DATING A SEDIMENT CORE USING A SPHEROIDAL CARBONACEOUS PARTICLE CHRONOLOGY

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ABSTRACT

Spheroidal carbonaceous particles (SCPs), a type of insoluble fly-ash, are produced from the incomplete combustion of fossil fuels and are deposited in lake sediments. They are not influenced by chemical or biological decomposition; therefore, they provide a baseline reference for ecosystem disturbance from atmospheric pollution deposition. We hypothesize that using SCPs will track anthropogenic inputs of atmospheric pollution; and that they can be used as a primary dating tool since different SCP concentrations in lake sediments archive the local historical occurrence of industrial fossil fuel combustion**.** Utilizing a method to date cores using a SCP chronology is significant to the historical environment reconstruction process since it fills in data gaps by describing historical variables.

A sediment core was taken from the depositional basin of Mosquito Creek Reservoir (MCR), located in Trumbull County in the Mahoning Valley industrial region of Northeastern Ohio, using a 5-cm diameter piston corer. A chronology was constructed by comparing annual raw steel production in the Lower Mahoning River Basin to sediment SCP concentrations. A very strong, positive linear correlation (Pearson Product-Moment Correlation Coefficient: $r = 0.83$, N= 15 $p < 0.001$) between steel production and smoothed SCP ($\geq 6.25\mu m$) concentrations enables determination of a chronology and allows the opportunity for reservoir sediment cores from other similar industrial regions to be dated primarily by a SCP chronology instead of less precise alternatives. Metals were analyzed to supplement the chronology, but their concentrations were not strongly correlated to SCP concentrations or regional raw steel production. Therefore, metal concentrations in the MCR do not reflect regional atmospheric deposition.

