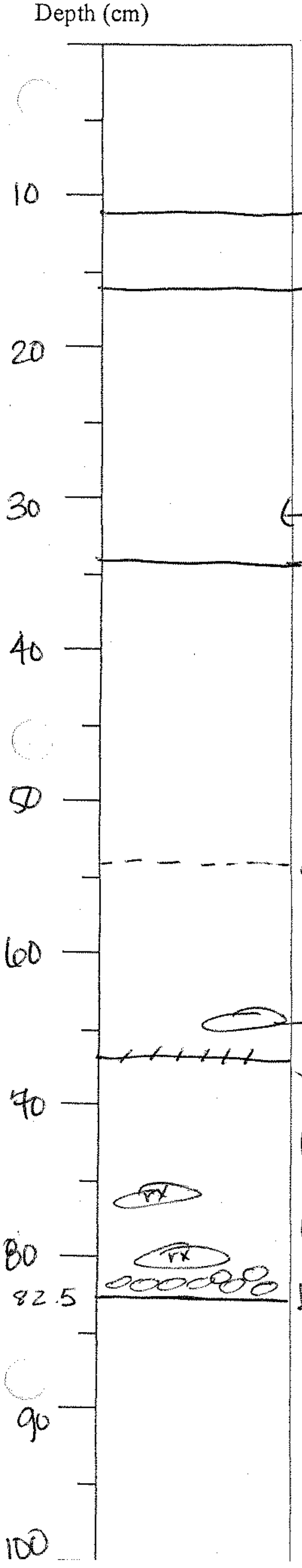


Sampled Interval	Grain Size

P1 of 1

GRAPHIC LOG

PROJECT: NGSP
CORE ID: Core 4
DATE COLLECTED: 10/7/08
INITIAL LENGTH: ____________(cm)
COMPACTION: ____________(cm)
FINAL LENGTH: ____________(cm)
DATE OPENED: 10/8/08
NOTES: ____________



0-12 cm
5Y 2/1 → 5Y 3/2
v. sl. gritty, soupy mud - v. soft; organic matter

12-16 cm lumpy?
12
5Y 3/2 ; v. sl. sandy mud w/ non-gritty mud lenses; plant (root) matter; mod. soft
16

16-34 cm
10 YR 4/2 w/ 5 YR 5/2 mottles; very firm sl. sandy clay;

(~32) = big stick ~ 3/4" diam.

34

34-67 cm
5YR 5/2; mod. firm to 54 cm mod. sandy clay/mud; fairly cohesive

change in firmness @ 54 cm

mod. soft bet. 54-67 cm. (higher water content · soupier)

big rock just above 67 cm.

67 texture change

67-82.5 cm.
5YR 5/2 w/ 10 YR 4/2 pockets; very sandy clay or mud; very firm from ~73 to bottom - but rocky - might affect firmness; roots

bottom

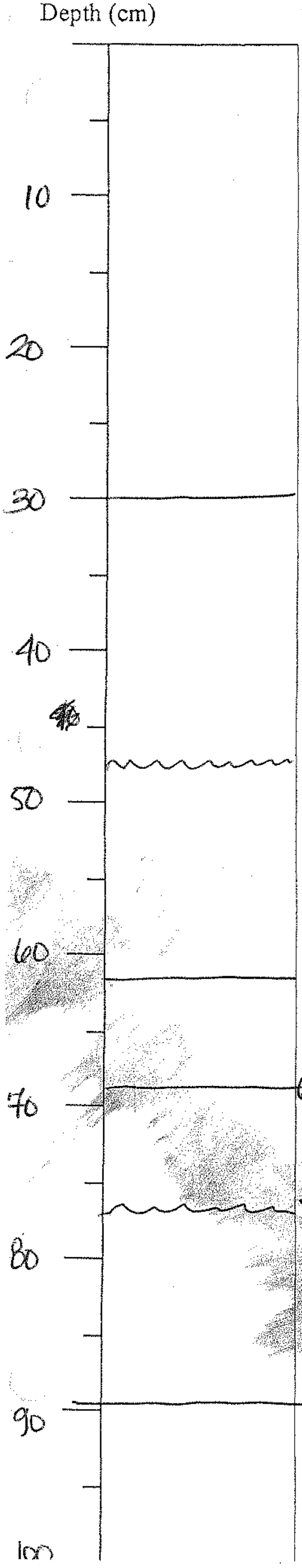
Sampled Interval	Grain Size
0-12	✓
12-16	✓
16-34	✓
34-54	✓
54-67	✓
67-82.5	✓

p 1 of 1

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 5
DATE COLLECTED: 10/7/2008
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: ______ (cm)
DATE OPENED: 10/8/2008

NOTES: ______



0-30 cm = 5Y 2/1
v. soft, v. soupy,
v. slightly gritty mud;
plant matter/roots (SAV?)
sl. firmer ~30 cm -
gradational

30
30-48 = 10YR 3/2
sl. firm; fairly smooth - v. sl.
gritty mud/clay; cohesive

48 - color change
48-62 cm = 10 YR 4/2
mod. firm; v. sl. gritty mud
not much in way of organics

62
62-68 cm = 10 YR 4/2
organic layer - mod. firm
68 root structure, wood (~~sawdust~~? chips
darker than what have seen
previously); small stick

76 color change
68-76 = 10 YR 4/2; mod - very
firm; firmer w/ depth; bits of sticks, leaves; mod. sandy mu
76-89 = 10 YR 5/4 w/ N2 (aq.)
mottles
much sandier than above - v. sandy mud
89 - bottom

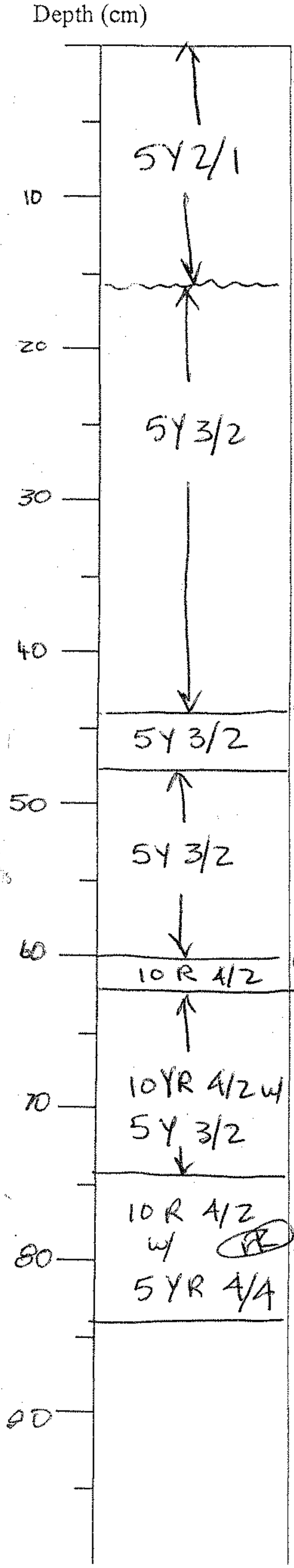
Sampled Interval	Grain Size
0-30	✓
30-62	✓
62-76	✓
76-89	✓

P 1 of 1

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 6
DATE COLLECTED: 10/7/2008
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: ______ (cm)
DATE OPENED: 10/8/2008

NOTES: ______



0-16 cm = 5Y 2/1
V. soft, soupy, v. sl. gritty mud, few small roots

16-44 cm = 5Y 3/2
16 cm - color change & firmness "
mod. soft → sl. firm (firmer w/ depth to 44 cm)
less soupy; still sl. gritty clayey mud; roots (few)
~~no roots~~

44 44-48 5Y 3/2
organic layer; feels like coarse sawdust; [illegible]
48

48-60 - sl. firm grading to mod. firm @ 60 cm; sl. gritty clayey mud
~60 - some organics

60-62 } 10 R 4/2 - smooth clay

62-74 - organic layer - much sandier
mod. muddy med. sand; lower H₂O content
mod. firm
@72 cm = pine cone
lots of sticks, leaves, bark } piece of bark? @ 66 cm
74

74-84 cm: reddish, v. firm clay
lots of rocks thruout - large one @ 78 cm - no roots

84 - bottom

Sampled Interval	Grain Size
0-16	
16-44	
44-48	
48-62	
62-74	
74-84	

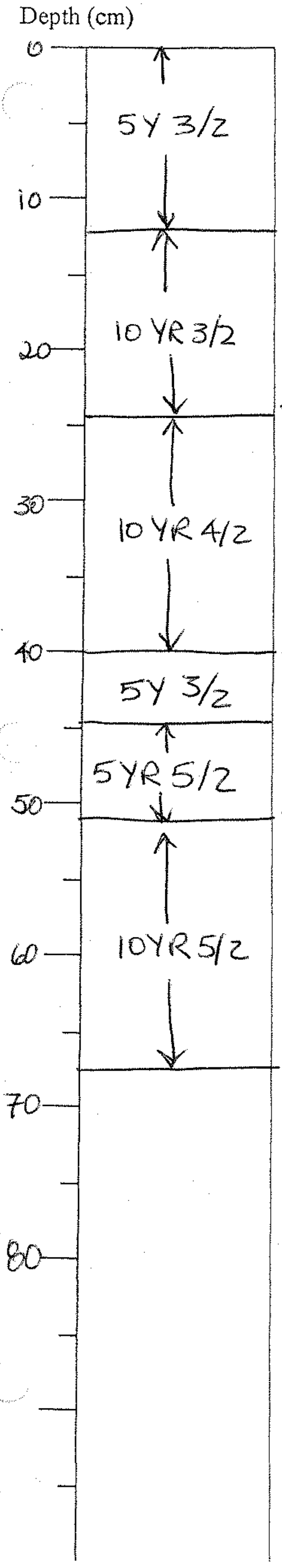
P 1 of 1

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 7
DATE COLLECTED: 10/8/2008
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: ______ (cm)
DATE OPENED: 10/8/2008

NOTES: cut core too low - add at least 3cm to length -

gassy to ~40 cm



<u>0-12cm</u>: sl. gritty, soupy mud; firmer w/ depth to 12 cm

12cm

<u>12-24cm</u>: sl. firm, w/ slight ↑ in firmness w/ depth to 24cm; sl. gritty mud; sl. organics throughout - roots, leaves bits

24 cm

<u>24-40cm</u>: mod. firm; sl. gritty clayey mud - more cohesive than 12-24 cm section; small wood chips/(sawdust) chunks

40cm
44 cm
} org. layer; bark ~2" wide - both sides of core; roots; small pieces of wood; mod. gritty, v. soupy mud around wood

51 cm

<u>44-51 cm</u>: v. firm, sl. gritty clay; root structs; big stick; some org. throughout

68 - bottom

<u>51-68 cm</u>: starts out v. firm to mod. firm @ depth. more H_2O content near bottom (due to loss of bottom during collection?)
sl. gritty clay; org. throughout - root struct & bits of leaves - esp near top of section - fewer @ depth
a little sandier @ depth (last 5-6 cm)

Sampled Interval	Grain Size
0-12	
12-40	
40-44	
44-51	
51-68	

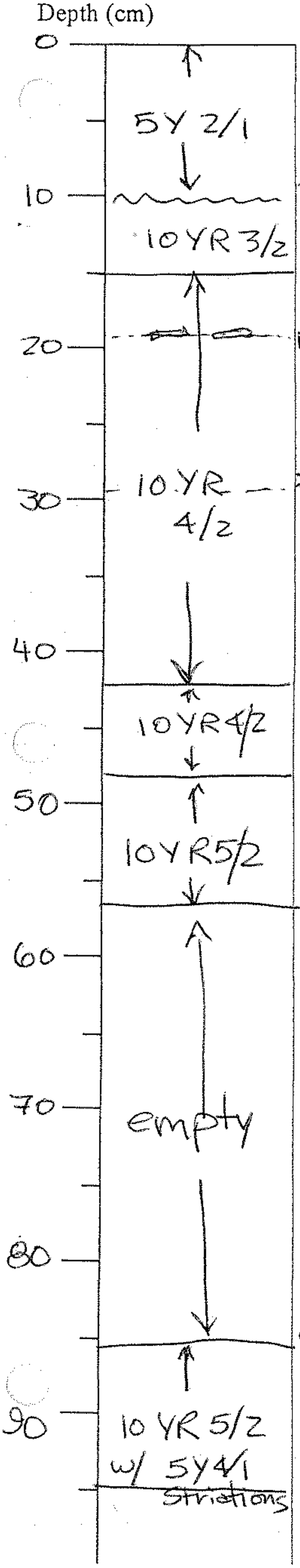
P1 of 1

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 7A
DATE COLLECTED: 10/8/08
INITIAL LENGTH: ______(cm)
COMPACTION: ______(cm)
FINAL LENGTH: ______(cm)
DATE OPENED: 10/8/08

NOTES: very soupy at the top; big chunk missing in middle looks like seperation during retrieval

gossy to 42 cm



0-15 - sl. gritty, soupy mud- firmer, less soupy w/ depth to 15 cm; green SAV at surface, some root struct ; v. soft to mod.

10 - color change

soft @ 15 cm

15

15-42cm: very firm; layer @ 19 = stick or piece of wood; v. sl. gritty muddy clay

19/20

29 cm - piece of bark/wood

30-42 cm - few org. throughout

42

organics } tree trunk or branch v. sl. gritty mud; maybe higher H_2O content

48

48-57 cm & 86-94.5 : very firm, sl. gritty clay

@ 56cm = intense root layer = above pt. of separation

57

core separation during retrieval

86

few roots throughout this section

94.5 "bottom"

Sampled Interval	Grain Size
0-15	
15-42	
42-48	
48-57 +	
86-94.5	

single sample

p 1 of 1

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 8
DATE COLLECTED: 10/8/08
INITIAL LENGTH: ____ (cm)
COMPACTION: ____ (cm)
FINAL LENGTH: ____ (cm)
DATE OPENED: 10/9/08

NOTES: ____

Depth (cm)

0–9	5Y 2/1
9–16	5Y 3/1
16–34	5Y 3/2
34–38	10 YR 4/2
38–44	10YR 5/2
44–56	10YR 6/2
56–74	10 YR 5/2
74–87 (81, 83)	10 YR 4/2
87–88	Wood
88–90	10 YR 4/2+6/2
90–92	wood
92–100	10YR 4/2

0-9cm: v. sl. gritty, v. soft soupy mud; gassy

9-16cm: v. soft → sl. soft, sl. gritty; sml. woody pieces - sticks, sml. pieces of bark throughout; gassy

16-34cm: mod firm → v. firm @ 34 cm; less gassy w/ depth; v. sl. gritty muddy clay, few sml org. thruout - leaves, sml. pieces of wood

34 } mod. firm, v. sl. gritty muddy clay
38 } few orgs. thruout - like above but diff. color

38-44 cm: mod. firm → v. firm w/ depth @ 44 cm; sandier than above; mod. sandy clayey mud; few orgs. throughout

44-56: v. firm, sl. muddy sand few orgs thruout - wood chips, leaf matter;

56-74: mod. firm, mod. muddy sand; sticks throughout; more orgs. than above

74-81: mod. firm; wood shavings; stick @ 76 cm; same gr. size as 56-74; dk pieces of org. matter - leaves & pieces of stick

81 } ~~sawdust~~?; watery (just in wood?)
83 } stick = don't think it's sawdust

81:90: same grain size & firmness as 74-81

87-88: layer of woody pieces; darker than 81-83

90-92: another woody layer; " " 87-88

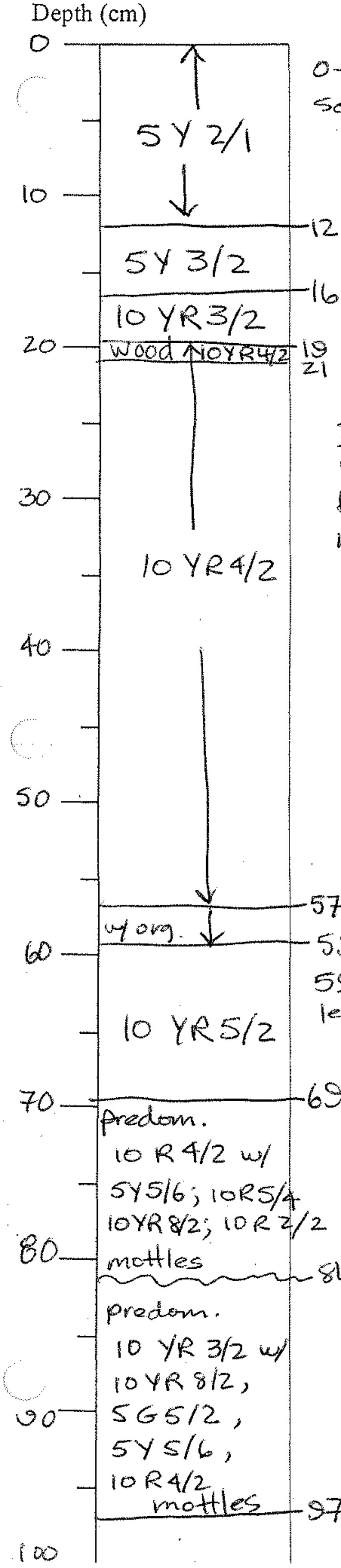
92-100 - v. firm, sl. muddy sand
stick
100 = bottom

Sampled Interval	Grain Size
0-16	
16-44	
44-56	
56-81	
81-83	
83-92	
92-100	

p 1 of 1

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 9
DATE COLLECTED: 10/8/08
INITIAL LENGTH: ____ (cm)
COMPACTION: ____ (cm)
FINAL LENGTH: ____ (cm)
DATE OPENED: 10/9/08
NOTES: looks like we hit bottom; gassy to 57 cm



0-12: v. sl. gritty, v soft, soupy mud; gassy

12-16 cm (to 21 cm) - roots @ 12 cm; sml sticks & leaf debris throughout; v sl. gritty mud
12-16 cm: v. soft
16-19: mod. soft
19-21: sl. soft, wood chunk

21-57: sl. soft, sl. gritty mud
from ~ 55-57 cm ↑ in sand content
no obvious orgs. (sticks/leaves - No)

57-59: mod. firm, mod. muddy sand w/ organics; sml pieces of wood, leaf debris, root struct.