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TABLE OF CONTENTS

ABSTRACT ……………………………………………………………………….iii

ACKNOWLEDGEMENTS ………………………………………………………….iv

TABLE OF CONENTS ………………………………………………………………v

LIST OF FIGURES …………………………………………………………..….viii

LIST OF TABLES …………………………………………………………….....ix

1. INTRODUCTION

1.0 Spheroidal Carbonaceous Particle Overview ……………………………..1

1.1 Thesis Summary……………………………………………………….…..2

1.1.1 Thesis Hypothesis …………………………………………….....2

1.1.2 Thesis Objectives ……………………………………………….2

2. LITERATURE REVIEW

2.0 Lake Sediments: Records of Atmospheric Pollution ……………………..4

2.1 Sediment Cores …………………………………………………….....4

2.2 Spheroidal Carbonaceous Particles in Lake Sediments …………………..5

2.3 Metal Concentrations in Lake Sediments ……………………………...7

2.4 Development of SCP Extraction Methods ………………………………..8

2.5 SCPs: Detecting Local Deposition ………………………………………..9

3. METHODS

3.0 Study Site: Industrial Region Selection ……………………………....11

3.0.1 Northeast Ohio: Mahoning Valley …………………………...….11

3.1 Study Site: Reservoir Selection …………………………………………13

3.1.1 Mosquito Creek Reservoir ………………………………………13

3.2 Field Methods ……………………………………………………………...15

3.3 Laboratory Methods: Percent Moisture and Loss on Ignition …………..17

3.3.1 Percent Moisture ………………………………………………...18

3.3.2 Loss on Ignition ……………………………...……………18

3.4 Laboratory Methods: SCP Analyses ……………………………………18

3.4.1 SCP Digestion …………………………………………………...18

3.4.2 Slide Preparation ………………………………………………...19

3.4.3 Identifying SCPs ………………………………………………...20

3.4.4 Counting Methods ………………………………………………20

3.5 SCP Chronology and Statistical Methods ………………………………22

3.5.1 Regional Historical Data Involving the Mahoning
Valley Steel Mills ………………………………………………22

3.5.2 SCP Size Classifications Associated with a Regional
Influence ……………………………………………………...22

3.5.3 Medium and Large SCP Data Manipulation ……….…………22

3.5.4 Statistical Methods: SCP Concentrations and Raw Steel
Production …………….………………………………………24

3.6 Laboratory Methods: Metal Analyses …………………………………...24

3.6.1 Metal Digestion …………………………………………………24

3.6.2 Metal Data Manipulation and Statistical Methods ………………25

4. RESULTS

4.0 Percent Moisture and Loss on Ignition …………………………………27

4.1 Smoothed Medium and Large SCP Concentrations ……………………27

4.3 SCP Chronology ...29

4.4 Metal Analyses ...34

5. DISCUSSION

5.0 SCP Particle Size and Expected Source Locations ...39

5.1 Historical & Modern SCP Point Sources ...39

5.2 SCP Analysis Errors ...41

5.3 Metal Analysis Errors ...41

5.4 Metal Sources ...42

5.5 Further Validation of the MCR SCP Chronology ...42

5.6 Future Use of Model & References to Reservoir SCP Records ...46

6. CONCLUSIONS

6.0 Conclusions and Recommendations ...47

REFERENCES ...48

APPENDIX A SCP, Diatom, and IAS Wet Weights ...52

APPENDIX B Percent Moisture Calculations ...54

APPENDIX C Loss on Ignition Calculations ...57

APPENDIX D Raw SCP Counts ...60

APPENDIX E Medium & Large SCP Concentration Calculations ...62

APPENDIX F Smoothed Medium and Large SCP Concentrations ...66

APPENDIX G Coefficient of Variance Calculations ...68

APPENDIX H Original and Smoothed Metal Concentrations ...72

APPENDIX I Quality Assurance and Quality Control ...80

APPENDIX J Pearson Product-Moment Correlation Coefficient Outputs ……..88

APPENDIX K Sedimentation Rates …………………………………………..91

LIST OF FIGURES

Figure 2.0: SCP prepared from lake sediments (Wik et al. 1986) ………………………..6

Figure 3.0: Northeast Ohio- Mahoning Valley (Google Earth 2013) …………………...12

Figure 3.1: Mahoning Valley (Google Earth 2013) ……………………………………..12

Figure 3.2: Mosquito Creek Reservoir in Trumbull County, Ohio
(Center for Urban Studies, Youngstown State University 2001) …………..14

Figure 3.3: MCR Bathymetric Map (Ohio Division of Wildlife 2004) …………………16

Figure 3.4: MCR Sediment Core Location (Google Earth 2013) ……………………….17

Figure 3.5 a, b: SCP (left) and a non-SCP (right) (Clark 2007) ………………………...21

Figure 3.6: Lower Mahoning River Basin Raw Steel Production (OEPA 1984) ……….23

Figure 3.7: Industrial Regions Surrounding the Mahoning Valley
(Google Earth 2013) ……………………………………………………..23

Figure 4.0: MCR Sediment Core – Percent Moisture …………………………………...28

Figure 4.1: MCR Sediment Core – Percent Organic Carbon Content …………………..28

Figure 4.2: Smoothed Medium and Large SCP Concentrations ………………………...29

Figure 4.3 a, b: Raw Steel Production described by Year and Depth …………………...30

Figure 4.4: Raw Steel Production and Smoothed Medium & Large SCP
Concentrations …………………………………………………………...32

Figure 4.5: Raw Steel Production vs. Smoothed Medium & Large SCP
Concentrations ………………………………………………………...……32

Figure 4.6: Raw Steel Production and Smoothed Medium & Large SCP
Concentrations with Dates ……………………………………………….33

Figure 4.7: SCP Chronology …………………………………………………………….34

Figure 4.8: Smoothed SCPs (gDW^{-1}) & Smoothed Metal Concentrations (mg/kg) 37

Figure 4.9: Smoothed Metal Concentrations (mg/kg) 38

Figure 5.0: Power Plants near MCR (U.S. Energy Information Administration 2013) 40

Figure 5.1: Mahoning River Watershed and Mosquito Creek Sub-Watershed (Center for Urban Studies, Youngstown State University 2001) 43

Figure 5.2: Mosquito Creek Watershed Land Use (Martin 2004) 44

Figure 5.3: Industrial and Municipal Point Source Discharges (Center for Urban Studies, Youngstown State University 2001) 45

LIST OF TABLES

Table 4.0: Corresponding Variables for Raw Steel and Smoothed Medium and Large SCP Concentrations 31

Table 4.1: Corresponding Variables for Raw Steel and Smoothed Metal Concentrations 36

CHAPTER 1

INTRODUCTION

1.0 Spheroidal Carbonaceous Particle Overview

Spheroidal carbonaceous particles (SCPs), a type of fly-ash, are anthropogenic air pollutants that are derived from the incomplete combustion of fossil fuel (Wik and Renberg 1996, Peterson 1972, McCrone and Delly 1973). SCPs are considered contaminants since they aide in the deterioration of buildings and monuments and since other pollutants, such as trace metals, sulfur, and polycyclic aromatic hydrocarbons, adsorb onto their surfaces (Rose and Monteith 2005, Wik and Renberg 1996). SCPs are deposited in lake sediments and are insoluble. Their matrix primarily consists of elemental carbon which makes them resistant to chemical and biological decomposition. Therefore, SCPs are well preserved in sediments and are indicators of atmospheric deposition. The study of SCPs is environmentally significant, since SCPs are able to provide a baseline for ecosystem disturbance from atmospheric pollution deposition from industrial fossil fuel combustion (Wik and Renberg 1996).