59-69 cm: v. firm, sl. muddy sand w/ org. debris throughout - less concentrated than 57-59 cm - little pieces of wood

69 major text. + color change
69 - bottom - very firm, med to fine sand, v. sl. muddy rocks throughout
@ 82 cm - stick

81 cm

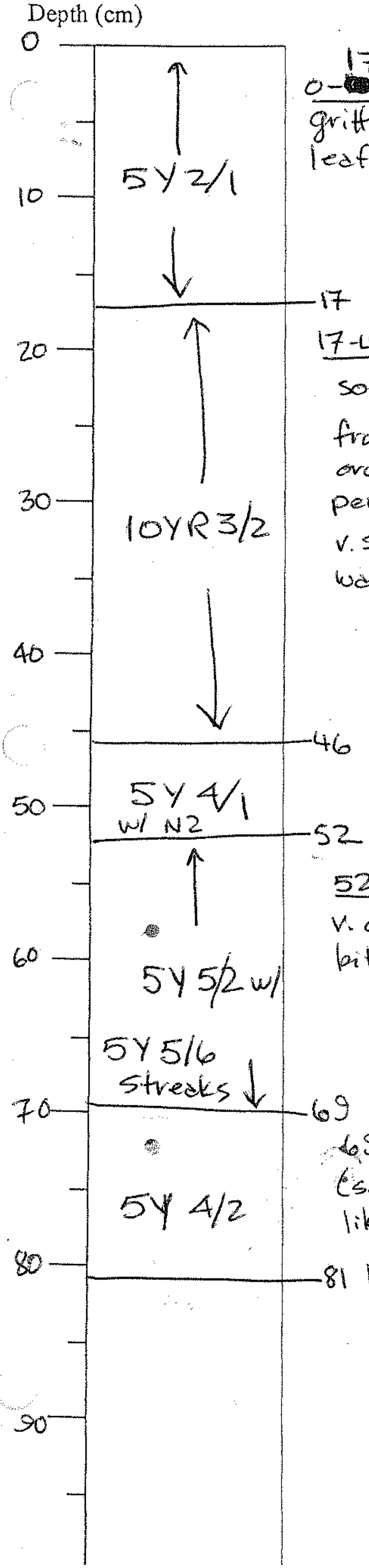
97 = bottom

Sampled Interval	Grain Size
0 - 21	
21 - 59	
59 - 69	
69 - 81	
81 - 97	

P 1of1

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 10
DATE COLLECTED: 10/8/08
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: ______ (cm)
DATE OPENED: 10/9/08



0-17: v. soft, watery, v.v. sl. gritty soupy mud; few roots, leaf debris throughout

17-46: mod. soft → sl. soft @ 46 cm; from ~ 20 cm - 46 = lots of organics - may be sawdust - pervasive throughout layer; ? + larger pieces of wood ~2 across v. sl. gritty mud; still fairly watery/soupy

46-52: mod. firm, sl. gritty clay; black (N2) organic? matter (leaf bits?); root struct. ~46 cm c̄ throughout

52-69: mod. firm, v. sl. gritty clay v. cohesive/dense/heavy; tiniest bit of grit; small roots throughout

69-81: mod. firm, v. sl. gritty clay (same as 52-69 cm); dense also, like above " "; v. few roots throughout

NOTES: lots of drippage during core cutting - fairly muddy to bottom; diff than what we've seen till now

gassy to 46 cm.

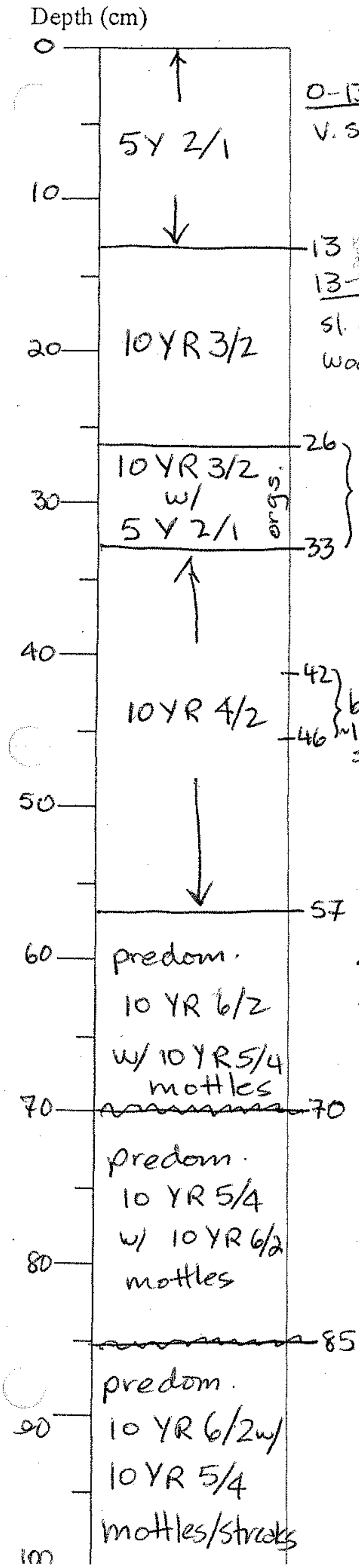
Sampled Interval	Grain Size
0-17	
17-46	
46-52	
52-69	
69-81	

P. 1 of 2

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 11
DATE COLLECTED: 10/8/08
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: ______ (cm)
DATE OPENED: 10/9/08

NOTES: channel sample for MDE on 1/2; other 1/2 for MGS subsamples; gassy to 33 cm



0-13: v. sl. gritty, soupy mud; v. soft; some roots throughout

13-26: v. soft → sl. firm; sl. gritty mud; lots of sml woodchunks & stx throuout & roots

26-33 sl. firm, lots of orgs.; sawdust-sized chunks of wood & bark; few roots; sl. gritty mud

33-57: sl. firm, gritty mud few sml woody pieces thru-out, maybe from lg. stick

42-46 lg. branch ~1.5" diam. solid

57-116: v. firm; colors similar, except predominance changes; fairly clayey & cohesive/dense; few orgs. at all; little to no gas

Sampled Interval	Grain Size
0-26	
26-33	
33-57	
57-116	
116-149	
149-172	

P. 2 of 2

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 11
DATE COLLECTED: 10/8/08
INITIAL LENGTH: ______(cm)
COMPACTION: ______(cm)
FINAL LENGTH: ______(cm)
DATE OPENED: 10/9/08

NOTES: channel sample for MDE on ½; other ½ for MGS sub-samples

Depth (cm)

100

same as 85-100

110

116

mix of 10 YR 6/2 10 YR 5/2 10 YR 4/2 in ~fairly distinct lenses

120

116-149 cm: still v. firm v. muddy sand - much sandier than layer above, rx throut - red ss, grey ss.

@ 117 cm - sml rk.

130

@ 139 cm - some orgs - root?
142 " " "

@ 142-149 - concentration of orgs.

140

@ 135-149 - sand lens - much more sand = sl. muddy med-coarse sand

149

150

predom. 10R 4/2 w/ 5Y 5/6,

149-172: sml stones throut; v. v. firm; slightly muddy med. sand.

160

@ 165 - sml piece of stk
not much else in way of orgs.

170

172 bottom

180

Sampled Interval	Grain Size

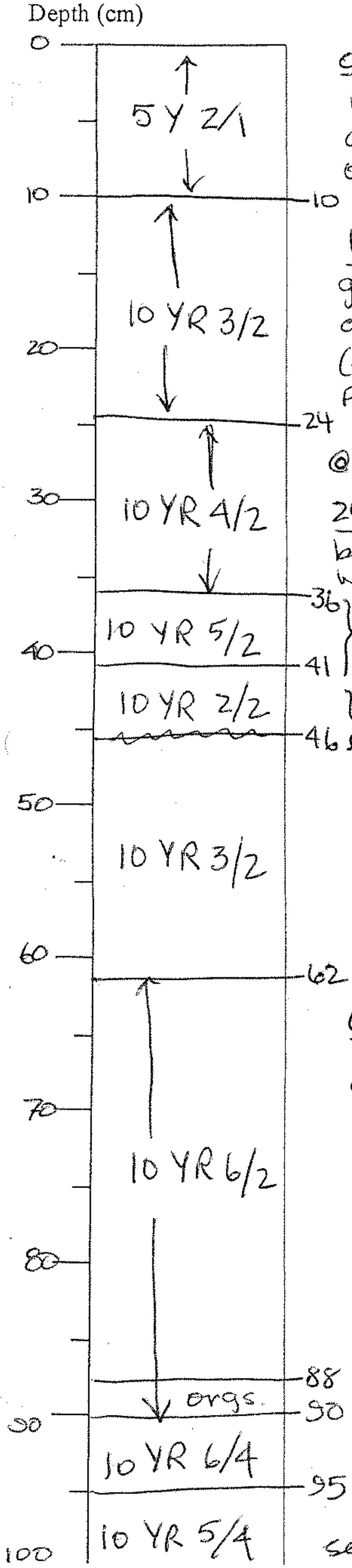
see p. 1

P1 of 2

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 12
DATE COLLECTED: 10/8/08
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: ______ (cm)
DATE OPENED: 10/9/08

NOTES: gassy to ~16cm



0-10: v. sl. gritty, soupy mud; v. soft; leaf debris & root struct. thru-out; gassy

10-24cm: mod. soft, sl. gritty mud; hi conc. of organic matter throughout (sml wood chips, stx) - pervasive

@26cm - sml gray clay pocket (5Y6/1)

24-36 cm: mod. soft, color change but sim. in texture to 10-24cm; sawdust/wood chips highly conc. in layer

36-41 } v. soft, v. sl. gritty mud.; slightly larger wood pieces/chunks; some root struct @ 41cm (interface)

41-46 } intense org. layer; big wood chunk; root struc. from 41-62cm Mod. soft @ 41cm to mod. firm @ 62, continuously firmer; mod. sandy mud; many stx & root struct. thruout, but conc. in 41-46 cm.

62-88: 62-84: firm

@ 84-88 - mod. firm; higher H_2O content?

Slightly muddy med. sand throut

leaf debris, root struc; sml wooden chips & stx throughout

88-90 w/ orgs. (N2) } same g.s. as 62-88 but conc. orgs root struct., big stx, leaf debris; mod. firm

90-95 } mod. firm, med. sand; no orgs.

see next page for 95-110

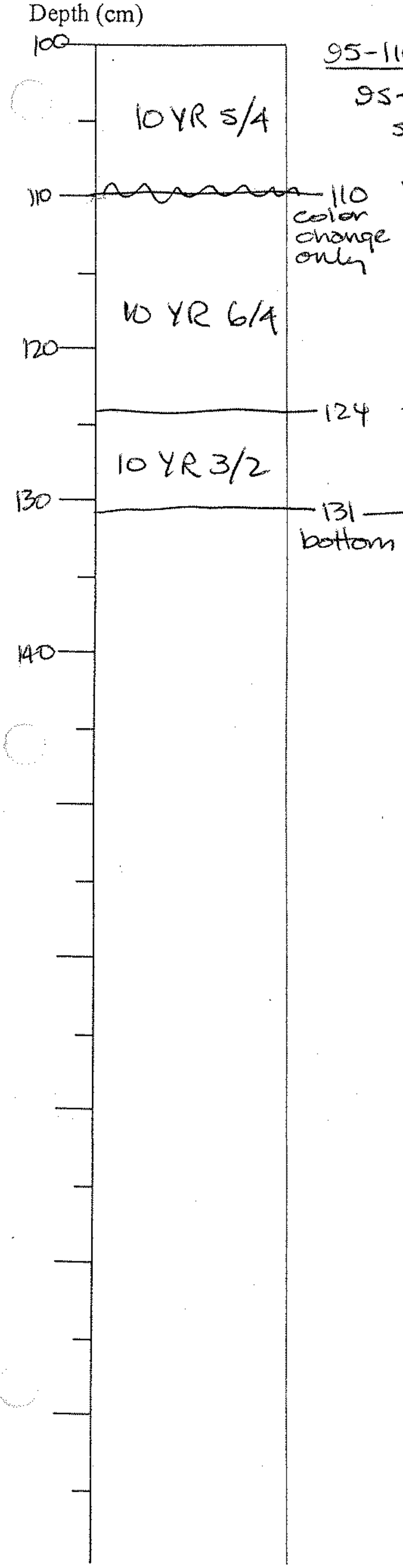
Sampled Interval	Grain Size
0-10	✓
10-36	✓
36-62	
62-90	
90-124	
124-131	

p2. of 2.

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 12
DATE COLLECTED: 10/8/08
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: ______ (cm)
DATE OPENED: 10/9/08

NOTES: ______



95-110 cm:

95-124: mod. firm med. sand

95-98 - conc. org. layer = wood pieces/chunks

124-131
sl. soft, v. sl. gritty mud; ~~some~~ a lot stx, stk frags:
NO Rocks

appears to be mud lens (sand around edges)

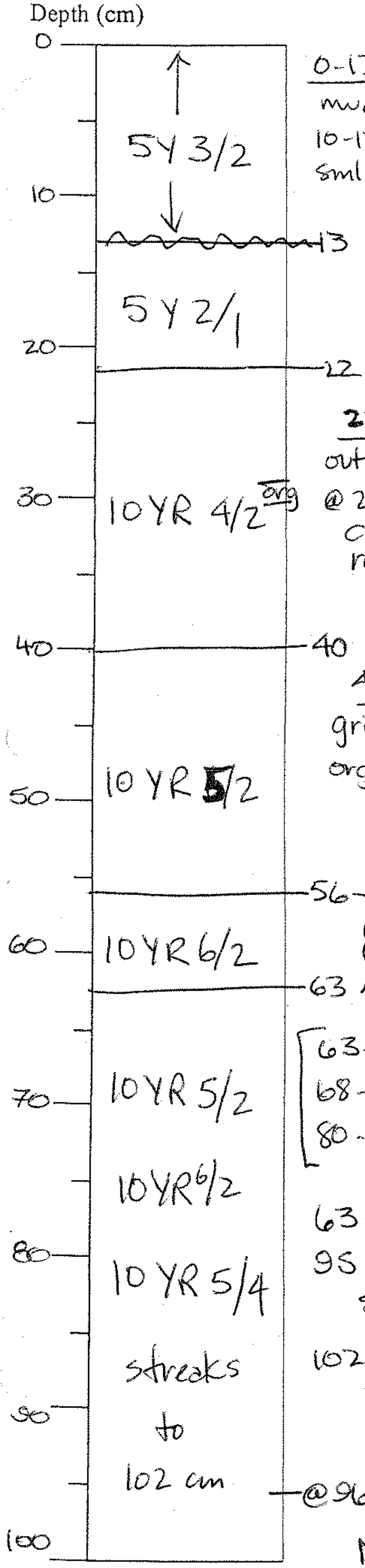
Sampled Interval	Grain Size

P. 1 of 2

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 13
DATE COLLECTED: 10/9/08
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: ______ (cm)
DATE OPENED: 10/9/08

NOTES: gassy to ~40 cm



0-13 cm: v. sl. gritty, soupy mud; v. soft
10-13 cm - some root struct, sml stx, wood chips

13-22 cm: v. soft → mod. soft @ 22 cm; skinny worm @ 18 cm; v. sl. gritty mud; xtensive roots thruout 13-22 cm

22-40 cm: mod. soft thru-out; sl. gritty mud
@ 28-30 - organic layer w/ v. big chunk-o-wood & wood chips & root struct. / few orgs. from 30-40 cm

40-56 cm - mod. firm, v. sl. gritty clay; v. dense; very few orgs. (pieces of root)

56-63: mod. firm → v. firm; sl. muddy med. sand; no orgs. apparent

63-68 - v. firm
68-80 - mod. firm
80 - bottom - v. firm

63-95: sl. muddy med. sand
95-102: gradually coarsening sand
102-109.5 - sl. muddy coarse sand

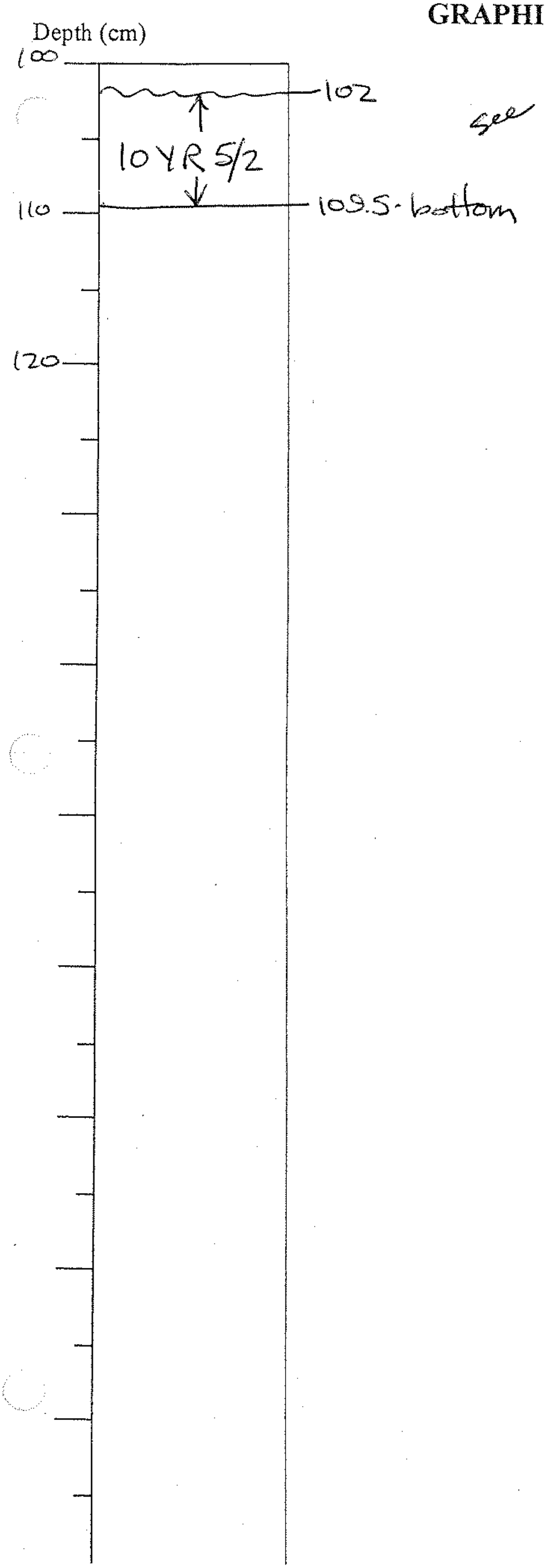
@ 96: N2 orgs - piece of wood

NO ROCKS

Sampled Interval	Grain Size
0-22	
22-40	
40-56	
56- ~~[illegible]~~ 102	
102-109.5	

p. 2. of 2.

GRAPHIC LOG



see p. 1

PROJECT: NGSP

CORE ID: 13

DATE COLLECTED: 10/9/08

INITIAL LENGTH: ______ (cm)

COMPACTION: ______ (cm)

FINAL LENGTH: ______ (cm)

DATE OPENED: 10/9/08

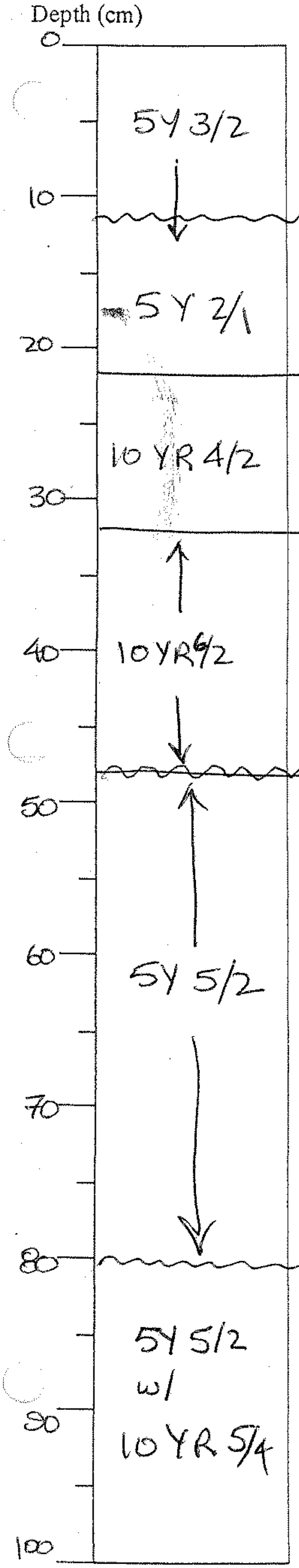
NOTES: ______

Sampled Interval	Grain Size

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 14
DATE COLLECTED: 10/9/08
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: ______ (cm)
DATE OPENED: 10/9/08

NOTES: ______



0-22: v. sl. gritty mud; v. soft, watery; orgs thru-out, — sml leaf debris, root structure

12 cm

22cm

<u>22-32 cm</u>: mod soft to sl. firm; v. sl. gritty muddy clay; 22-26 cm - intense org. layer - leaf debris; sml wood chips, bark, stx

32 cm

32-70 mod. firm
70-104 v. firm

32-104 - v. sl. gritty clay
@ 39 - little stick - no other obvious orgs.

48 cm - color change

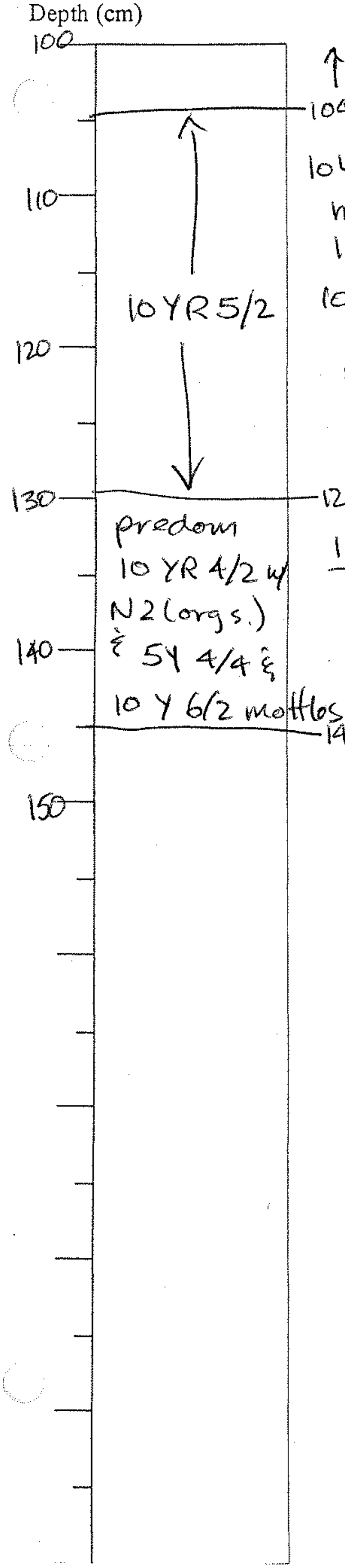
80cm

Sampled Interval	Grain Size
0-22	
22-104	
104-129	
129-145	

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 14
DATE COLLECTED: 10/9/08
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: ______ (cm)
DATE OPENED: 10/9/08

NOTES: ______



↑ see above

104 cm

104 –
mod. firm → v. firm @ 129 cm

104 - 129 - sl. muddy med. sand; very few orgs (N2 splotches)

129 cm

129 - 145 cm: v. firm, coarse sand thruout; sml stx thruout & sml pebbles from ~142 - 145 cm = coarse sand & pebbles in this sub-layer

145 cm - bottom

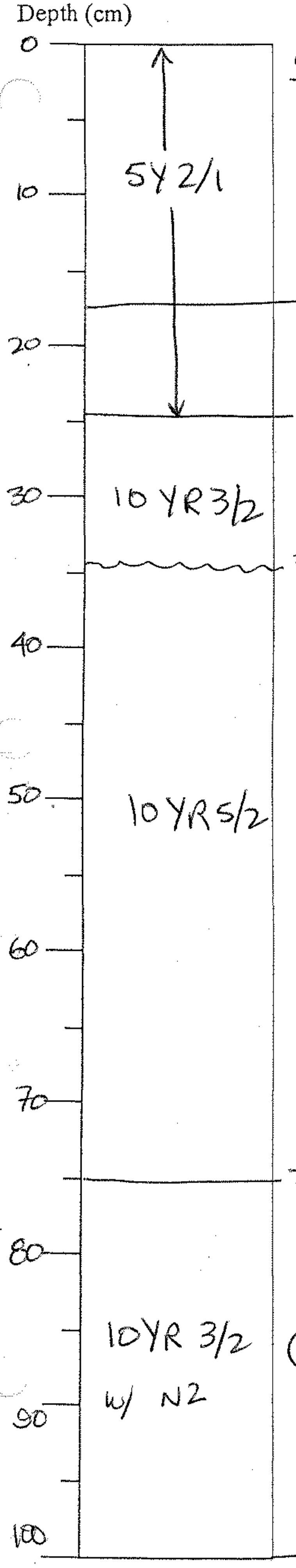
Sampled Interval	Grain Size

p. 1 of 2

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 15
DATE COLLECTED: 10/9/08
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: ______ (cm)
DATE OPENED: 10/9/08

NOTES: channel sample from 0-100 cm



0-18 cm: v. sl. gritty, soupy mud; v. soft to mod. soft @ 18 cm; roots; bits of stx

18 cm same g.s. as 0-18 cm; very thick org. layer; roots, chunks of wood; mod. soft

24 cm

24-34: sl. firm, sl. gritty clayish; root struct. throut, esp. around outside of core

34 cm

34-75 cm - v. firm except @ 46 cm (soft spot); v. sl. gritty clay; some root struct. throut - few only

75 cm

75-100 cm: v. firm, sl. gritty clay w/ spots of heavy orgs.; (sawdust bits (?) @ 82-88 cm);

92-100 cm - ↑ in sandiness

100 cm

Sampled Interval	Grain Size	
0-34		
34-100		
100-107		
107-126		
126-142		
142-145		
Channel		0-100

p. 2 of 2

GRAPHIC LOG

PROJECT: NGSP
CORE ID: 15
DATE COLLECTED: 10/9/08
INITIAL LENGTH: ______ (cm)
COMPACTION: ______ (cm)
FINAL LENGTH: ______ (cm)
DATE OPENED: 10/9/08

NOTES: ______

Depth (cm)

100

110

120

130

140

150

160

100 cm

10 YR 6/2
w/ N2 spots

sl. muddy f-med. sand;
V. firm; few orgs (N2) thruout

107 cm — @ 107 = layer of pebbles & rx.

multicolored
mottles:
5Y 5/6;
10R 3/4;
5G 5/2;
5Y 7/2;
5YR 3/2

v. firm thruout
pebbly "
med-coarse sand; roots

126 cm

predom.
10 YR 4/2 w/
sim. colored
mottles
as above

126-145 cm = V. coarse sand, pebbles, gravel, cobble
V. firm

142

10 R 4/2

145 cm
bottom

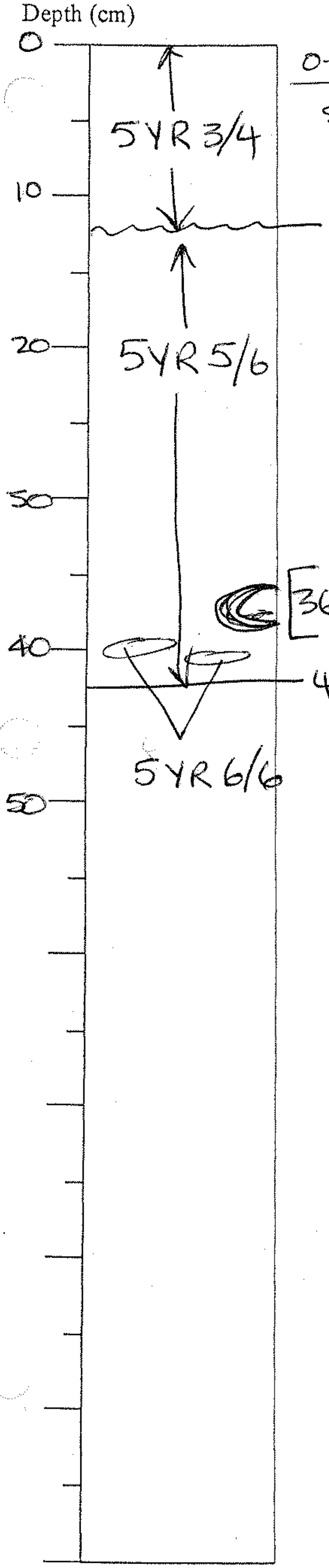
Sampled Interval	Grain Size

P 1of1

GRAPHIC LOG

PROJECT: NGSP
CORE ID: SOIL
DATE COLLECTED: 10/9/08
INITIAL LENGTH: ____ (cm)
COMPACTION: ____ (cm)
FINAL LENGTH: ____ (cm)
DATE OPENED: 10/9/08

NOTES: SOIL sample from downstream, left bank, ~150 m from dam



0-13 cm: med. sand w/ sml pebbles & rx throut 1/4"-2" diam.

13 cm

13-43 cm - med-coarse sand; same size rx - 1/4-2" diam.

[36 cm - lens of coarse sand 10YR 7/4]

43 cm - bottom

Sampled Interval	Grain Size
0-13	
13-43	

Appendix C

Core Stratigraphy

Core Label	Length Meters	Firm Mud Depth-Meters	Organic Layer Depth-Meters	End of Organic Layer Depth-Meters	Coarse Material Depth-Meters	Soil Horizon Depth-Meters	Easting MetersUTM	Northing NAD83	WaterDepth Meters
1	1.04	0.28	0.45	0.57	0.86	NO	661132	4388726	2.09
2	1.24	0.29	0.45	0.50	0.92	1.08	661127	4388734	2.01
3	1.55	0.12	0.55	0.71	0.93	1.12	661143	4388716	2.13
4	0.83	0.12	NO	NO	0.67	0.73	661173	4388794	1.49
5	0.89	0.30	0.62	0.68	0.76	NO	661153	4388800	2.04
6	0.84	0.16	0.44	0.48	0.72	0.74	661138	4388810	1.65
7	0.68	0.12	0.40	0.44	0.63	NO	661189	4388881	1.16
7A	0.67	0.15	0.42	0.48	0.56	NO	661190	4388882	1.22
8	1.00	0.16	0.56	0.92	0.92	NO	661200	4388876	1.55
9	0.97	0.21	0.57	0.59	0.59	0.69	661216	4388870	1.55
10	0.81	0.17	0.46	0.52	NO	NO	661249	4389044	0.76
11	1.72	0.13	0.26	0.33	1.16	1.49	661268	4389030	0.85
12	1.31	0.10	0.41	0.46	0.62	NO	661279	4389026	0.76
13	1.10	0.13	0.28	0.30	0.56	NO	661335	4389149	0.34
14	1.45	0.21	0.23	0.26	1.04	1.42	661351	4389139	0.43
15	1.45	0.18	0.18	0.24	1.00	1.07	661366	4389124	0.46
16	0.43	NO	NO	NO	NO	0.00	661110	4388545	0.00

Table C-1. Observed data recording the depth in the collected cores to the identified facies. Identification of the facies was performed through a comparison and analysis of core logs, photographs, physical properties, and elemental properties of the collected cores. NO means that the facies was not observed.

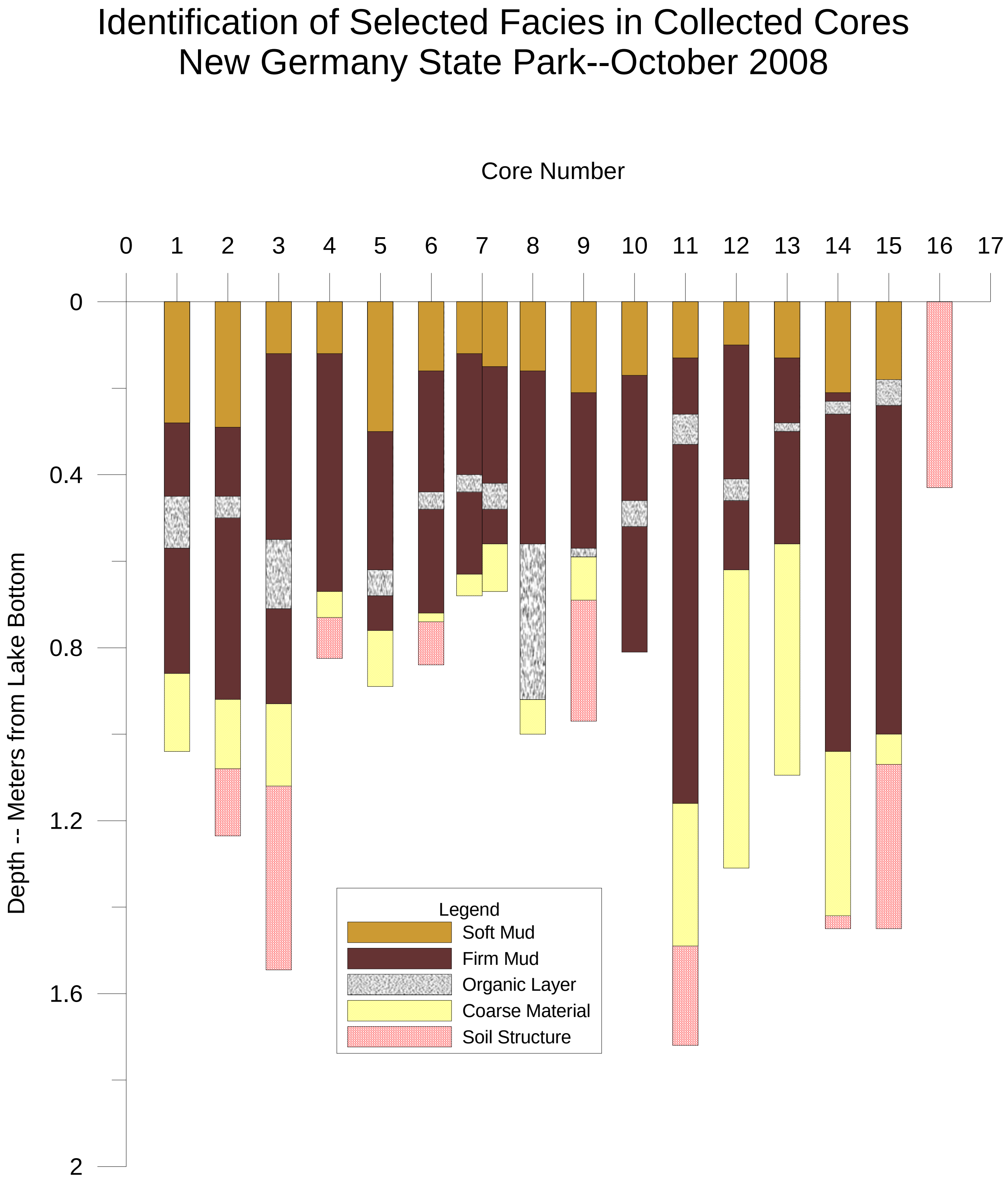


Figure C-1. Graph identifying selected facies versus depth in the collected cores. Depth is total sediment depth regardless of water depth at the collection location. Core locations are identified in Figure A-1. The cores are bracketed in their transects which are ordered from downstream to upstream.

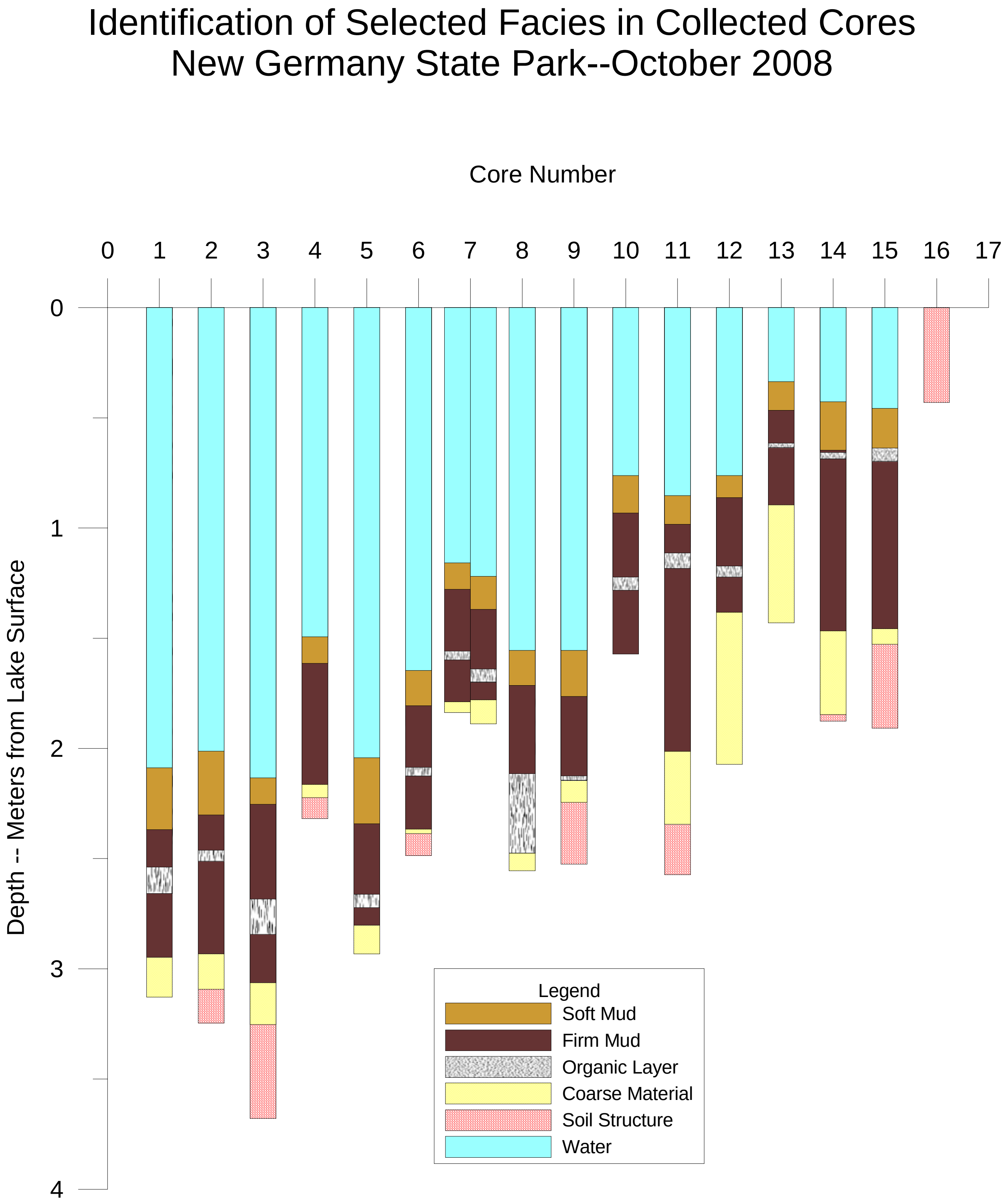


Figure C-2. Graph identifying selected facies versus depth in the collected cores. Depth is meters from lake surface.