SCPs have been used in palaeolimnological studies as a mechanism for dating lake sediment cores (Rose et al. 1999), but ^{137}Cs and ^{210}Pb dating methods are more commonly utilized in the research. However, ^{137}Cs and ^{210}Pb dating analyses are less precise when applied to reservoir sediment cores. A ^{210}Pb chronology is prone to errors due to highly variable sedimentation rates and the relatively young age of many reservoirs (Science Museum of Minnesota 2013, U.S. Geological Survey 2004). ^{137}Cs results are more reliable than ^{210}Pb, but only the 1964 marker is applicable (Science Museum of Minnesota 2013). Therefore, a SCP chronology would allow the opportunity for reservoir sediment cores from industrial regions to be dated by a more precise mechanism while allowing the opportunity to describe regional atmospheric deposition of pollutants without the influence of sources in the terrestrial sub-watershed.

1.1 Thesis Summary

Developing a SCP chronology to date sediment cores instead of less precise methods is significant to the historical environment reconstruction process since it fills in data and monitoring gaps by identifying historical variables. This thesis utilizes a SCP chronology to date a sediment core from Mosquito Creek Reservoir (MCR) in Trumbull County and within the Mahoning Valley industrial region of Ohio. The chronology is created by comparing yearly raw steel production levels in the Lower Mahoning River Basin and smoothed medium and large SCP concentrations from the MCR sediment core. SCPs are found to be correlated with metals; therefore, metal concentrations in the MCR sediment core were analyzed to supplement the chronology.

1.1.1 Thesis Hypothesis

SCP's track anthropogenic inputs of atmospheric pollution, therefore, SCP's can be used as a primary dating tool since their concentrations in sediment archive the regional occurrence of industrial fossil fuel combustion; additionally, SCP's can serve as a proxy for associated contaminants of concern.

1.1.2 Thesis Objectives

1. Determine if a sediment chronology can be established using SCP analysis instead of less precise alternatives in a region with a history of industrial fossil fuel combustion.

2. Determine the particle size that bests indicates a “true regional” chronology with regards to local and long range transport.
3. Supplement and validate the SCP chronology with sediment geochemistry.

CHAPTER 2

LITERATURE REVIEW

2.0 Lake Sediments: Records of Atmospheric Pollution

In industrialized regions of Europe and North America, lake sediments can provide a quantitative record of atmospheric pollutants (Boyle et al. 2004). Creating an inventory for sediment sequences based exclusively on concentrations of anthropogenic pollutants is difficult, because of the potentially high levels of those same materials from non-anthropogenic sources (Boyle et al. 1998, Boyle et al. 2004). Conversely, a spheroidal carbonaceous particle inventory can be precisely determined since the only source of SCPs is from fossil fuel combustion (Boyle et al. 1998). This is not to imply that metal analyses would not enhance a SCP chronology. Metal analyses could support a SCP chronology, because atmospheric deposited metals from industrial emissions follow similar distribution patterns (Larson 2003). Therefore, peak concentrations of SCPs and atmospherically deposited metals should occur concomitantly. In addition to metal analyses, biological indicators, such as diatoms, would complement a SCP chronology. Diatom species that are pollutant tolerant would be most abundant when high concentrations of metals and SCPs are present (Office of Wetlands, Oceans, & Watersheds, EPA 2010).

2.1 Sediment Cores

Sediment sequences are collected by coring. Cores can be collected year round depending upon lake conditions and the method of coring. Olli (2008) took core samples during the winter when the bay was covered by thick ice. The ice was able to support the weight of humans and the equipment. No matter the season, the macrophyte zone should be avoided due to dredging (Olli 2008). In addition, lake areas that are most affected by resuspension and bioturbation should be avoided whenever possible (Odgaard et al. 1993). Part of a study on Lochnagar, a lake in Scotland, showed variability in the SCP sediment record across the loch basin. The cores taken from the center of the basin had SCP profiles typical of the 'standard' UK pattern. Cores taken from the deepest part of the basin showed unusual temporal patterns. They resembled cores from marginal areas of the basin. It should be noted that the deepest part of the basin was located relatively closer to the shore than the center of the basin (Rose 2007). The area of the basin that showed typical SCP profiles is also termed the depositional basin and this is where deposition of particles occurs. Unlike in lakes, the depositional basin in reservoirs is normally closer to the dam structure than the middle of the reservoir as seen in lakes. This is due to higher sedimentation rates upstream where tributaries enter the reservoir (Vukić and Appleby 2003).