Appendix D

Pesticide Analysis

Send Report To:
Richard Ortt
410-554-5541
rortt@dnr.state.md.us

State of Maryland
DHMH - Laboratories Administration
Division of Enviromental Chemistry
TRACE ORGANICS SECTION
201 W. Preston Street, Baltimore, Maryland 21201
John M. DeBoy, Dr. P.H., Director

Lab No. Date Received
990822 OCT 30 8
Do not write above this line

LABORATORY ANALYSIS REQUEST

Bottle No: NGSP Core 1 **Plant / Site Name:** NGSP **County:** GARRETT

Sample Source: 2300 St. Paul Street (Street) Baltimore, MD 21218 (Town or City) **Location:** LAKE Sediment #1 (well no., lab sink, sample tap, etc.)

Sampler ID: ☐☐☐☐☐☐ **PWSID:** ☐☐☐☐☐☐☐ **Plant ID:** ☐☐

Collector: Richard Ortt 410-554-5541 (include telephone number)

Date Collected: 7 / 09 /2008 **Time Collected:** 10 **a.m.** ______ **p.m.**

Field Preserved: ☐ Yes ☒ No **Preservative Used:** ☐ 1:1 HCI+Ascorbic acid ☐ Na_2So_4 ☐ 6 mg NH_4CI

Sample Type:
- ☐ Drinking Water
- ☐ Community
- ☐ Non-Community
- ☐ Private
- ☐ Landfill
- ☐ Stream
- ☐ Sediment
- ☐ Source (Raw Water)
- ☐ Distribution (Treated)
- ☐ Water Treatment Plant POE
- ☐ Liquid
- ☐ Solid
- ☒ Other 8270

Specify Program: ☐ SDWA ☐ NPDES ☐ CWA ☐ RCRA ☐ Consumer Products ☒ Other ______

Test Requested : ☐ Trihalomethanes ☐ Volatiles ☒ Semi-volatiles ☐ Haloacetic Acids

FIELD DATA: ______ pH ______ Free CI ______ Total CI

Field Blank Bottle No.: ______
Trip Blank Bottle No.: ______

Remarks: Pesticides

Laboratory Supervisor: Sadia Muneem

Date Reported: 11 / 19 / 08

•Phone: (410) 767-4388 •Fax: (410) 225-9318

Form Revised 12/05
DHMH 4362

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State of Maryland
Department of Health and Mental Hygiene
Division of Environmental Chemistry

TRACE ORGANICS SECTION

201 W. Preston Street, Baltimore, MD 21201
John M. Deboy,Dr. P.H., Director

Certificate of Analysis - Semivolatiles

Method:	3540/8270
Date Analyzed:	11/07/08
Sample Name:	990822

Contaminants	**DL***	**Results**
Alpha BHC	333	ND
Beta BHC	333	ND
Gamma BHC (Lindane)	333	ND
Heptachlor	333	ND
Delta BHC	333	ND
Aldrin	333	ND
Heptachlor Epoxide	333	ND
Endosulfan I	333	ND
4,4' - DDE	333	ND
Dieldrin	333	ND
4,4' - DDD	333	ND
Endosulfan II	333	ND
Endrin Aldehyde	333	ND
Endosulfan Sulfate	333	ND
4,4' - DDT	333	ND
Methoxychlor	333	ND
Endrin Ketone	333	ND

*All results are in parts per billion
ND = Less than detection limit
e = estimated value

Section Chief: Sadia Muneer Date Approved: 11/19/08

Phone: (410)-767-5582 ***Fax: (410) 225-9318***

Send Report To:
Richard Orth
410-554-5541
rorth@dnr.state.md.us

State of Maryland
DHMH - Laboratories Administration
Division of Enviromental Chemistry
TRACE ORGANICS SECTION
201 W. Preston Street, Baltimore, Maryland 21201
John M. DeBoy, Dr. P.H., Director

Lab No. Date Received
990823 OCT 30 08
Do not write above this line

LABORATORY ANALYSIS REQUEST

Bottle No: NGSP 11 **Plant / Site Name:** NGSP **County:** GARRET

Sample Source: 2300 St. Paul St. (Street) Baltimore MD 21218 (Town or City) **Location:** Lake Sediment #11 (well no., lab sink, sample tap, etc.)

Sampler ID: ☐☐☐☐☐☐ **PWSID:** ☐☐☐☐☐☐☐ **Plant ID:** ☐☐

Collector: Richard Orth 410-554-5541 (include telephone number)

Date Collected: 8 / 07 /2008 **Time Collected:** 10 **a.m.** ______ **p.m.**

Field Preserved: ☐ Yes ☒ No **Preservative Used:** ☐ 1:1 HCl+Ascorbic acid ☐ Na_2So_4 ☐ 6 mg NH_4Cl

Sample Type:
- ☐ Drinking Water
- ☐ Community
- ☐ Non-Community
- ☐ Private
- ☐ Landfill
- ☐ Stream
- ☐ Sediment
- ☐ Source (Raw Water)
- ☐ Distribution (Treated)
- ☐ Water Treatment Plant POE
- ☐ Liquid
- ☐ Solid
- ☒ Other 8270

Specify Program: ☐ SDWA ☐ NPDES ☐ CWA ☐ RCRA ☐ Consumer Products ☒ Other ______

Test Requested : ☐ Trihalomethanes ☐ Volatiles ☑ Semi-volatiles ☐ Haloacetic Acids

FIELD DATA: ____ pH ____ Free Cl ____ Total Cl

Field Blank Bottle No.: ______________
Trip Blank Bottle No.: ______________

Remarks: Pesticides

Laboratory Supervisor: Sadia Naeem **Date Reported:** 11 / 19 / 08

•Phone: (410) 767-4388 •Fax: (410) 225-9318

Form Revised 12/05
DHMH 4362

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State of Maryland
Department of Health and Mental Hygiene
Division of Environmental Chemistry

TRACE ORGANICS SECTION

201 W. Preston Street, Baltimore, MD 21201
John M. Deboy,Dr. P.H., Director

Certificate of Analysis - Semivolatiles

Method: 3540/8270
Date Analyzed: 11/07/08
Sample Name: 990823

Contaminants	**DL***	**Results**
Alpha BHC	333	ND
Beta BHC	333	ND
Gamma BHC (Lindane)	333	ND
Heptachlor	333	ND
Delta BHC	333	ND
Aldrin	333	ND
Heptachlor Epoxide	333	ND
Endosulfan I	333	ND
4,4' - DDE	333	ND
Dieldrin	333	ND
4,4' - DDD	333	ND
Endosulfan II	333	ND
Endrin Aldehyde	333	ND
Endosulfan Sulfate	333	ND
4,4' - DDT	333	ND
Methoxychlor	333	ND
Endrin Ketone	333	ND

*All results are in parts per billion
ND = Less than detection limit
e = estimated value

Section Chief: Sadia Kleneem   Date Approved: 11/18/08

Phone: (410)-767-5582   ***Fax: (410) 225-9318***

Send Report To:
Richard Ortt
410-554-5541
rortt@dnr.state.md.us

State of Maryland
DHMH - Laboratories Administration
Division of Enviromental Chemistry
TRACE ORGANICS SECTION
201 W. Preston Street, Baltimore, Maryland 21201
John M. DeBoy, Dr. P.H., Director

Lab No. Date Received

990824 OCT 3 08

Do not write above this line

LABORATORY ANALYSIS REQUEST

Bottle No: NG5P15 **Plant / Site Name:** NG5P **County:** Garrett

Sample Source: 2300 St. Paul Street (Street) Baltimore, MD 21218 (Town or City) **Location:** Lake Sediment # 15 (well no., lab sink, sample tap, etc.)

Sampler ID: ☐☐☐☐☐☐ **PWSID:** ☐☐☐☐☐☐☐ **Plant ID:** ☐☐

Collector: Richard Ortt 410-554-5541 (include telephone number)

Date Collected: 7 /OCT/2008 **Time Collected:** 10 a.m. ______ p.m.

Field Preserved: ☐ Yes ☒ No **Preservative Used:** ☐ 1:1 HCI+Ascorbic acid ☐ Na_2So_4 ☐ 6 mg NH_4CI

Sample Type:
☐ Drinking Water
☐ Community
☐ Non-Community
☐ Private
☐ Landfill
☐ Stream
☐ Sediment
☐ Source (Raw Water)
☐ Distribution (Treated)
☐ Water Treatment Plant POE
☐ Liquid
☐ Solid
☒ Other 8270

Specify Program: ☐ SDWA ☐ NPDES ☐ CWA ☐ RCRA ☐ Consumer Products ☒ Other ______

Test Requested : ☐ Trihalomethanes ☐ Volatiles ☒ Semi-volatiles ☐ Haloacetic Acids

FIELD DATA: ___ pH ___ Free CI ___ Total CI

Field Blank Bottle No.: ______
Trip Blank Bottle No.: ______

Remarks: Pesticides

Laboratory Supervisor: Sadia Muneem **Date Reported:** 11 /19 /08

•Phone: (410) 767-4388 •Fax: (410) 225-9318

Form Revised 12/05
DHMH 4362

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State of Maryland
Department of Health and Mental Hygiene
Division of Environmental Chemistry

TRACE ORGANICS SECTION

201 W. Preston Street, Baltimore, MD 21201
John M. Deboy,Dr. P.H., Director

Certificate of Analysis - Semivolatiles

Method: 3540/8270
Date Analyzed: 11/07/08
Sample Name: 990824

Contaminants	DL*	Results
Alpha BHC	333	ND
Beta BHC	333	ND
Gamma BHC (Lindane)	333	ND
Heptachlor	333	ND
Delta BHC	333	ND
Aldrin	333	ND
Heptachlor Epoxide	333	ND
Endosulfan I	333	ND
4,4' - DDE	333	ND
Dieldrin	333	ND
4,4' - DDD	333	ND
Endosulfan II	333	ND
Endrin Aldehyde	333	ND
Endosulfan Sulfate	333	ND
4,4' - DDT	333	ND
Methoxychlor	333	ND
Endrin Ketone	333	ND

*All results are in parts per billion
ND = Less than detection limit
e = estimated value

Section Chief: ____________ Date Approved: 11/09/08

Phone: (410)-767-5582 ***Fax: (410) 225-9318***

Appendix E

EPA 8270 Semi-Volatile Analysis

Note: The following results are from samples which were analyzed beyond the accepted holding times established in the EPA 8270 protocol.

Send Report To:
Richard Ortt
2300 St. Paul Street
Baltimore, MD 21218

State of Maryland
DHMH - Laboratories Administration
Division of Enviromental Chemistry
TRACE ORGANICS SECTION
201 W. Preston Street, Baltimore, Maryland 21201
John M. DeBoy, Dr. P.H., Director

Lab No. Date Received

991066 [illegible] 168

Do not write above this line

LABORATORY ANALYSIS REQUEST

Bottle No: NGSP 15 **Plant / Site Name:** NGSP **County:** GARRETT

Sample Source: 2300 St. Paul Street (Street) Baltimore, MD 21218 (Town or City) **Location:** Lake Sediment #15 (well no., lab sink, sample tap, etc.)

Sampler ID: ☐☐☐☐☐☐ **PWSID:** ☐☐☐☐☐☐☐ **Plant ID:** ☐☐

Collector: Richard Ortt 410-554-5541 (include telephone number)

Date Collected: 9 / OCT /2008 **Time Collected:** 10 a.m. ______ p.m.

Field Preserved: ☐ Yes ☒ No **Preservative Used:** ☐ 1:1 HCI+Ascorbic acid ☐ Na_2So_4 ☐ 6 mg NH_4CI

Sample Type:
☐ Drinking Water
☐ Community
☐ Non-Community
☐ Private
☐ Landfill
☐ Stream
☒ Sediment
☐ Source (Raw Water)
☐ Distribution (Treated)
☐ Water Treatment Plant POE
☐ Liquid
☐ Solid
☒ Other 8270

Specify Program: ☐ SDWA ☐ NPDES ☐ CWA ☐ RCRA ☐ Consumer Products ☒ Other ______

Test Requested : ☐ Trihalomethanes ☐ Volatiles ☒ Semi-volatiles ☐ Haloacetic Acids

FIELD DATA: ___ pH ___ Free CI ___ Total CI

Field Blank Bottle No.: ______
Trip Blank Bottle No.: ______

Remarks: ANALYZE FOR FULL EPA 8270 Semi-Volatiles

Laboratory Supervisor: **Date Reported:** 12/21/08

•Phone: (410) 767-4388 •Fax: (410) 225-9318

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DHMH 4362

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State of Maryland
Department of Health and Mental Hygiene
Division of Environmental Chemistry

TRACE ORGANICS SECTION

201 W. Preston Street, Baltimore, MD 21201
John M. Deboy, Dr. P.H., Director

Certificate of Analysis - Semivolatiles

Method:	3540/8270
Date Analyzed:	12/24/08
Sample Name:	991065

Contaminants	**DL**	**Results**	**Contaminants**	**DL**	**Result**
Phenol	333	ND	4-Nitrrophenol	333	ND
Bis(2-Chloroethyl)ether	333	ND	2,4-Dinitrotoluene	333	ND
2-Chlorophenol	333	ND	2,3,4,6-Tetrachlorophenol	333	ND
1,3-Dichlorobenzene	333	ND	Fluorene	333	ND
1,4-Dichlorobenzene	333	ND	Diethylphthalate	333	ND
1,2-Dichlorobenzene	333	ND	4-Chlorophenyl phenyl ether	333	ND
Bis(2-Chloroisopropyl)ether	333	ND	4,6 -Dinitro-2-methylphenol	333	ND
2-Methyl phenol	333	ND	Diphenylamine	333	ND
Hexachloroethane	333	ND	4-Bromophenyl phenyl ether	333	ND
3&4-Methyl Phenol	333	ND	1,3,5-Trinitrobenzene	333	ND
Nitrobenzene	333	ND	Phenacetin	333	ND
Isophorone	333	ND	Hexachlorobenzene	333	ND
2-Nitrophenol	333	ND	Pentachlorophenol	333	ND
2,4-Dimethylphenol	333	ND	Pentachloronitrobenzene	333	ND
Bis(2-Chloroethoxy)methane	333	ND	Phenantherene	333	ND
2,4-Dichlorophenol	333	ND	Anthracene	333	ND
1,2,4-Trichlorobenzene	333	ND	2,4,6-Sec-butyl-Dinitrophenol	333	ND
Naphthalene	333	ND	Di-n-Butylphthalate	333	ND
2,6-Dichlorophenol	333	ND	4-Nitroquinoline-N-oxide	333	ND
Hexachloropropylene	333	ND	Methapyrilene	333	ND
Hexachlorobutadiene	333	ND	Fluoranthene	333	ND
4-Chloro-3-Methylphenol	333	ND	Pyrene	333	ND
1,2,4,5-Tetrachlorobenzene	333	ND	Di-methylaminoazobenzene	333	ND
hexachlorocyclopentadiene	333	ND	Butyl benzyl phthalate	333	ND
2,4,6-Trichlorophenol	333	ND	Benz(a)Anthracene	333	ND
2,4,5-Trichlorophenol	333	ND	Chrysene	333	ND
2-Chloronaphthalene	333	ND	Bis(2-Ethylhexyl)phthalate	333	ND
1,4-Naphthoquinone	333	ND	Di-n-octyl phthalate	333	ND
Acenaphthylene	333	ND	7,12-Dimethylbenz(a)anthracene	333	ND
Dimethylphthalate	333	ND	Benzo(b)fluoranthene	333	ND
2,6-Dinitrotoluene	333	ND	Benzo(k)fluoranthene	333	ND
Acenaphthene	333	ND	Benzo(a)pyerene	333	ND
2,4-Dinitrophenol	333	ND	Indeno(1,2,3-cd) pyrene	333	ND
Pentachlorobenzene	333	ND	Di benz(a,h)anthracene	333	ND
			Benzo(g,h,i)perylene	333	ND

*All results are in parts per billion
ND = Less than detection limit
e = estimated value

Section Chief: Deborah Miller-Tuck Date Approved: 12/31/08

Phone: (410)-767-5582 ***Fax: (410) 225-9318***

Send Report To:
RICHARD Ott
2300 St. Paul Street
Baltimore, MD 21218

State of Maryland
DHMH - Laboratories Administration
Division of Enviromental Chemistry
TRACE ORGANICS SECTION
201 W. Preston Street, Baltimore, Maryland 21201
John M. DeBoy, Dr. P.H., Director

Lab No. Date Received
991065 DEC 16 08
Do not write above this line

LABORATORY ANALYSIS REQUEST

Bottle No: NGSP 11 **Plant / Site Name:** NGSP **County:** GARRETT

Sample Source: 2300 St. Paul Street (Street) Baltimore, MD 21218 (Town or City) **Location:** Lake Sediment #11 (well no., lab sink, sample tap, etc.)

Sampler ID: ☐☐☐☐☐☐ **PWSID:** ☐☐☐☐☐☐☐ **Plant ID:** ☐☐

Collector: Richard Ott 410-554-5541 (include telephone number)

Date Collected: 8 /OCT/2008 **Time Collected:** 10 a.m. ____ p.m.