2.2 Spheroidal Carbonaceous Particles in Lake Sediments

Spheroidal carbonaceous particles are a type of fly-ash that is emitted into the atmosphere during the combustion of fossil fuels. They are solely the result of human activities as they do not occur from natural processes (Larsen 2003). Wik and Renberg (1996) state that there is no standard terminology for SCPs, but the name "spheroidal carbonaceous particles" has been used the most throughout the research community in the United States and Europe. Other names include: carbonaceous particles, carbonaceous cenospheres, cokey matter, charcoal, and elemental particulate carbon, etc. (Wik and Renberg 1996).

SCPs are organic ash spheres that range in appearance from lightly perforated to sponge-like spheres (Figure 2.0) (Larsen 2003). The SCP matrix consists of mainly elemental carbon. Depending on the type of fuel that is combusting; other elements are dispersed through the matrix. In oil combustion, the major elements are vanadium (V) and sulfur (S) and the minor elements include: aluminum (Al), silicon (Si), sodium (Na), magnesium (Mg), potassium (K), calcium (Ca), iron (Fe), and copper (Cu) (Wik and Renberg 1996). In coal combustion, the major

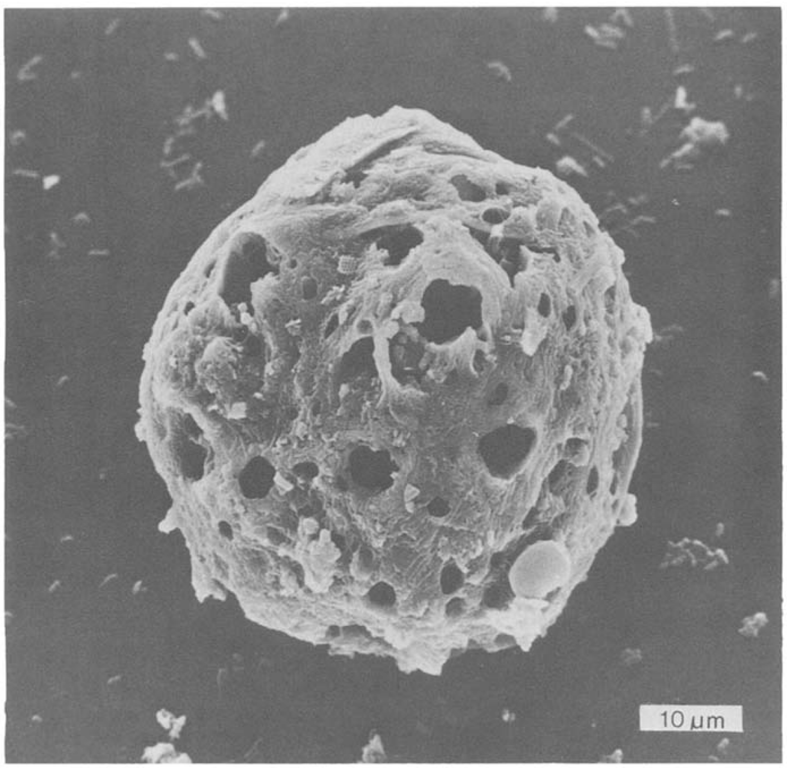

Figure 2.0: SCP prepared from lake sediments (Wik et al. 1986).

element dispersed in the carbon matrix is sulfur and the minor elements are V, Al, Si, Ca, and K (Wik and Renberg 1996).

The elemental carbon matrix makes SCPs very resistant to chemical degradation (Wik and Renberg 1996). Consequently SCPs are well preserved in sediments facilitating the study of SCPs in the United States, Sweden, Great Britain, Norway, Finland, Denmark, and Estonia. In the United States, SCPs have been analyzed from Lake Whitney, Lake Michigan, Green Lake in New York, and the PIRLA lakes throughout North America (Wik and Renberg 1996). SCPs patterns in these studies reflect the increased use of fossil fuels during the 20th century (Wik and Renberg 1996).

SCPs have been used as a mechanism for dating lake sediment cores (Rose et al. 1999), but ^{137}Cs and ^{210}Pb dating methods are commonly utilized (Science Museum of Minnesota 2013). ^{210}Pb analyses are the primary dating method and are validated with ^{137}Cs analyses since ^{210}Pb is prone to errors due to highly variable sedimentation rates and disturbed watersheds. ^{210}Pb focuses on human impacts from the last 100 to 200 years and ^{137}Cs analyses only provide a maker for 1964, which was the peak of atmospheric nuclear testing. The Chernobyl accident provides European sediment cores with another marker, 1986 (Science Museum of Minnesota 2013).

2.3 Metal Concentrations in Lake Sediments

In lake sediments, metal and SCP concentrations both indicate the atmospheric deposition of pollutants (Boyle et al. 2004). Birks et al. (1990) found that increases in Cu, Cr, Zn, and Pb concentrations reflected atmospheric contamination by deposition into lakes from fossil-fuel combustion emissions. However, heavy metal concentrations are complex due to various sources and pathways of occurrence. For instance, biogeochemical cycling creates natural fluxes of heavy metals in sediments; a classic example is lead (Pb) (Boyle et al. 2004). Trends in North America and Europe show that there is typically an up-core increase in Pb concentrations due to industrialization (Boyle et al. 1998). However, Norton et al. (1992) studied 30 lakes in the United States and found that Pb started to increase pre-industrialization (Boyle et al. 1998). This creates the need for isotopic data to date core sediments unless it is compared to another proxy such as SCPs (Boyle et al. 2004), which do not occur naturally (Rose 2007, Olli 2008).

Metal chronology without isotopic data and SCP comparison is an issue if the sedimentation rate of metals is too low to produce an anthropogenic signal. A weak anthropogenic signal may be detected using shorter core sections, but it is not guaranteed (Boyle et al. 2004). Metal analyses of sediment cores used throughout research apply different techniques depending on the instruments readily available. Induced coupled plasma atomic emission spectrometry (ICP-AES) and induced coupled plasma mass spectrometry (ICP-MS) are two instruments commonly used to analyze metals. However, ICP-AES detects a larger array of metals compared to ICP-MS. ICP-MS can detect arsenic, beryllium, cadmium, chromium, cobalt, iron, lead, molybdenum, selenium, and thallium. ICP-AES can detect all the same elements except selenium and arsenic, but it does detect aluminum, antimony, barium, calcium, copper, vanadium, magnesium, manganese, nickel, potassium, silver, sodium, vanadium, and zinc as well (EPA 1996).

2.4 Development of SCP Extraction Methods

Griffin and Goldberg (1979) were first to demonstrate the occurrence of SCPs in lake sediments. For SCP extraction, they used modified methods developed by Smith et al. (1975) to take into account sediments with higher organic matter. Dried sediments were ground and passed through chemical treatments with KOH, H_2O_2, HCL, and HF. Then infrared spectroscopy was used to determine the amount of elemental carbon. However, both techniques used an infrared method, which required large amounts of sediment (10 g of dry sediment). Therefore, these techniques did not allow for palaeolimnological analysis of recent environmental changes since they did not allow for interval sub-sampling. Interval sub-sampling is often desirable and advantageous, because a single core can be used for several different analyses including SCPs, metals, diatoms, and dating analyses (Wik and Renberg 1996).

Renberg and Wik (1985) developed a SCP extraction method that was fast, simple, and required a small amount of sediment which allows interval sub-sampling. The sediment is oxidized with hydrogen peroxide, washed with water, the suspension is homogenized, and aliquots are poured into glass Petri dishes. However, only SCPs larger than 5-10µm can be identified (Wik and Renberg 1996). Rose (1990, 1994) developed a fourth method that is sensitive to particles smaller than 5-10µm. It is very similar to Griffin &Goldberg (1975); however, the Rose method is more sensitive to low particle numbers and allows for interval sub-sampling (Wik and Renberg 1996). In addition, it is more accurate than Griffin & Goldberg (1975) due to more efficient extraction methods and higher microscopic magnification for particle counting (Rose 1990). It is also more sensitive than the Renberg & Wik method since particles as small as 1µm can be counted at 1000x magnification, but the standard magnification is 400x (Wik and Renberg 1996).

2.5 SCPs: Detecting Local Deposition

SCPs are transported by the wind, therefore larger concentrations and diameter sizes will be found immediately downwind and closer to a source. Particles greater than 10 microns are associated with being within 20 km of a source while particles smaller than 5 microns are associated with long range transport (Larson 2003). However, there are many variables that can affect the deposition of SCPs, such as precipitation and altitude (Larson 2003). It is also important to note that the distribution of particles emitted from point sources have changed over time. For instance, combustion techniques and emission controls have generally improved and industrialization may result in an increase of local sources while other local sources may no longer be operating (Wik and Renberg 1996).

CHAPTER 3

METHODS

3.0 Study Site: Industrial Region Selection

Dating a sediment core by regional SCP deposition requires a lake or reservoir to be located close to industrial fossil fuel combustion sources, such as steel mills. Dating analyses are complicated by long range transport SCPs, since regional deposited SCPs need to be isolated in order to compare concentrations with regional emission statistics or some other form of data that relates to regional emission statistics. Examples include a regional historical timeline of events involving industrial fossil fuel combustion and regional production levels.