Field Preserved: ☐ Yes ☒ No **Preservative Used:** ☐ 1:1 HCI+Ascorbic acid ☐ Na_2So_4 ☐ 6 mg NH_4Cl

Sample Type:
☐ Drinking Water
☐ Community
☐ Non-Community
☐ Private
☐ Landfill
☐ Stream
☒ Sediment
☐ Source (Raw Water)
☐ Distribution (Treated)
☐ Water Treatment Plant POE
☐ Liquid
☐ Solid
☒ Other 8270

Specify Program: ☐ SDWA ☐ NPDES ☐ CWA ☐ RCRA ☐ Consumer Products ☒ Other ____

Test Requested : ☐ Trihalomethanes ☐ Volatiles ☒ Semi-volatiles ☐ Haloacetic Acids

FIELD DATA: ____ pH ____ Free CI ____ Total CI

Field Blank Bottle No.: ____
Trip Blank Bottle No.: ____

Remarks: ANALYZE FOR FULL EPA 8270 Semi-volatiles

Laboratory Supervisor: Deborah Miller-[illegible] **Date Reported:** 12 / 31 / 08

•Phone: (410) 767-4388 •Fax: (410) 225-9318

Form Revised 12/05
DHMH 4362

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State of Maryland
Department of Health and Mental Hygiene
Division of Environmental Chemistry

TRACE ORGANICS SECTION

201 W. Preston Street, Baltimore, MD 21201
John M. Deboy, Dr. P.H., Director

Certificate of Analysis - Semivolatiles

Method: 3510/8270
Date Analyzed: 12/25/08
Sample Name: 991066

Contaminants	**DL***	**Results**	**Contaminants**	**DL**	**Result**
Phenol	333	ND	4-Nitrrophenol	333	ND
Bis(2-Chloroethyl)ether	333	ND	2,4-Dinitrotoluene	333	ND
2-Chlorophenol	333	ND	2,3,4,6-Tetrachlorophenol	333	ND
1,3-Dichlorobenzene	333	ND	Fluorene	333	ND
1,4-Dichlorobenzene	333	ND	Diethylphthalate	333	ND
1,2-Dichlorobenzene	333	ND	4-Chlorophenyl phenyl ether	333	ND
Bis(2-Chloroisopropyl)ether	333	ND	4,6 -Dinitro-2-methylphenol	333	ND
2-Methyl phenol	333	ND	Diphenylamine	333	ND
Hexachloroethane	333	ND	4-Bromophenyl phenyl ether	333	ND
3&4-Methyl Phenol	333	ND	1,3,5-Trinitrobenzene	333	ND
Nitrobenzene	333	ND	Phenacetin	333	ND
Isophorone	333	ND	Hexachlorobenzene	333	ND
2-Nitrophenol	333	ND	Pentachlorophenol	333	ND
2,4-Dimethylphenol	333	ND	Pentachloronitrobenzene	333	ND
Bis(2-Chloroethoxy)methane	333	ND	Phenantherene	333	ND
2,4-Dichlorophenol	333	ND	Anthracene	333	ND
1,2,4-Trichlorobenzene	333	ND	2,4,6-Sec-butyl-Dinitrophenol	333	ND
Naphthalene	333	ND	Di-n-Butylphthalate	333	ND
2,6-Dichlorophenol	333	ND	4-Nitroquinoline-N-oxide	333	ND
Hexachloropropylene	333	ND	Methapyrilene	333	ND
Hexachlorobutadiene	333	ND	Fluoranthene	333	ND
4-Chloro-3-Methylphenol	333	ND	Pyrene	333	ND
1,2,4,5-Tetrachlorobenzene	333	ND	Di-methylaminoazobenzene	333	ND
hexachlorocyclopentadiene	333	ND	Butyl benzyl phthalate	333	ND
2,4,6-Trichlorophenol	333	ND	Benz(a)Anthracene	333	ND
2,4,5-Trichlorophenol	333	ND	Chrysene	333	ND
2-Chloronaphthalene	333	ND	Bis(2-Ethylhexyl)phthalate	333	ND
1,4-Naphthoquinone	333	ND	Di-n-octyl phthalate	333	ND
Acenaphthylene	333	ND	7,12-Dimethylbenz(a)anthracene	333	ND
Dimethylphthalate	333	ND	Benzo(b)fluoranthene	333	ND
2,6-Dinitrotoluene	333	ND	Benzo(k)fluoranthene	333	ND
Acenaphthene	333	ND	Benzo(a)pyerene	333	ND
2,4-Dinitrophenol	333	ND	Indeno(1,2,3-cd) pyrene	333	ND
Pentachlorobenzene	333	ND	Di benz(a,h)anthracene	333	ND
			Benzo(g,h,i)perylene	333	ND

*All results are in parts per billion
ND = Less than detection limit
e = estimated value

Section Chief: Date Approved: 12/31/08

Phone: (410)-767-5582 ***Fax: (410) 225-9318***

Send Report To:
Richard Ott
2300 St. Paul Street
Baltimore, MD 21218

State of Maryland
DHMH - Laboratories Administration
Division of Enviromental Chemistry
TRACE ORGANICS SECTION
201 W. Preston Street, Baltimore, Maryland 21201
John M. DeBoy, Dr. P.H., Director

Lab No. Date Received

Do not write above this line
991067 DEC 16 8

LABORATORY ANALYSIS REQUEST

Bottle No: NGSP Core 1 **Plant / Site Name:** NGSP **County:** GARRETT

Sample Source: 2300 St. Paul Street (Street) Baltimore, MD 21218 (Town or City) **Location:** Lake Sediment #1 (well no., lab sink, sample tap, etc.)

Sampler ID: ☐☐☐☐☐☐ **PWSID:** ☐☐☐☐☐☐☐ **Plant ID:** ☐☐

Collector: RICHARD ORTT 410-554-5541 (include telephone number)

Date Collected: 7 / OCT /2008 **Time Collected:** 10 **a.m.** ______ **p.m.**

Field Preserved: ☐ Yes ☒ No **Preservative Used:** ☐ 1:1 HCI+Ascorbic acid ☐ Na_2So_4 ☐ 6 mg NH_4CI

Sample Type:
☐ Drinking Water
☐ Community
☐ Non-Community
☐ Private
☐ Landfill
☐ Stream
☒ Sediment
☐ Source (Raw Water)
☐ Distribution (Treated)
☐ Water Treatment Plant POE
☐ Liquid
☐ Solid
☒ Other 8270

Specify Program: ☐ SDWA ☐ NPDES ☐ CWA ☐ RCRA ☐ Consumer Products ☒ Other ______

Test Requested : ☐ Trihalomethanes ☐ Volatiles ☒ Semi-volatiles ☐ Haloacetic Acids

FIELD DATA: ______ pH ______ Free CI ______ Total CI

Field Blank Bottle No.: ______
Trip Blank Bottle No.: ______

Remarks: ANALYZE FOR FULL ~~82~~ EPA 8270 Semi-volatiles

Laboratory Supervisor: **Date Reported:** 12 / 31 / 08

•Phone: (410) 767-4388 •Fax: (410) 225-9318

Form Revised 12/05
DHMH 4362

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State of Maryland
Department of Health and Mental Hygiene
Division of Environmental Chemistry

TRACE ORGANICS SECTION

201 W. Preston Street, Baltimore, MD 21201
John M. Deboy, Dr. P.H., Director

Certificate of Analysis - Semivolatiles

Method:	3540/8270
Date Analyzed:	12/24/08
Sample Name:	991067

Contaminants	**DL**	**Results**	**Contaminants**	**DL**	**Result**
Phenol	333	ND	4-Nitrrophenol	333	ND
Bis(2-Chloroethyl)ether	333	ND	2,4-Dinitrotoluene	333	ND
2-Chlorophenol	333	ND	2,3,4,6-Tetrachlorophenol	333	ND
1,3-Dichlorobenzene	333	ND	Fluorene	333	ND
1,4-Dichlorobenzene	333	ND	Diethylphthalate	333	ND
1,2-Dichlorobenzene	333	ND	4-Chlorophenyl phenyl ether	333	ND
Bis(2-Chloroisopropyl)ether	333	ND	4,6 -Dinitro-2-methylphenol	333	ND
2-Methyl phenol	333	ND	Diphenylamine	333	ND
Hexachloroethane	333	ND	4-Bromophenyl phenyl ether	333	ND
3&4-Methyl Phenol	333	ND	1,3,5-Trinitrobenzene	333	ND
Nitrobenzene	333	ND	Phenacetin	333	ND
Isophorone	333	ND	Hexachlorobenzene	333	ND
2-Nitrophenol	333	ND	Pentachlorophenol	333	ND
2,4-Dimethylphenol	333	ND	Pentachloronitrobenzene	333	ND
Bis(2-Chloroethoxy)methane	333	ND	Phenantherene	333	ND
2,4-Dichlorophenol	333	ND	Anthracene	333	ND
1,2,4-Trichlorobenzene	333	ND	2,4,6-Sec-butyl-Dinitrophenol	333	ND
Naphthalene	333	ND	Di-n-Butylphthalate	333	ND
2,6-Dichlorophenol	333	ND	4-Nitroquinoline-N-oxide	333	ND
Hexachloropropylene	333	ND	Methapyrilene	333	ND
Hexachlorobutadiene	333	ND	Fluoranthene	333	ND
4-Chloro-3-Methylphenol	333	ND	Pyrene	333	ND
1,2,4,5-Tetrachlorobenzene	333	ND	Di-methylaminoazobenzene	333	ND
hexachlorocyclopentadiene	333	ND	Butyl benzyl phthalate	333	ND
2,4,6-Trichlorophenol	333	ND	Benz(a)Anthracene	333	ND
2,4,5-Trichlorophenol	333	ND	Chrysene	333	ND
2-Chloronaphthalene	333	ND	Bis(2-Ethylhexyl)phthalate	333	ND
1,4-Naphthoquinone	333	ND	Di-n-octyl phthalate	333	ND
Acenaphthylene	333	ND	7,12-Dimethylbenz(a)anthracene	333	ND
Dimethylphthalate	333	ND	Benzo(b)fluoranthene	333	ND
2,6-Dinitrotoluene	333	ND	Benzo(k)fluoranthene	333	ND
Acenaphthene	333	ND	Benzo(a)pyerene	333	ND
2,4-Dinitrophenol	333	ND	Indeno(1,2,3-cd) pyrene	333	ND
Pentachlorobenzene	333	ND	Di benz(a,h)anthracene	333	ND
			Benzo(g,h,i)perylene	333	ND

*All results are in parts per billion
ND = Less than detection limit
e = estimated value

Section Chief: Deborah Miller-[illegible] Date Approved: 12/31/08

Phone: (410)-767-5582 ***Fax: (410) 225-9318***

Appendix F

Elemental Analysis Data

Sample	Interval	S	P	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	Au	Ag	Mo	Al	As	Ba	Be	Bi	Br	Ca	Co	Cs	Eu	Hf	Hg
		%	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppb	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Detection Limit		0.01	0.001	0.3	2	1	0.01	1	1	3	1	2	0.3	1	0.01	0.5	50	1	2	0.5	0.01	1	1	0.2	1	1
Core4	0-12	0.2	0.054	1.7	81	21	4.58	388	52	49	260	< 2	< 0.3	1	7.17	14	570	4	< 2	8	0.16	23	4	1.7	6	< 1
Core4	12-16	0.11	0.055	1.1	70	21	3.7	365	46	44	202	< 2	0.5	2	7.9	12	420	3	< 2	< 0.5	0.16	20	5	1.6	5	< 1
Core4	16-34	0.01	0.022	< 0.3	39	6	2.35	124	16	13	42	< 2	< 0.3	< 1	4.01	10	200	1	< 2	< 0.5	0.08	6	3	0.9	7	< 1
Core4	34-54	< 0.01	0.011	< 0.3	32	5	2.11	76	13	12	30	< 2	< 0.3	1	3.52	8	360	1	< 2	< 0.5	0.05	4	4	0.8	9	< 1
Core4	54-67	< 0.01	0.01	< 0.3	42	8	2.72	81	15	13	28	< 2	< 0.3	1	3.71	16	320	1	< 2	< 0.5	0.04	4	3	< 0.2	8	< 1
Core4	67-82.5	< 0.01	0.015	< 0.3	30	5	4.1	166	15	17	26	< 2	< 0.3	1	3.68	13	270	1	< 2	< 0.5	0.03	6	3	0.4	6	< 1
Core5	30-62	0.06	0.08	0.3	68	21	3.03	388	32	24	117	< 2	0.4	1	7.12	11	700	3	< 2	8	0.18	14	6	1.3	8	< 1
Core5	62-76	0.02	0.011	< 0.3	35	9	1.02	132	15	12	47	< 2	< 0.3	1	3.55	3	390	1	< 2	3	0.16	6	3	0.9	12	< 1
Core5	76-89	0.01	0.015	< 0.3	37	14	1.22	104	13	11	34	< 2	< 0.3	< 1	2.85	4	< 50	1	< 2	< 0.5	0.09	6	2	0.5	9	< 1
Core13	0-22	0.21	0.054	2.1	69	21	3.13	367	52	32	276	< 2	< 0.3	1	6.27	12	590	4	< 2	10	0.17	23	5	1.3	9	< 1
Core13	22-40	0.06	0.04	0.4	62	16	2.35	212	29	25	98	< 2	< 0.3	1	6.38	9	< 50	3	< 2	3	0.13	12	5	1.3	11	< 1
Core16	0-13	0.01	0.05	< 0.3	57	25	8.59	931	25	28	69	< 2	< 0.3	1	4.94	30	< 50	2	< 2	< 0.5	0.02	16	< 1	1.1	10	< 1
Core16	13-43	< 0.01	0.052	< 0.3	41	12	4.33	416	23	19	54	< 2	< 0.3	2	3.67	13	< 50	2	< 2	< 0.5	0.09	11	< 1	0.9	9	< 1

Sample	Interval	Ir_ppb	K	Mg	Na	Sb	Rb	Sc	Se	Sr	Ta	Ti	Th	U	V	W	Y	La	Ce	Nd	Sm	Sn	Tb	Yb	Lu
		ppb	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
Detection Limit		5	0.01	0.01	0.01	0.1	15	0.1	3	1	0.5	0.01	0.2	0.5	2	1	1	0.5	3	5	0.1	0.01	0.5	0.2	0.05
Core4	0-12	< 5	1.49	0.39	0.15	1.2	75	11.7	< 3	79	< 0.5	0.3	10.7	2.9	75	< 1	24	41.4	62	23	5.5	0.01	< 0.5	2.6	0.77
Core4	12-16	< 5	2.09	0.44	0.14	1	139	11.8	< 3	84	< 0.5	0.5	12	2.9	112	< 1	26	42	50	31	5	0.01	1	2.5	0.57
Core4	16-34	< 5	1.15	0.19	0.08	0.9	42	5.8	< 3	45	< 0.5	0.1	7	3.2	21	< 1	16	24.4	38	9	2.9	0.01	< 0.5	1.6	0.54
Core4	34-54	< 5	0.96	0.16	0.08	1.2	73	5.3	< 3	39	1.7	0.2	7.2	2.6	35	< 1	14	25.7	41	21	3.1	0.01	0.6	2.1	0.57
Core4	54-67	< 5	1.13	0.18	0.08	1.1	57	5.8	< 3	40	1.8	0.2	7.4	2.9	47	< 1	14	25	46	11	2.9	0.01	< 0.5	1.8	0.5
Core4	67-82.5	< 5	1.29	0.17	0.07	1.7	45	6	< 3	37	< 0.5	0.2	7	3	65	< 1	14	20.6	36	12	2.6	0.01	0.6	1.8	0.45
Core5	30-62	< 5	1.95	0.44	0.22	0.8	118	11.1	< 3	82	2.4	0.6	10.7	4.1	98	< 1	26	42.8	69	23	5	0.01	< 0.5	3	0.74
Core5	62-76	< 5	0.87	0.19	0.11	0.6	66	6.3	< 3	41	1	0.1	7.2	3.9	12	< 1	26	30.4	48	23	3.8	0.01	< 0.5	2.5	0.66
Core5	76-89	< 5	0.74	0.17	0.08	0.5	< 15	4.9	< 3	33	1.2	0.3	6.6	3	35	< 1	19	25.1	44	17	3.1	0.01	< 0.5	1.7	0.46
Core13	0-22	< 5	1.64	0.37	0.15	1.1	89	10.7	< 3	74	1.6	0.3	10	5.5	52	< 1	28	39.6	67	30	5.3	0.01	< 0.5	3.3	0.78
Core13	22-40	< 5	1.66	0.36	0.14	1.2	103	10.6	< 3	70	< 0.5	0.2	10	6.5	60	< 1	27	40.4	68	27	5	0.01	1	2.8	0.61
Core16	0-13	< 5	1.33	0.23	0.06	1.6	105	7.9	< 3	43	< 0.5	0.3	7.8	3.7	76	< 1	26	26.6	53	20	3.9	0.01	< 0.5	1.8	0.5
Core16	13-43	< 5	1.13	0.19	0.05	1.3	< 15	6.4	< 3	41	< 0.5	0.3	6.8	4	59	< 1	24	24.2	43	< 5	3.3	0.01	0.7	1.9	0.5

Table F-1. Laboratory Results from elemental analysis of selected samples.