3.0.1 Northeast Ohio: Mahoning Valley

Northeast Ohio (Figure 3.0) and specifically the Mahoning Valley (Figure 3.1) is an ideal region to date a sediment core by a SCP chronology. The Mahoning Valley includes portions of Mahoning and Trumbull counties in Ohio as well as Mercer and Lawrence counties in Pennsylvania. However, the two industrial hotspots include Warren in Trumbull county and Youngstown in Mahoning county (Cart et al. 2000). Industrial fossil fuel combustion in the form of the steel industry has its roots in the valley starting in 1802 when the first Ohio blast furnace was built in Poland Township, a suburb of Youngstown. By the 1870-s and the 1880-s, steel replaced iron as the primary metal produced in Ohio. The Mahoning Valley shifted away from iron production and toward steel production as well during the 1900-s (Ohio Steel Council 2012).

Even before the United States entered the Second World War (1940-1945), the steel industry in the Mahoning Valley was filling steel orders for other countries (Cart et al.

2000). When the U.S. entered the war, the steel industry was at full production capacity. Even during times of high production, the Mahoning Valley steel production was occasionally interrupted usually in the form of strikes. The longest strikes included a 31 day strike in 1949, a 55 day strike in 1952, and a 116 day strike in 1959 (Cart et al. 2000).

Figure 3.0: Northeast Ohio- Mahoning Valley (Google Earth 2013).

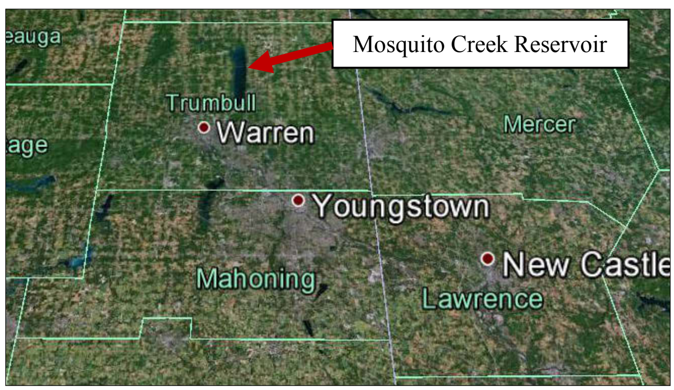

Figure 3.1: Mahoning Valley (Google Earth 2013).

September 19, 1977 was deemed "Black Monday" and marked the fall of the steel industry in the Mahoning Valley (Cart et al. 2000). This was the day that the Youngstown Sheet & Tube announced their closing. One by one other major steel mills followed in suit. This hurt the valley economy substantially, because over 39,000 people were employed by the steel mills as of 1977. There still is a presence of steel mills in the area, but the number of mills and their employees has dwindled greatly. By the year 2000, there were only approximately 5,800 steel mill employees (Cart et al. 2000).

3.1 Study Site: Reservoir Selection

The ideal location to take a core from a lake or reservoir in the Mahoning Valley would be relatively close and downwind of Youngstown and Warren. The regional prevailing wind direction varies, but it is primarily from the West South-West direction (National Climatic Data Center 1998). Possible sampling sites are in blue squares in Figure 3.2, and the site chosen, Mosquito Creek Reservoir, is in the red square. Due to Youngstown's primary long term wind directions, Mosquito Creek Reservoir may not be the most ideal site; however, it is in very close in proximity to Warren and it lays in the general downwind direction from sources in Warren.

3.1.1 Mosquito Creek Reservoir

Mosquito Creek Reservoir (MCR) is located in Trumbull County and in the Mahoning River Watershed (Figure 3.2). The first settlers arrived in the area in 1805 and cleared the surrounding forest for agriculture (Ohio State Parks, Cited 2012). Agriculture was the first and most prominent industry in the area, but other industries included feed and flour mills, cheese, dairy and canning factories, mercantiles, and lumberyards (Ohio State Parks, Cited 2012). Under the Federal Flood Control Act in the 1930's, plans were established to dam Mosquito Creek to alleviate floods and water shortages along the Mahoning River, which receives water from MCR (Ohio State Parks, Cited 2012; Cart et al. 2000). The damming of MCR along with the damming of Lake Milton and the Berlin Reservoir gave industries up and down the Mahoning River access to more than 75 billion gallons of water for the cooling stage of steel production (Cart et al. 2000).