Sample	Start_int	End_Int	P	Cr	Cu	Fe	Mn	Ni	Pb	Zn	As	As-correcte	Ba	Co	Cs	Eu	Hf	Mg
Core4	0	12	0.59	0.93	0.44	0.93	0.47	0.80	4.50	4.26	8.93	7.14	1.54	1.06	1.53	1.63	2.30	0.19
Core4	12	16	0.55	0.73	0.40	0.68	0.40	0.64	3.67	3.01	6.95	5.56	1.03	0.83	1.74	1.39	1.74	0.20
Core4	16	34	0.43	0.80	0.22	0.86	0.27	0.44	2.13	1.23	11.40	9.12	0.97	0.49	2.05	1.54	4.79	0.17
Core4	34	54	0.24	0.75	0.21	0.88	0.19	0.41	2.24	1.00	10.39	8.31	1.98	0.37	3.12	1.56	7.01	0.16
Core4	54	67	0.21	0.93	0.32	1.07	0.19	0.44	2.31	0.89	19.72	15.77	1.67	0.35	2.22		5.92	0.17
Core4	67	82.5	0.32	0.67	0.20	1.63	0.39	0.45	3.04	0.83	16.15	12.92	1.42	0.54	2.24	0.75	4.47	0.16
Core5	30	62	0.88	0.79	0.44	0.62	0.47	0.49	2.22	1.93	7.06	5.65	1.90	0.65	2.31	1.25	3.08	0.22
Core5	62	76	0.24	0.81	0.38	0.42	0.32	0.46	2.23	1.56	3.86	3.09	2.13	0.56	2.32	1.74	9.27	0.19
Core5	76	89	0.41	1.07	0.74	0.63	0.32	0.50	2.54	1.40	6.42	5.13		0.69	1.93	1.20	8.66	0.21
Core13	0	22	0.68	0.91	0.50	0.73	0.51	0.91	3.36	5.18	8.75	7.00	1.82	1.21	2.19	1.42	3.94	0.21
Core13	22	40	0.49	0.80	0.38	0.54	0.29	0.50	2.58	1.81	6.45	5.16		0.62	2.15	1.40	4.73	0.20
Core16	0	13	0.79	0.95	0.76	2.54	1.63	0.56	3.73	1.64	27.77	22.21		1.07		1.53	5.55	0.16
Core16	13	43	1.11	0.92	0.49	1.72	0.98	0.69	3.41	1.73	16.20	12.96		0.99		1.68	6.73	0.18
		Mean	0.53	0.85	0.42	1.02	0.49	0.56	2.92	2.04	11.54	9.23	1.61	0.72	2.16	1.42	5.25	0.19

Sample	Start_int	End_Int	Sb	Rb	Sc	Sr	Ti	Th	U	V	Y	La	Ce	Nd	Sm	Yb	Lu
Core4	0	12	6.89	0.96	0.61	0.24	0.62	1.28	1.23	0.64	0.83	1.58	1.19	0.94	1.05	0.99	1.77
Core4	12	16	5.21	1.61	0.56	0.23	0.95	1.30	1.12	0.86	0.82	1.46	0.87	1.15	0.87	0.87	1.19
Core4	16	34	9.24	0.96	0.54	0.25	0.40	1.50	2.43	0.32	1.00	1.67	1.30	0.66	0.99	1.09	2.22
Core4	34	54	14.03	1.90	0.56	0.24	0.82	1.75	2.25	0.61	0.99	2.00	1.60	1.75	1.21	1.64	2.67
Core4	54	67	12.20	1.40	0.58	0.24	0.78	1.71	2.38	0.77	0.94	1.85	1.70	0.87	1.07	1.33	2.22
Core4	67	82.5	19.01	1.12	0.61	0.22	0.82	1.63	2.48	1.08	0.95	1.54	1.34	0.96	0.97	1.34	2.01
Core5	30	62	4.62	1.52	0.58	0.25	1.16	1.29	1.76	0.84	0.91	1.65	1.33	0.95	0.96	1.16	1.71
Core5	62	76	6.95	1.70	0.66	0.25	0.28	1.74	3.35	0.21	1.83	2.35	1.85	1.90	1.47	1.93	3.06
Core5	76	89	7.22		0.64	0.25	1.27	1.99	3.21	0.75	1.66	2.42	2.12	1.75	1.49	1.64	2.66
Core13	0	22	7.22	1.30	0.64	0.26	0.76	1.37	2.67	0.51	1.11	1.73	1.47	1.41	1.16	1.44	2.05
Core13	22	40	7.74	1.48	0.62	0.24	0.54	1.34	3.11	0.57	1.06	1.74	1.46	1.24	1.07	1.20	1.57
Core16	0	13	13.33	1.94	0.60	0.19	0.82	1.35	2.28	0.94	1.31	1.48	1.47	1.19	1.08	1.00	1.67
Core16	13	43	14.58		0.65	0.25	0.98	1.59	3.32	0.98	1.63	1.81	1.61		1.23	1.42	2.24
		Mean	9.86	1.44	0.61	0.24	0.79	1.53	2.43	0.70	1.16	1.79	1.48	1.23	1.13	1.31	2.08

Table F-2. Enrichment Factors based on Aluminum

Sample	Start_int	End_Int	P	Cr	Cu	Mn	Ni	Pb	Zn	Al	As	As-correct	Ba	Co	Cs	Eu	Hf	Mg
Core4	0	12	0.63	1.00	0.47	0.50	0.85	4.82	4.57	1.07	9.56	7.65	1.65	1.13	1.64	1.74	2.46	0.21
Core4	12	16	0.80	1.07	0.58	0.58	0.93	5.36	4.39	1.46	10.14	8.12	1.50	1.22	2.54	2.03	2.54	0.29
Core4	16	34	0.50	0.93	0.26	0.31	0.51	2.49	1.44	1.17	13.31	10.65	1.13	0.57	2.40	1.80	5.59	0.20
Core4	34	54	0.28	0.85	0.24	0.21	0.46	2.56	1.14	1.14	11.86	9.49	2.26	0.43	3.56	1.78	8.00	0.18
Core4	54	67	0.20	0.87	0.30	0.18	0.41	2.15	0.83	0.93	18.40	14.72	1.56	0.33	2.07		5.52	0.16
Core4	67	82.5	0.20	0.41	0.12	0.24	0.27	1.87	0.51	0.61	9.92	7.93	0.87	0.33	1.37	0.46	2.75	0.10
Core5	30	62	1.42	1.26	0.71	0.76	0.79	3.57	3.11	1.61	11.35	9.08	3.06	1.04	3.72	2.01	4.95	0.35
Core5	62	76	0.58	1.93	0.90	0.77	1.10	5.30	3.71	2.38	9.20	7.36	5.07	1.32	5.52	4.14	22.08	0.45
Core5	76	89	0.66	1.71	1.17	0.51	0.80	4.06	2.24	1.60	10.26	8.20		1.11	3.08	1.92	13.84	0.34
Core13	0	22	0.93	1.24	0.69	0.69	1.25	4.60	7.09	1.37	11.99	9.59	2.50	1.65	3.00	1.95	5.40	0.29
Core13	22	40	0.91	1.49	0.70	0.53	0.93	4.79	3.35	1.86	11.98	9.58		1.15	3.99	2.60	8.78	0.37
Core16	0	13	0.31	0.37	0.30	0.64	0.22	1.47	0.65	0.39	10.92	8.74		0.42		0.60	2.18	0.06
Core16	13	43	0.64	0.53	0.28	0.57	0.40	1.98	1.00	0.58	9.39	7.51		0.57		0.98	3.90	0.11
		Mean	0.62	1.05	0.52	0.50	0.69	3.46	2.62	1.24	11.41	9.13	2.18	0.87	2.99	1.83	6.77	0.24

Sample	Start_int	End_Int	Sb	Rb	Sc	Sr	Ti	Th	U	V	Y	La	Ce	Nd	Sm	Yb	Lu
Core4	0	12	7.38	1.02	0.65	0.26	0.67	1.37	1.32	0.68	0.89	1.70	1.27	1.01	1.13	1.07	1.89
Core4	12	16	7.61	2.35	0.82	0.34	1.39	1.90	1.63	1.26	1.20	2.13	1.27	1.68	1.27	1.27	1.73
Core4	16	34	10.78	1.12	0.63	0.29	0.46	1.75	2.84	0.37	1.16	1.95	1.52	0.77	1.16	1.28	2.59
Core4	34	54	16.01	2.16	0.64	0.28	0.94	2.00	2.57	0.69	1.13	2.29	1.82	2.00	1.38	1.87	3.04
Core4	54	67	11.38	1.31	0.55	0.22	0.73	1.60	2.22	0.72	0.88	1.72	1.59	0.81	1.00	1.24	2.07
Core4	67	82.5	11.67	0.69	0.37	0.14	0.51	1.00	1.53	0.66	0.58	0.94	0.82	0.59	0.60	0.82	1.24
Core5	30	62	7.43	2.44	0.94	0.41	1.86	2.07	2.82	1.35	1.46	2.65	2.14	1.53	1.55	1.86	2.75
Core5	62	76	16.56	4.05	1.58	0.60	0.68	4.14	7.97	0.49	4.35	5.59	4.42	4.53	3.50	4.60	7.29
Core5	76	89	11.54		1.03	0.41	2.02	3.17	5.13	1.20	2.66	3.86	3.38	2.80	2.38	2.62	4.25
Core13	0	22	9.89	1.78	0.87	0.35	1.04	1.87	3.66	0.69	1.53	2.37	2.01	1.93	1.59	1.98	2.81
Core13	22	40	14.37	2.74	1.15	0.45	1.01	2.50	5.77	1.06	1.96	3.23	2.72	2.31	2.00	2.24	2.92
Core16	0	13	5.24	0.76	0.24	0.08	0.32	0.53	0.90	0.37	0.52	0.58	0.58	0.47	0.43	0.39	0.66
Core16	13	43	8.45		0.38	0.14	0.57	0.92	1.93	0.57	0.95	1.05	0.93		0.72	0.82	1.30
		Mean	10.64	1.86	0.76	0.30	0.94	1.91	3.10	0.78	1.48	2.31	1.88	1.70	1.44	1.70	2.66

Table F-3. Enrichment Factors based on Iron.

Table F-4 . Correlation matrix for element concentrations and sediment textural data based on selected core samples. The correlations were performed using Pearson product-moment technique. Values listed in table are Pearson correlation coefficients (r). Sample sizes (N) for correlations range from 9 to 13. Critical value (Student's t distribution with N-2 degrees of freedom) at 95% is 2.2. Non significant r-values are indicated by grey type.

	% H20	Blk D.	GRAVEL	SAND	SILT	CLAY	Mg	Sb	Rb	Sc	Sr	Ti	Th	U	V	Y	La	Ce	Nd	Sm	Yb	Lu
% H20	1.00																					
Blk D.	-0.98	1.00																				
GRAVEL	-0.65	0.77	1.00																			
SAND	-0.77	0.67	0.09	1.00																		
SILT	0.95	-0.94	-0.70	-0.68	1.00																	
CLAY	0.88	-0.88	-0.62	-0.77	0.75	1.00																
Mg	0.83	-0.78	-0.31	-0.93	0.72	0.89	1.00															
Sb	-0.35	0.46	0.63	-0.11	-0.33	-0.28	-0.08	1.00														
Rb	0.53	-0.50	-0.14	-0.64	0.47	0.54	0.78	-0.22	1.00													
Sc	0.81	-0.74	-0.21	-0.96	0.69	0.84	0.98	0.06	0.73	1.00												
Sr	0.86	-0.81	-0.37	-0.92	0.75	0.92	0.99	-0.08	0.73	0.97	1.00											
Ti	0.45	-0.40	-0.07	-0.69	0.34	0.64	0.81	-0.02	0.83	0.73	0.76	1.00										
Th	0.81	-0.77	-0.35	-0.88	0.69	0.89	0.98	-0.03	0.77	0.97	0.98	0.78	1.00									
U	0.42	-0.37	-0.02	-0.50	0.58	0.15	0.39	0.02	0.37	0.43	0.37	0.07	0.31	1.00								
V	0.28	-0.20	0.18	-0.67	0.13	0.52	0.74	0.33	0.68	0.73	0.69	0.90	0.75	0.02	1.00							
Y	0.58	-0.50	0.11	-0.77	0.49	0.42	0.69	-0.14	0.71	0.73	0.64	0.46	0.62	0.64	0.41	1.00						
La	0.91	-0.87	-0.44	-0.89	0.82	0.89	0.96	-0.22	0.77	0.95	0.96	0.69	0.95	0.46	0.57	0.73	1.00					
Ce	0.79	-0.72	-0.22	-0.86	0.78	0.65	0.82	-0.10	0.64	0.83	0.80	0.56	0.76	0.68	0.44	0.76	0.87	1.00				
Nd	0.67	-0.61	-0.16	-0.70	0.62	0.52	0.73	-0.11	0.84	0.75	0.71	0.55	0.74	0.50	0.46	0.82	0.80	0.68	1.00			
Sm	0.88	-0.80	-0.27	-0.93	0.77	0.80	0.93	-0.09	0.73	0.96	0.93	0.63	0.91	0.50	0.56	0.82	0.97	0.90	0.83	1.00		
Yb	0.88	-0.83	-0.42	-0.82	0.90	0.72	0.81	-0.18	0.64	0.80	0.82	0.52	0.77	0.62	0.35	0.71	0.88	0.86	0.81	0.87	1.00	
Lu	0.89	-0.84	-0.46	-0.78	0.84	0.76	0.71	-0.25	0.38	0.72	0.75	0.37	0.67	0.39	0.18	0.59	0.81	0.79	0.61	0.82	0.89	1.00

	%H20	Blk D.	GRAVEL	SAND	SILT	CLAY	P	Cr	Cu	Fe	Mn	Ni	Pb	Zn	Al	As	Ba	Co	Cs	Eu	Hf
%H20	1.00																				
Blk D.	-0.98	1.00																			
GRAVEL	-0.65	0.77	1.00																		
SAND	-0.77	0.67	0.09	1.00																	
SILT	0.95	-0.94	-0.70	-0.68	1.00																
CLAY	0.88	-0.88	-0.62	-0.77	0.75	1.00															
P	0.49	-0.38	0.18	-0.88	0.36	0.59	1.00														
Cr	0.77	-0.69	-0.14	-0.92	0.62	0.78	0.82	1.00													
Cu	0.51	-0.41	0.18	-0.79	0.37	0.47	0.82	0.87	1.00												
Fe	-0.25	0.38	0.80	-0.32	-0.38	-0.16	0.46	0.34	0.54	1.00											
Mn	-0.03	0.16	0.72	-0.51	-0.16	-0.01	0.67	0.51	0.77	0.90	1.00										
Ni	0.79	-0.68	-0.16	-0.89	0.64	0.73	0.75	0.93	0.76	0.29	0.43	1.00									
Pb	0.63	-0.53	-0.02	-0.81	0.42	0.68	0.70	0.90	0.76	0.46	0.52	0.93	1.00								
Zn	0.84	-0.74	-0.27	-0.84	0.70	0.73	0.65	0.88	0.70	0.18	0.33	0.98	0.88	1.00							
Al	0.77	-0.71	-0.23	-0.92	0.64	0.86	0.80	0.94	0.75	0.26	0.40	0.88	0.87	0.82	1.00						
As	-0.29	0.40	0.73	-0.22	-0.37	-0.21	0.35	0.30	0.46	0.95	0.82	0.20	0.35	0.10	0.20	1.00					
Ba	0.45	-0.42	-0.12	-0.51	0.35	0.46	0.61	0.55	0.65	0.02	0.29	0.40	0.36	0.38	0.44	-0.08	1.00				
Co	0.68	-0.55	0.04	-0.89	0.52	0.62	0.80	0.92	0.87	0.47	0.62	0.97	0.93	0.94	0.84	0.36	0.24	1.00			
Cs	0.58	-0.52	-0.09	-0.84	0.57	0.65	0.82	0.73	0.60	0.21	0.39	0.67	0.57	0.59	0.83	0.17	0.41	0.64	1.00		
Eu	0.42	-0.35	-0.08	-0.50	0.28	0.48	0.44	0.55	0.47	0.22	0.22	0.67	0.73	0.66	0.54	0.02	0.45	0.67	0.23	1.00	
Hf	-0.10	0.09	0.15	0.17	0.06	-0.42	-0.19	-0.25	-0.03	-0.18	0.04	-0.34	-0.46	-0.32	-0.35	-0.15	-0.30	-0.27	-0.07	-0.58	1.00
Mg	0.83	-0.78	-0.31	-0.93	0.72	0.89	0.82	0.93	0.76	0.13	0.33	0.87	0.81	0.82	0.98	0.07	0.85	0.82	0.84	0.53	-0.29
Sb	-0.35	0.46	0.63	-0.11	-0.33	-0.28	0.11	0.03	0.03	0.73	0.45	0.09	0.23	0.01	0.06	0.71		0.17	0.14	0.17	-0.22
Rb	0.53	-0.50	-0.14	-0.64	0.47	0.54	0.70	0.67	0.73	0.06	0.34	0.61	0.56	0.55	0.72	-0.02	0.62	0.62	0.74	0.41	-0.03
Sc	0.81	-0.74	-0.21	-0.96	0.69	0.84	0.82	0.96	0.79	0.25	0.42	0.91	0.88	0.86	0.99	0.18	0.66	0.88	0.82	0.56	-0.25
Sr	0.86	-0.81	-0.37	-0.92	0.75	0.92	0.79	0.92	0.69	0.09	0.27	0.88	0.82	0.84	0.98	0.03	0.87	0.81	0.83	0.53	-0.32
Ti	0.45	-0.40	-0.07	-0.69	0.34	0.64	0.82	0.70	0.70	0.26	0.41	0.63	0.62	0.55	0.77	0.20	0.68	0.63	0.75	0.47	-0.43
Th	0.81	-0.77	-0.35	-0.88	0.69	0.89	0.74	0.91	0.71	0.13	0.29	0.87	0.85	0.82	0.99	0.08	0.83	0.81	0.81	0.54	-0.35
U	0.42	-0.37	-0.02	-0.50	0.58	0.15	0.37	0.35	0.34	-0.05	0.17	0.31	0.11	0.28	0.33	-0.05	0.07	0.32	0.51	0.00	0.55
V	0.28	-0.20	0.18	-0.67	0.13	0.52	0.77	0.69	0.68	0.53	0.56	0.61	0.73	0.49	0.77	0.46	0.21	0.65	0.68	0.53	-0.52
Y	0.58	-0.50	0.11	-0.77	0.49	0.42	0.73	0.70	0.80	0.24	0.58	0.67	0.58	0.62	0.65	0.12	0.16	0.74	0.62	0.28	0.32
La	0.91	-0.87	-0.44	-0.89	0.82	0.89	0.72	0.90	0.71	-0.03	0.22	0.83	0.75	0.81	0.93	-0.08		0.76	0.80	0.43	-0.10
Ce	0.79	-0.72	-0.22	-0.86	0.78	0.65	0.72	0.84	0.75	0.11	0.36	0.71	0.57	0.68	0.77	0.10	0.76	0.70	0.76	0.23	0.20
Nd	0.67	-0.61	-0.16	-0.70	0.62	0.52	0.59	0.67	0.66	0.04	0.33	0.72	0.63	0.71	0.70	-0.08	0.50	0.72	0.71	0.42	0.16
Sm	0.88	-0.80	-0.27	-0.93	0.77	0.80	0.76	0.94	0.81	0.15	0.39	0.90	0.82	0.88	0.91	0.07	0.76	0.88	0.77	0.49	-0.04
Yb	0.88	-0.83	-0.42	-0.82	0.90	0.72	0.60	0.71	0.54	-0.14	0.12	0.73	0.53	0.75	0.74	-0.19	0.95	0.65	0.79	0.25	0.13
Lu	0.89	-0.84	-0.46	-0.78	0.84	0.76	0.55	0.71	0.48	-0.12	0.11	0.72	0.54	0.77	0.66	-0.16	0.94	0.65	0.63	0.21	0.05