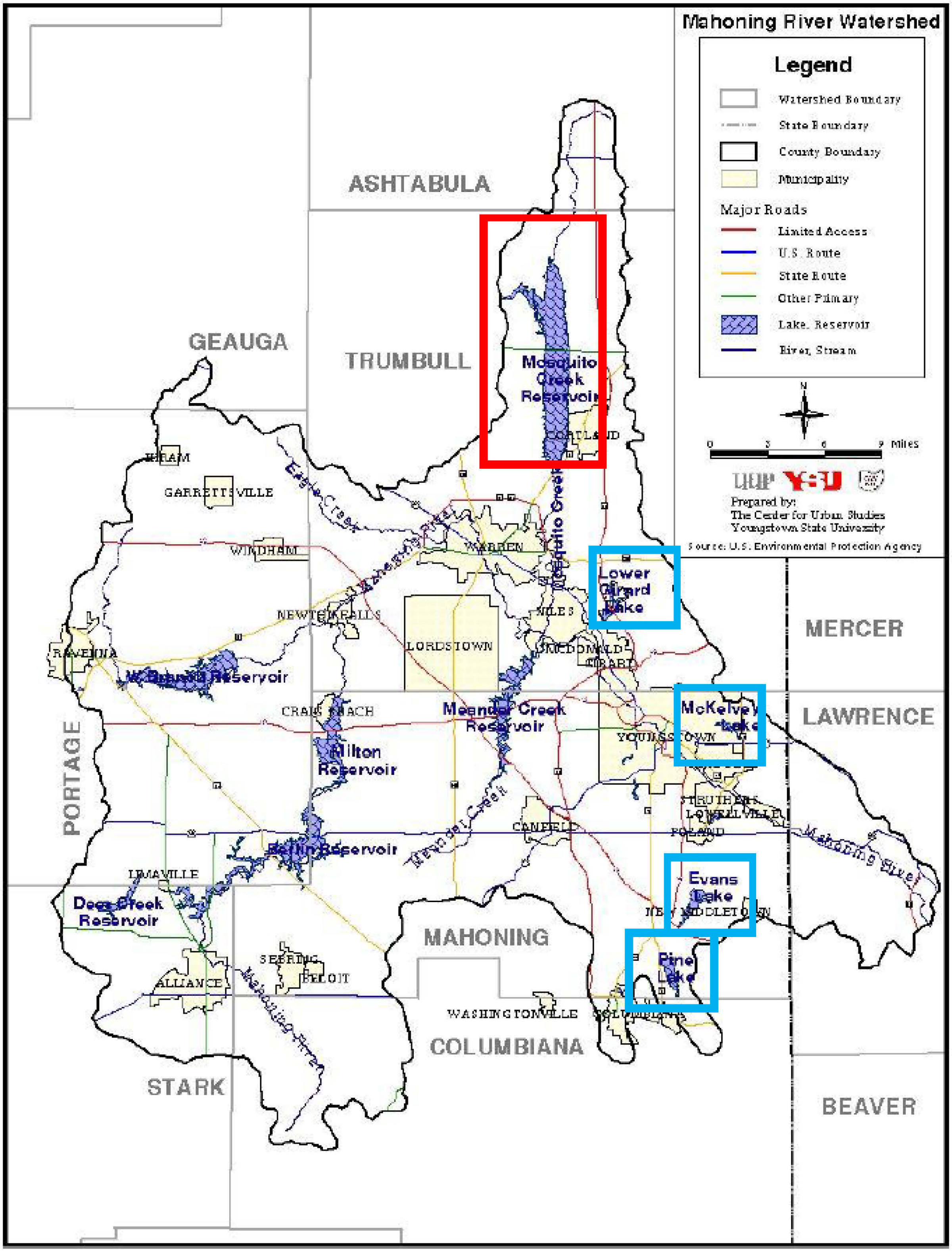

Figure 3.2: Mosquito Creek Reservoir in Trumbull County, Ohio (Center for Urban Studies, Youngstown State University 2001).

The MCR dam was completed in April 1944 and held a capacity of 34 billion gallons of water that covered 7,850 acres of land. In addition to flood control, the Mosquito Creek Reservoir provides a domestic water supply for the city of Warren and pollution abatement for the industrialized steel production along the Mahoning River (Ohio State Parks, Cited 2012). As of 2004, the reservoir covered only 7,241 acres of land due to sedimentation (Figure 3.3) (Ohio Division of Wildlife 2004). Mosquito Creek Reservoir is now part of the Mosquito Lake State Park and is open to recreational activities such as boating and fishing. Re-growth has occurred around the lake and it mainly consists of beech-maple stands (Ohio State Parks, Cited 2012).

3.2 Field Methods

The MCR sediment core was taken on August 26, 2012. It was 86°F, mostly sunny, and there were 5-8 mi/hr winds. The sediment core was taken with a 5-cm diameter piston corer supported by a tripod on a pontoon boat in 6.1m of water in the depositional basin (Figure 3.3). The depositional basin was determined by locating the deepest part of the reservoir near the dam by using the bathymetric map (Figure 3.3) and a simple weight and rope method. The deepest parts of the reservoir were 7.3m. However, these were very small areas and they were unlikely to be found using a simple weight and rope method. The basin's majority depth was at 6.4m near the original creek.