			Buffalo River NIST SRM 8702					Inorganics in Marine Sed-NIST SRM 2702					PACS-2				
			Certified/Referenc Va		MGS Results			Certified/Referenc Valu		MGS Results			Certified/Referenc Values		MGS Results		
Element	**Symbol**	**Units**	**Certified**	**Std**	**Ave.**	**Std**	**% Recovery**	**Certified**	**Std**	**Ave.**	**Std**	**% Recovery**	**Certified**	**Std**	**Ave.**	**Std**	**% Recovery**
Sulfur	**S**	%			0.355	0.010		1.5		1.5375	0.043	102.50	1.29	0.13	1.2425	0.062	96.32
Phosphorus	**P**	%			0.0905	0.003		0.1552	0.006	0.14125	0.003	91.01	0.096	0.004	0.09425	0.004	98.18
Cadmium	**Cd**	ppm	2.94	0.29	3	0.115	102.04	0.817	0.011	0.95	0.058	116.28	2.11	0.15	2.225	0.150	105.45
Chromium	**Cr**	ppm	121.9	3.8	120	5.888	98.44	352	22	332.5	20.158	94.46	90.7	4.6	91.5	3.697	100.88
Copper	**Cu**	ppm			84.5	2.646		117.7	5.6	110.5	4.933	93.88	310	12	303.5	15.674	97.90
Iron	**Fe**	%	3.97	0.1	3.9575	0.100	99.69	7.91	0.24	7.3775	0.176	93.27	4.09	0.06	4.0425	0.158	98.84
Manganese	**Mn**	ppm	544	21	578	9.626	106.25	1757	58	1692.5	74.106	96.33	440	19	441.5	25.173	100.34
Nickel	**Ni**	ppm	42.9	3.7	44	0.816	102.56	75.4	1.5	76.5	1.000	101.46	39.5	2.3	41.25	1.893	104.43
Leand	**Pb**	ppm	150	17	141.25	6.021	94.17	132.8	1.1	120.5	3.317	90.74	183	8	169.25	8.261	92.49
Zinc	**Zn**	ppm	408	15	383.5	11.958	94.00	485.3	4.2	445	15.033	91.70	364	23	355.5	10.661	97.66
Silver	**Au**	ppb											1.22	0.14			
Gold	**Ag**	ppm						0.622	0.078	0.975	0.050	156.75					
Molybdimum	**Mo**	ppm						10.8	1.6	5.75	2.630	53.24	5.43	0.28	4.25	0.500	78.27
Aluminum	**Al**	%	6.1	0.18	6.155	0.288	100.90	8.41	0.22	7.6175	0.497	90.58	6.62	0.32	6.5975	0.316	99.66
Arsenic	**As**	ppm	17		21	2.309	123.53	45.3	1.8	57.25	3.948	126.38	26.2	1.5	36	6.683	137.40
Barium	**Ba**	ppm	413	13	422.5	95.350	102.30	397.4	3.2	460		115.75					
Beryllium	**Be**	ppm						3		3	0.000	100.00	1	0.2	1	0.000	100.00
Bismuth	**Bi**	ppm															
Bromine	**Br**	ppm															
Calcium	**Ca**	%	2.641	0.083	2.815	0.070	106.59	0.343	0.024	0.335	0.030	97.67	1.96	0.18	2.125	0.104	108.42
Cobalt	**Co**	ppm	13.57	0.43	13.5	1.291	99.48	27.76	0.58	27.25	3.594	98.16	11.5	0.3	13.5	0.577	117.39
Cesium	**Cs**	ppm	5.83	0.12	4.5	0.577	77.19	7.1									
Europium	**Eu**	ppm	1.31	0.038	1.2	0.183	91.60										
Hafnium	**Hf**	ppm	8.4	1.5	7.25	0.957	86.31	12.6		8.5	0.577	67.46					
Mercury	**Hg**	ppm						0.4474	0.0069				3.04	0.2			
Iridium	**Ir_ppb**	ppb															
Potassium	**K**	%	2.001	0.041	2.0725	0.314	103.57	2.054	0.072	2.1725	0.126	105.77	1.24	0.05	1.23	0.243	99.19
Magnesium	**Mg**	%	1.2	0.018	1.1575	0.039	96.46	0.99	0.074	0.91	0.018	91.92	1.47	0.13	1.38	0.076	93.88
Sodium	**Na**	%	0.553	0.015	0.5975	0.034	108.05	0.681	0.02	0.7625	0.086	111.97	3.45	0.17	3.29	0.109	95.36
Antimony	**Sb**	ppm	3.07	0.32	3.4	0.141	110.75	5.6	0.24	5.825	0.126	104.02	11.3	2.6	12.7	0.535	112.39
Rubidium	**Rb**	ppm						127.7	8.8								
Scandium	**Sc**	ppm	11.26	0.19	11.5	0.258	102.13	25.9	1.1	23.825	0.222	91.99					
Selenium	**Se**	ppm						4.95	0.46				0.92	0.22			
Strontium	**Sr**	ppm						119.7	3	110	9.592	91.90	276	30	268.5	13.675	97.28
Tantatum	**Ta**	ppm															
Titanium	**Ti**	%	0.457	0.02	0.425	0.024	93.00	0.884	0.082	0.74	0.110	83.71	0.443	0.032	0.445	0.024	100.45
Thorium	**Th**	ppm	9.07	0.16	9.175	0.737	101.16	20.51	0.96	20.2	1.447	98.49					
Uranium	**U**	ppm	3.09	0.13	4.03	0.115	130.53	10.4		7.425	1.857		3				
Vanadium	**V**	ppm	94.6	4				357.6	9.2	305.5	49.776	85.43	133	5	131	6.481	
Tungsten	**W**	ppm						6.2									
Yttrium	**Y**	ppm															
Lanthanum	**La**	ppm						73.5	4.2	73.4	5.193	99.86					
Cerium	**Ce**	ppm	66.5	2	55.75	9.465	83.83	123.4	5.8	108.25	17.614	87.72					
Neodymium	**Nd**	ppm						56		45.25	10.372	80.80					
Samarium	**Sm**	ppm						10.8		9.825	0.650	90.97					
Tin	**Sn**	%						31.6	2.4				19.8	2.5			
Terbium	**Tb**	ppm															
Ytterbium	**Yb**	ppm															
Lutetium	**Lu**	ppm															

Table F-5. Quality Assurance / Quality Control Values from elemental analysis. Results are from 16 reference samples submitted as blind unknowns and were run with the samples from this study.

Appendix G

Core Physical Properties

	RESULTS							
Sample ID	%H20	Bulk Density	%GRAVEL	%SAND	%SILT	%CLAY	SHEPCLASS	FOLK'S CLASS
Core 2 0-29cm	**73.50**	**1.20**	**0.00**	**14.41**	**37.38**	**48.21**	**Silty-Clay**	
Core 2 80-92cm	**22.14**	**1.97**	**0.00**	**60.67**	**28.96**	**10.37**	**Silty-Sand**	
Core 2 116-124cm	**15.88**	**2.14**	**19.33**	**68.17**	**8.38**	**4.13**		**gravelly muddy Sand**
Core 3 0-12cm	**65.11**	**1.28**	**0.00**	**34.86**	**27.28**	**37.87**	**Sand-Silt-Clay**	
Core 3 12-20cm	**26.00**	**1.88**	**41.49**	**53.11**	**2.79**	**2.61**		**sandy Gravel**
Core 3 20-54cm	**52.99**	**1.42**	**0.00**	**3.94**	**45.33**	**50.73**	**Silty-Clay**	
Core 3 54-56cm	**52.77**	**1.43**	**0.00**	**38.59**	**40.53**	**20.88**	**Sand-Silt-Clay**	
Core 3 56-71cm	**35.42**	**1.69**	**0.00**	**42.34**	**36.41**	**21.25**	**Sand-Silt-Clay**	
Core 3 71-80cm	**22.63**	**1.96**	**0.00**	**69.68**	**21.42**	**8.89**	**Silty-Sand**	
Core 3 80-93cm	**31.73**	**1.76**	**0.00**	**72.33**	**18.61**	**9.06**	**Silty-Sand**	
Core 3 93-112cm	**17.47**	**2.09**	**29.96**	**56.45**	**8.46**	**5.12**		**gravelly muddy Sand**
Core 3 112-154.5cm	**9.77**	**2.33**	**38.62**	**38.14**	**13.91**	**9.33**		**muddy sandy Gravel**
Core 4 0-12cm	**68.29**	**1.25**	**0.00**	**3.98**	**40.99**	**55.04**	**Silty-Clay**	
Core 4 12-16cm	**51.48**	**1.44**	**0.00**	**17.01**	**32.39**	**50.60**	**Silty-Clay**	
Core 4 16-34cm	**26.59**	**1.87**	**0.00**	**50.69**	**22.81**	**26.50**	**Sand-Silt-Clay**	
Core 4 34-54cm	**20.34**	**2.02**	**0.00**	**61.17**	**23.26**	**15.57**	**Silty-Sand**	
Core 4 54-67cm	**20.11**	**2.02**	**5.04**	**61.19**	**20.30**	**13.47**		**gravelly muddy Sand**
Core 4 67-82.5cm	**12.71**	**2.23**	**21.63**	**48.30**	**17.66**	**12.41**		**gravelly muddy Sand**
Core 5 0-30cm	**74.50**	**1.19**	**0.00**	**1.58**	**43.08**	**55.33**	**Silty-Clay**	
Core 5 30-62cm	**56.85**	**1.38**	**0.00**	**0.89**	**44.06**	**55.05**	**Silty-Clay**	
Core 5 62-76cm	**41.88**	**1.58**	**0.00**	**46.83**	**33.48**	**19.69**	**Silty-Sand**	
Core 5 76-89cm	**25.18**	**1.90**	**0.00**	**65.88**	**22.40**	**11.72**	**Silty-Sand**	
Core 6 0-16cm	**74.21**	**1.19**	**0.00**	**3.67**	**42.82**	**53.51**	**Silty-Clay**	
Core 6 16-44cm	**61.33**	**1.32**	**0.00**	**3.15**	**39.19**	**57.66**	**Silty-Clay**	
Core 6 44-48cm	**63.45**	**1.30**	**0.00**	**2.02**	**39.39**	**58.60**	**Silty-Clay**	
Core 6 48-62cm	**61.02**	**1.33**	**0.00**	**4.25**	**38.04**	**57.71**	**Silty-Clay**	
Core 6 62-74cm	**56.32**	**1.38**	**0.00**	**64.89**	**17.66**	**17.45**	**Silty-Sand**	
Core 6 74-84cm	**16.64**	**2.11**	**7.55**	**19.25**	**59.84**	**13.36**		**gravelly muddy Sand**
Core 8 0-16cm	**63.17**	**1.30**	**0.00**	**12.47**	**39.20**	**48.33**	**Silty-Clay**	
Core 8 16-44cm	**49.03**	**1.48**	**0.00**	**27.24**	**41.06**	**31.71**	**Sand-Silt-Clay**	
Core 8 44-56cm	**19.73**	**2.03**	**0.00**	**86.47**	**9.57**	**3.96**	**Sand**	
Core 8 56-81cm	**31.28**	**1.77**	**0.00**	**74.10**	**17.55**	**8.34**	**Silty-Sand**	
Core 8 81-83cm	**40.91**	**1.60**	**0.00**	**82.42**	**10.35**	**7.23**	**Sand**	
Core 8 83-92cm	**35.85**	**1.68**	**0.00**	**83.40**	**11.53**	**5.07**	**Sand**	
Core 8 92-100cm	**23.98**	**1.93**	**0.00**	**91.06**	**6.40**	**2.54**	**Sand**	
Core 13 0-22cm	**72.61**	**1.21**	**0.00**	**4.88**	**60.54**	**34.58**	**Clayey-Silt**	
Core 13 22-40cm	**52.11**	**1.43**	**0.00**	**17.50**	**48.72**	**33.78**	**Clayey-Silt**	
Core 13 40-56cm	**21.33**	**1.99**	**0.00**	**44.08**	**36.46**	**19.47**	**Silty-Sand**	
Core 13 56-102cm	**21.16**	**1.99**	**0.00**	**80.55**	**13.61**	**5.84**	**Sand**	
Core 13 102-109.5cm	**22.23**	**1.97**	**0.00**	**89.76**	**6.69**	**3.55**	**Sand**	
Core 16 0-13cm	**7.43**	**2.41**	**60.87**	**30.80**	**6.65**	**1.68**		**muddy sandy Gravel**
Core 16 13-43cm	**5.74**	**2.48**	**49.15**	**41.44**	**6.12**	**3.29**		**muddy sandy Gravel**

Table G-1. Physical properties of the collected core samples. Shephard's classification is used for samples without a gravel component. Folk's classification is used for samples with gravel.

Appendix H

Analysis of Cores 9, 11, and 15

Further analysis of the sediments was desired after the initial results were reported. Three cores were identified for further analysis due to their spatial location, existing data, and depth. Cores 9, 11, and 15, were analyzed for textural properties by MGS and for 48 elements by Actlabs. These cores were collected along the three up-stream transects in the Lake (Figure A-1).

STUDY OBJECTIVES

The objectives for this follow-on study were:

1) Further document physical and elemental characteristics of the sediment.
2) Identify any possible trends in the historical core sediments.

METHODOLOGY

Methods and interpreted analyses of the results are the same as those used for the first set of samples.

RESULTS AND DISCUSSION

Analytical results are presented in Table H-2 . Results of the Standard reference material (SRM) used for QA/QC are listed in Table H-3.

The cores penetrated sediments ranging from silts and clays at the top of the sediment column to coarse sand and gravel at depth (Table H-2). Because of the significant downcore changes in the textural character of the sediments, assessing any changes in chemistry in the sediment column was difficult even when using enrichment factors to normalize the elemental data.

Generally, the elemental analyses for the cores 9, 11, and 15 yielded concentrations similar to those reported for Core 4. However, the iron concentration reported for at least one sample from each core was less than 1% which was unexpected given that these iron-poor samples contained some silts and clays which usually are iron-rich. Enrichment factors using Fe as the normalizing element would be relatively high for other elements due to the low iron in these samples.

Table H-1. Comparison of average EF values using Fe and Al, respectively for sediments analyzed in Cores 9, 11, and 15.

	Mean EF using			**Mean EF using**	
Element	**Al**	**Fe**	**Element**	**Al**	**Fe**
P	0.49	0.70	**Mg**	0.22	0.36
Cr	1.14	1.91	**Rb**	1.42	2.35
Cu	0.69	1.03	**Sb**	8.46	13.70
Fe	0.71		**Sc**	0.74	1.24
Mn	0.29	0.44	**Sr**	0.28	0.47
Ni	0.70	1.14	**Ti**	0.97	1.54
Pb	2.74	4.55	**Th**	2.30	3.96
Zn	2.18	3.48	**U**	3.27	5.77
Al		1.71	**V**	0.68	1.04
As	9.74	16.25	**Y**	1.43	2.64
As- adjusted*	7.79	13.00	**La**	2.07	3.53
Ba	1.46	2.43	**Ce**	1.96	3.34
Co	0.92	1.49	**Nd**	2.02	3.45
Cs	1.93	3.23	**Sm**	1.67	2.89
Eu	2.30	4.01	**Yb**	2.22	3.94
Hf	8.53	15.59	**Lu**	2.17	3.86

* Arsenic concentrations were adjusted by multiplying reported concentration by 0.8 to correct for 125% recovery rate for reported by Actlabs.

Enrichment factors calculated using Fe and Al were similar to those reported for first set of samples (Tables 2 and H-1). Elements having significantly high enrichment (i.e., >2 for both Fe and Al based EF values) include arsenic (As), lead (Pb), antimony (Sb), thorium (Th), uranium (U), zinc (Zn), lanthanumn (La) and neodymium (Nd). Except for Pb and Zn, most elements do not show any downcore trend in enrichment. The high enrichment may reflect a natural regional abundance of the elements as they do not exhibit any significant downcore change. EFs tended to be higher in Core 15 which was collected in the upstream end of New Germany Lake and may have contained a higher percentage of unweathered parent rock.

Figures H-1 and H-2 show plots of the EF profiles for lead (Pb) and zinc (Zn) for Cores 9 and 11, respectively. Although the EFs were calculated using aluminum instead of iron, the downcore trends, particularly Zn, are similar to those for Core 4 (Figure 4). Plots suggest that sediments deeper than 21 cm [0.75 ft] in Core 9 and deeper than 33 cm [1 ft] in Core 11 are older than the early 1900s.

Plots of EF for Zn and Pb for Core 15 present a different picture (Figure H-3). EFs for both Zn and Pb do not show clear downcore trends. Core 15 was collected on the delta deposits at the upstream end of the lake. The delta area represents a higher energy deposition environment, subjected to storms and high flow events which would disturb and rework the sediments.

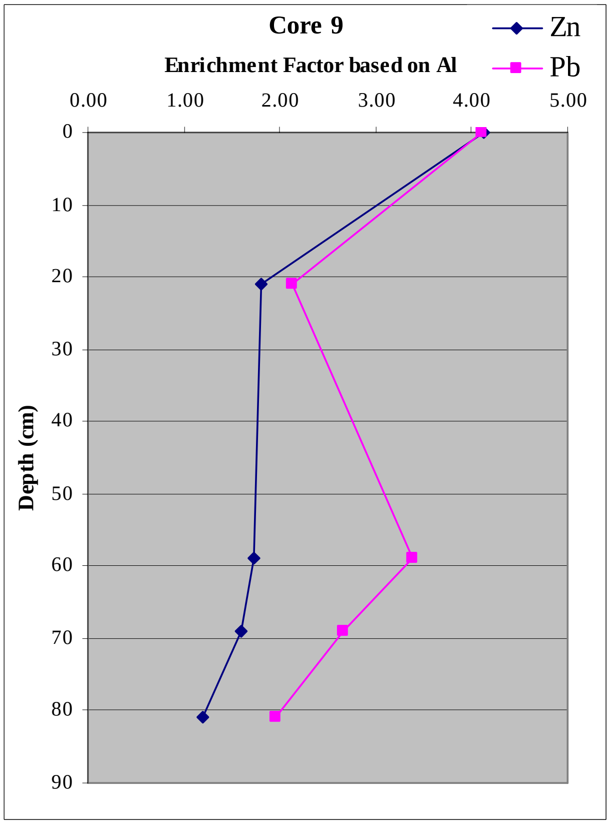

Figure H-1 . Plot of EF (normalized using Al) for Zn and PB in core 9.

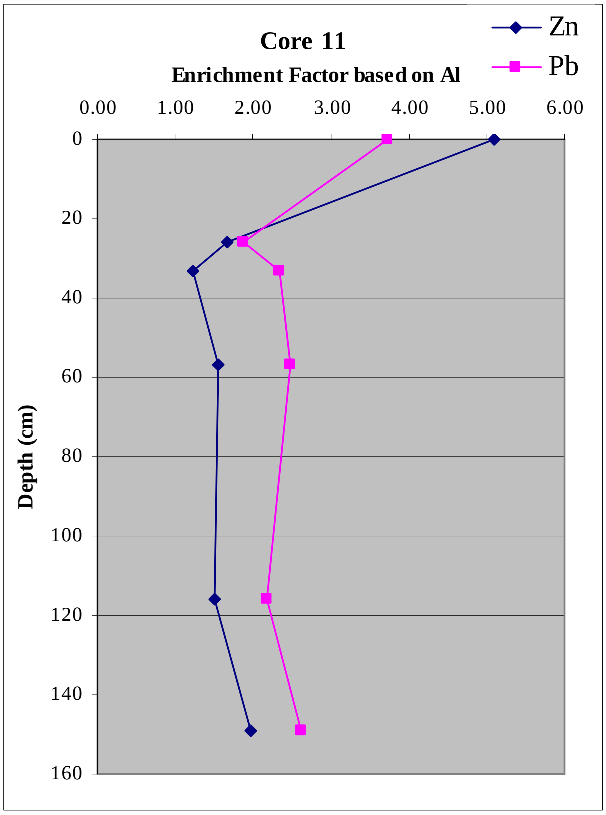

Figure H- 2 . Plots of EF (normalized using Al) for Zn and PB in core 11.

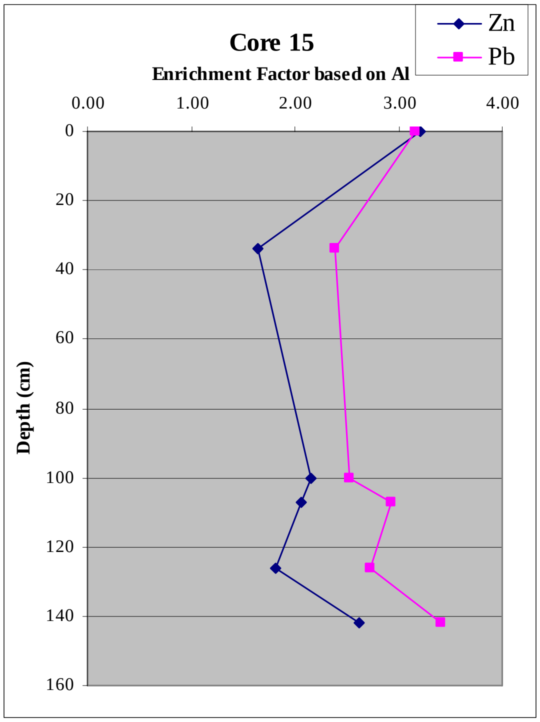

Figure H-3. Plot of EF (nomalized using Al) for Zn and PB in core 15.

Table H-2 -. Results from textural and elemental analysis of samples from cores 9, 11 and 15.

Sample ID and interval	**%H20**	**Bulk Density**	**%Gravel**	**%Sand**	**%Silt**	**%Clay**	**Shepard's Class**	**Folk's Class**
Core 9 0-21cm	61.85	1.32	0.00	3.97	38.76	57.27	Silty-Clay	
Core 9 21-59cm	49.86	1.46	0.00	26.81	30.72	42.48	Sand-Silt-Clay	
Core 9 59-69cm	24.16	1.92	1.24	87.12	7.99	3.65		Slightly Gravelly Muddy Sand
Core 9 69-81cm	12.87	2.23	41.08	48.55	6.90	3.47		Muddy Sandy Gravel
Core 9 81-97cm	16.36	2.12	13.07	45.20	25.25	16.48		Gravelly Muddy Sand
Core 11 0-26cm	69.59	1.24	0.00	13.16	39.16	47.68	Silty-Clay	
Core 11 26-33cm	66.79	1.27	0.00	23.66	36.47	39.87	Sand-Silt-Clay	
Core 11 33-57cm	25.58	1.89	0.00	46.84	35.48	17.68	Silty-Sand	
Core 11 57-116cm	19.35	2.04	0.00	48.00	32.62	19.38	Silty-Sand	
Core 11 116-149cm	19.59	2.03	0.33	58.83	26.61	14.23		Slightly Gravelly Muddy Sand
Core 11 149-172cm	24.70	1.91	8.81	58.68	20.75	11.77		Gravelly Muddy Sand
Core 15 0-34cm	74.61	1.19	0.00	8.60	56.70	34.71	Clayey-Silt	
Core 15 34-100cm	29.88	1.80	0.00	29.65	48.23	22.11	Sand-Silt-Clay	
Core 15 100-107cm	28.91	1.82	0.00	79.05	13.08	7.86	Sand	
Core 15 107-126cm	15.13	2.16	50.19	34.51	9.90	5.40		Muddy Sandy Gravel
Core 15 126-142cm	10.11	2.32	49.22	35.87	10.02	4.88		Muddy Sandy Gravel
Core 15 142-145cm	9.85	2.33	32.44	47.71	8.25	11.60		Muddy Sandy Gravel

Table H-2 –(cont.). Results from textural and elemental analysis of samples from cores 9, 11 and 15.

	Au	**Ag**	**Cu**	**Cd**	**Mo**	**Pb**	**Ni**	**Zn**	**S**	**Al**	**As**	**Ba**	**Be**	**Bi**	**Br**	**Ca**
Sample ID	**ppb**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**
Detection limit	**2**	**0.3**	**1**	**0.3**	**1**	**3**	**1**	**1**	**0.01**	**0.01**	**0.5**	**50**	**1**	**2**	**0.5**	**0.01**
Core 9 0-21cm	< 2	< 0.3	26	2	2	44	51	248	0.14	7.06	13.2	650	4	< 2	8	0.16
Core 9 21-59cm	< 2	< 0.3	20	0.5	< 1	18	29	86	0.06	5.58	7.4	410	2	< 2	5.3	0.14
Core 9 59-69cm	< 2	< 0.3	3	< 0.3	< 1	7	6	20	0.01	1.36	2.6	130	< 1	< 2	1.2	0.05
Core 9 69-81cm	< 2	< 0.3	9	< 0.3	< 1	11	15	37	0.01	2.72	3.8	240	1	< 2	< 0.5	0.05
Core 9 81-97cm	< 2	0.3	10	0.6	< 1	12	21	41	0.03	4.02	4.5	220	2	< 2	1	0.16
Core 11 0-26cm	< 2	0.4	38	2.1	1	35	57	268	0.23	6.17	10.9	470	4	< 2	9.5	0.2
Core 11 26-33cm	< 2	0.3	18	0.5	< 1	13	26	65	0.13	4.57	6.6	340	2	< 2	4.1	0.43
Core 11 33-57cm	< 2	< 0.3	13	< 0.3	< 1	13	15	38	< 0.01	3.65	4.6	230	2	< 2	1.3	0.13
Core 11 57-116cm	< 2	< 0.3	7	< 0.3	< 1	12	16	42	< 0.01	3.18	4	260	1	< 2	0.9	0.12
Core 11 116-149cm	< 2	0.3	8	< 0.3	< 1	11	14	43	0.01	3.34	3.2	270	1	< 2	0.8	0.14
Core 11 149-172cm	< 2	< 0.3	16	0.4	< 1	15	23	63	0.07	3.77	6.5	270	2	< 2	< 0.5	0.18
Core 15 0-34cm	< 2	< 0.3	18	1.6	2	27	43	153	0.2	5.61	9.1	510	3	< 2	10.7	0.22
Core 15 34-100cm	< 2	0.4	15	0.5	< 1	16	27	62	0.05	4.42	7.7	270	2	< 2	2.1	0.18
Core 15 100-107cm	< 2	0.3	13	< 0.3	< 1	9	21	43	0.22	2.34	12	140	1	< 2	1.6	0.1
Core 15 107-126cm	< 2	0.4	23	0.3	< 1	20	34	79	0.13	4.49	23.4	200	2	< 2	< 0.5	0.08
Core 15 126-142cm	< 2	< 0.3	71	0.6	< 1	18	25	67	0.04	4.34	12.4	220	2	< 2	< 0.5	0.06
Core 15 142-145cm	< 2	0.4	19	0.9	< 1	14	27	60	0.02	2.7	9.8	320	2	< 2	< 0.5	0.06

Table H-2 –(cont.). Results from textural and elemental analysis of samples from cores 9, 11 and 15.

	Co	**Cr**	**Cs**	**Eu**	**Fe**	**Hf**	**Hg**	**Ir**	**K**	**Mg**	**Mn**	**Na**	**P**	**Rb**	**Sb**	**Sc**
Sample ID	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppb**	**%**	**%**	**ppm**	**%**	**%**	**ppm**	**ppm**	**ppm**
Detection limit	**1**	**2**	**1**	**0.2**	**0.01**	**1**	**1**	**5**	**0.01**	**0.01**	**1**	**0.01**	**0.001**	**15**	**0.1**	**0.1**
Core 9 0-21cm	24	88	5	1.6	3.93	9	< 1	< 5	2.36	0.47	351	0.15	0.067	123	1.4	13.5
Core 9 21-59cm	11	57	4	1.2	2.17	10	< 1	< 5	1.64	0.35	220	0.12	0.036	72	0.7	9.1
Core 9 59-69cm	3	21	1	0.6	0.42	12	< 1	< 5	0.39	0.07	32	0.02	0.003	23	0.3	2.4
Core 9 69-81cm	4	35	2	1.3	1.46	12	< 1	< 5	1.13	0.12	34	0.04	0.02	40	0.7	4.9
Core 9 81-97cm	7	40	2	1.1	2.89	7	< 1	< 5	1.46	0.22	67	0.08	0.013	54	0.9	6.5
Core 11 0-26cm	22	76	5	1.5	3.65	9	< 1	< 5	2.05	0.42	347	0.13	0.063	107	0.9	11.5
Core 11 26-33cm	7	57	4	1.3	2.14	9	< 1	< 5	1.38	0.29	357	0.09	0.04	81	0.7	8.6
Core 11 33-57cm	5	48	3	1.3	1.14	14	< 1	< 5	0.95	0.19	92	0.08	0.013	48	0.5	6.8
Core 11 57-116cm	7	54	3	1.3	1.21	13	< 1	< 5	1.07	0.19	82	0.09	0.011	57	0.7	7.6
Core 11 116-149cm	6	48	2	1.2	0.8	12	< 1	< 5	0.94	0.18	66	0.07	0.008	46	0.5	6.5
Core 11 149-172cm	11	56	2	1.4	1.36	10	< 1	< 5	1.34	0.27	123	0.09	0.014	51	0.9	7.6
Core 15 0-34cm	18	66	5	1.3	2.48	9	< 1	< 5	1.69	0.32	234	0.11	0.079	94	0.8	10.4
Core 15 34-100cm	8	59	3	1.6	0.89	13	< 1	< 5	1.48	0.27	70	0.1	0.012	57	0.7	8.8
Core 15 100-107cm	12	29	1	1	0.73	9	< 1	< 5	0.7	0.13	28	0.04	0.009	35	0.6	4.5
Core 15 107-126cm	23	61	2	1.2	1.67	11	< 1	< 5	1.7	0.31	68	0.09	0.017	63	1.2	8.2
Core 15 126-142cm	12	60	2	1.2	3.74	10	< 1	< 5	1.58	0.27	284	0.06	0.035	57	1	7.7
Core 15 142-145cm	14	66	3	1.3	3.37	11	< 1	< 5	1.8	0.27	114	0.1	0.033	63	1	10

Table H-2 –(cont.). Results from textural and elemental analysis of samples from cores 9, 11 and 15.

	Se	**Sr**	**Ta**	**Ti**	**Th**	**U**	**V**	**W**	**Y**	**La**	**Ce**	**Nd**	**Sm**	**Sn**	**Tb**	**Yb**	**Lu**
Sample ID	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**
Detection limit	**3**	**1**	**0.5**	**0.01**	**0.2**	**0.5**	**2**	**1**	**1**	**0.5**	**3**	**5**	**0.1**	**0.01**	**0.5**	**0.2**	**0.05**
Core 9 0-21cm	< 3	92	1.8	0.35	14.8	4.3	85	< 1	25	41.8	79	38	6	< 0.01	< 0.5	3.8	0.57
Core 9 21-59cm	< 3	66	< 0.5	0.14	10.7	4.3	39	< 1	23	30.5	55	23	4.5	< 0.01	< 0.5	3.2	0.45
Core 9 59-69cm	4	17	< 0.5	0.13	4.9	2.5	12	< 1	16	14.4	27	12	2.2	< 0.01	< 0.5	1.9	0.28
Core 9 69-81cm	< 3	61	< 0.5	0.22	7.6	3.4	37	< 1	17	30.2	60	34	5.1	< 0.01	< 0.5	2.3	0.35
Core 9 81-97cm	< 3	44	< 0.5	0.23	8.8	3	52	< 1	23	23.3	46	19	4	< 0.01	< 0.5	2.6	0.39
Core 11 0-26cm	< 3	84	< 0.5	0.37	13.1	5	72	< 1	26	36.4	66	38	5.6	< 0.01	< 0.5	3.2	0.49
Core 11 26-33cm	< 3	62	< 0.5	0.41	10	4.4	66	< 1	22	28.3	55	18	4.3	< 0.01	< 0.5	2.7	0.43
Core 11 33-57cm	4	45	0.7	0.11	10.5	5.1	14	< 1	23	29.5	54	29	4.7	< 0.01	< 0.5	3.3	0.49
Core 11 57-116cm	< 3	39	< 0.5	0.38	10.9	4	51	< 1	19	29.6	55	23	4.6	< 0.01	0.9	3.2	0.51
Core 11 116-149cm	< 3	39	< 0.5	0.14	9.3	3.8	18	< 1	22	25.4	48	22	4.3	< 0.01	0.8	3.1	0.54
Core 11 149-172cm	< 3	45	< 0.5	0.2	10	4	40	< 1	26	27.4	52	25	4.9	< 0.01	< 0.5	3	0.55
Core 15 0-34cm	< 3	68	< 0.5	0.39	11.3	4.5	66	< 1	24	32.5	63	26	5.1	< 0.01	< 0.5	3.3	0.55
Core 15 34-100cm	< 3	52	< 0.5	0.18	12.2	4.4	35	< 1	29	31.4	59	29	5.6	< 0.01	1.1	4.1	0.72
Core 15 100-107cm	< 3	25	< 0.5	0.18	6.9	2.9	21	< 1	19	19	37	23	3.4	< 0.01	< 0.5	2.2	0.38
Core 15 107-126cm	< 3	47	< 0.5	0.26	11.3	4.6	52	< 1	21	26.5	49	23	4.3	< 0.01	< 0.5	3.1	0.5
Core 15 126-142cm	< 3	46	0.9	0.16	10.1	4.4	38	< 1	21	25.6	52	23	4.2	< 0.01	< 0.5	2.7	0.54
Core 15 142-145cm	< 3	38	< 0.5	0.44	12	3.6	69	< 1	8	32.9	61	31	5.1	< 0.01	< 0.5	3.3	0.59

Table H-3 . Quality Assurance / Quality Control Values from elemental analysis. Results are from 3 samples of NIST SRM 1646a, submitted as blind unknowns and were run with the second set of samples.

NIST SRM 1646a- Estuarine Sediment								
			Certified/Referenced values		Actlab Results			
Element	Symbol	Units	Certified values	Std dev	Ave	Std dev	Detection limit	% Recovery
Gold	**Au**	ppb					**2**	
Silver	**Ag**	ppm			0.6		**0.3**	
Copper	**Cu**	ppm	**10.01**	**0.34**	10.33	0.58	**1**	**103.2**
Cadmium	**Cd**	ppm	**0.148**	**0.007**	0.450	0.071	**0.3**	**304.1**
Molybdimum	**Mo**	ppm	**1.8**		2	0	**1**	**111.1**
Lead	**Pb**	ppm	**11.7**	**1.2**	10	1	**3**	**85.5**
Nickel	**Ni**	ppm	**23**		25	2	**1**	**108.7**
Zinc	**Zn**	ppm	**48.9**	**1.6**	49	3	**1**	**100.2**
Sulfur	**S**	%	**0.352**	**0.004**	0.377	0.021	**0.01**	**107.0**
Aluminum	**Al**	%	**2.297**	**0.018**	2.043	0.652	**0.01**	**89.0**
Arsenic	**As**	ppm	**6.23**	**0.21**	8.03	0.40	**0.5**	**128.9**
Barium	**Ba**	ppm	**210**		200	17	**50**	**95.2**
Beryllium	**Be**	ppm			1	0	**1**	
Bismuth	**Bi**	ppm					**2**	
Bromine	**Br**	ppm			40.967	0.7371	**0.5**	
Calcium	**Ca**	%	**0.519**	**0.02**	0.547	0.110	**0.01**	**105.3**
Cobalt	**Co**	ppm	**5**		5.67	0.58	**1**	**113.3**
Chromium	**Cr**	ppm	**40.9**	**1.9**	50	2.6458	**2**	**122.2**
Cesium	**Cs**	ppm			1		**1**	
Europium	**Eu**	ppm			0.7333	0.2082	**0.2**	
Iron	**Fe**	%	**2.008**	**0.039**	1.94	0.04	**0.01**	**96.6**
Hafnium	**Hf**	ppm			13	0	**1**	
Potassium	**K**	%	**0.864**	**0.016**	1.107	0.081	**0.01**	**128.1**

NIST SRM 1646a- Estuarine Sediment								
			Certified/Referenced values		Actlab Results			
Element	Symbol	Units	Certified values	Std dev	Ave	Std dev	Detection limit	% Recovery
Magnesium	Mg	%	0.388	0.009	0.417	0.049	0.01	107.4
Manganese	Mn	ppm	234.5	2.8	243.7	16.6	1	103.9
Sodium	Na	%	0.741	0.017	0.677	0.006	0.01	91.3
Phosphorus	P	%	0.027	0.001	0.030	0.001	0.001	111.1
Rubidium	Rb	ppm	38		35.5	2.1213	15	93.4
Antimony	Sb	ppm	0.3		0.3	0.1414	0.1	100.0
Scandium	Sc	ppm	5		4.8	0.1	0.1	96.0
Selenium	Se	ppm	0.193	0.028			3	
Strontium	Sr	ppm	68		69.3	13.3	1	102.0
Titanium	Ti	%	0.456	0.021	0.457	0.101	0.01	100.1
Thorium	Th	ppm	5.8		6.9333	0.1155	0.2	119.5
Uranium	U	ppm	2		2.5	0.6557	0.5	125.0
Vanadium	V	ppm	44.84	0.76	37.33	10.02	2	83.3
Tungsten	W	ppm					1	
Yttrium	Y	ppm			9.3333	2.8868	1	
Lanthanum	La	ppm	17		18.7	0.3464	0.5	110.0
Cerium	Ce	ppm	34		36	2.6458	3	105.9
Neodymium	Nd	ppm	15		18	2	5	117.8
Samarium	Sm	ppm			3	0	0.1	
Tin	Sn	%	1				0.01	
Terbium	Tb	ppm					0.5	
Ytterbium	Yb	ppm			1.6	0.1	0.2	
Lutetium	Lu	ppm			0.22	0.01	0.05	