The sediment core was taken relatively close to the original creek as well as being near to the dam to avoid high sedimentation rates (Figure 3.4). Even though the majority of the depositional basin was at a depth of 6.4m, this was probably not the case in the summer of 2012. Water levels were extremely low and the map depths were based on normal summer pool levels. Also there could be slight changes to the basin since the

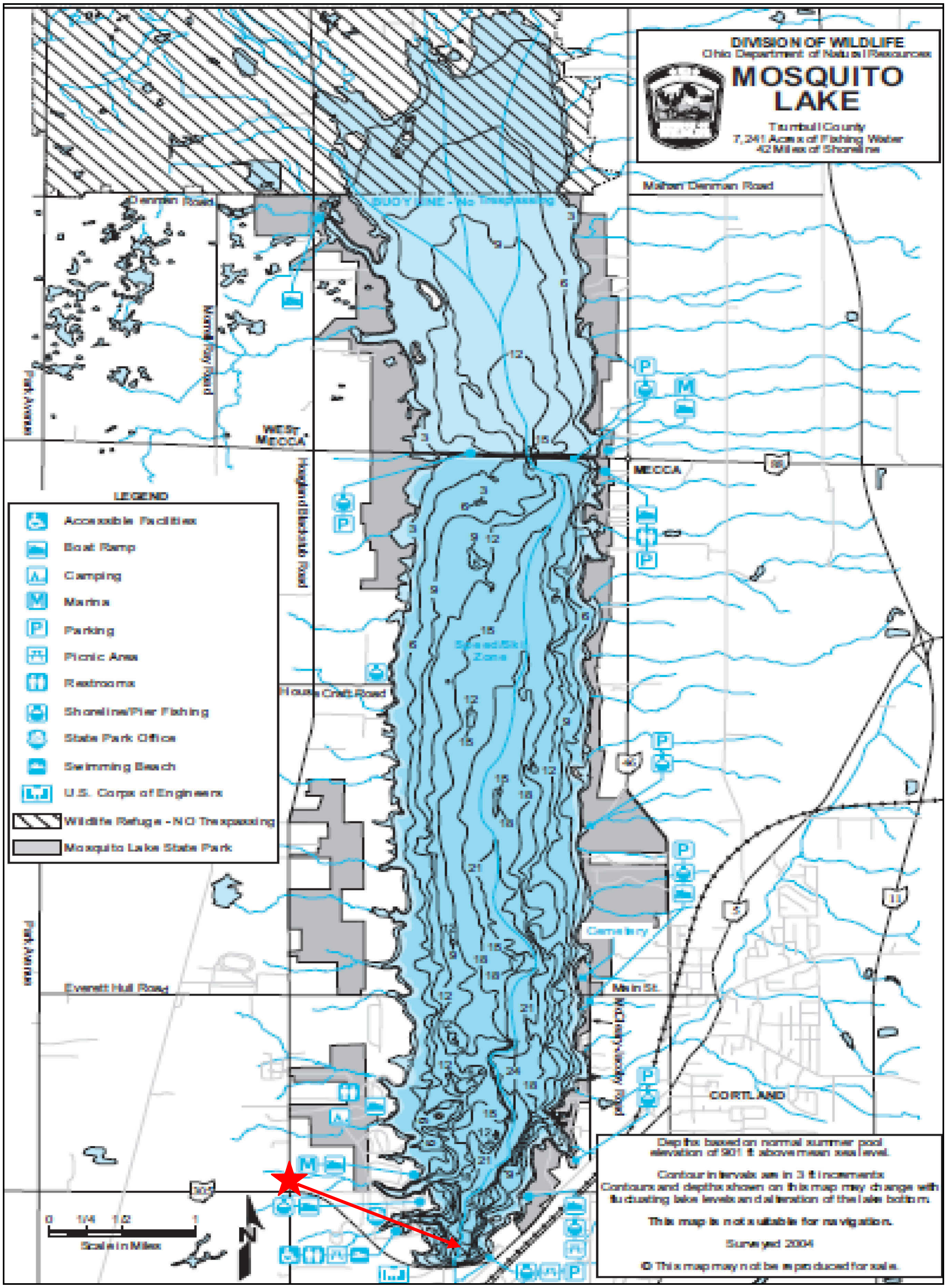

Figure 3.3: MCR Bathymetric Map (Ohio Division of Wildlife 2004).

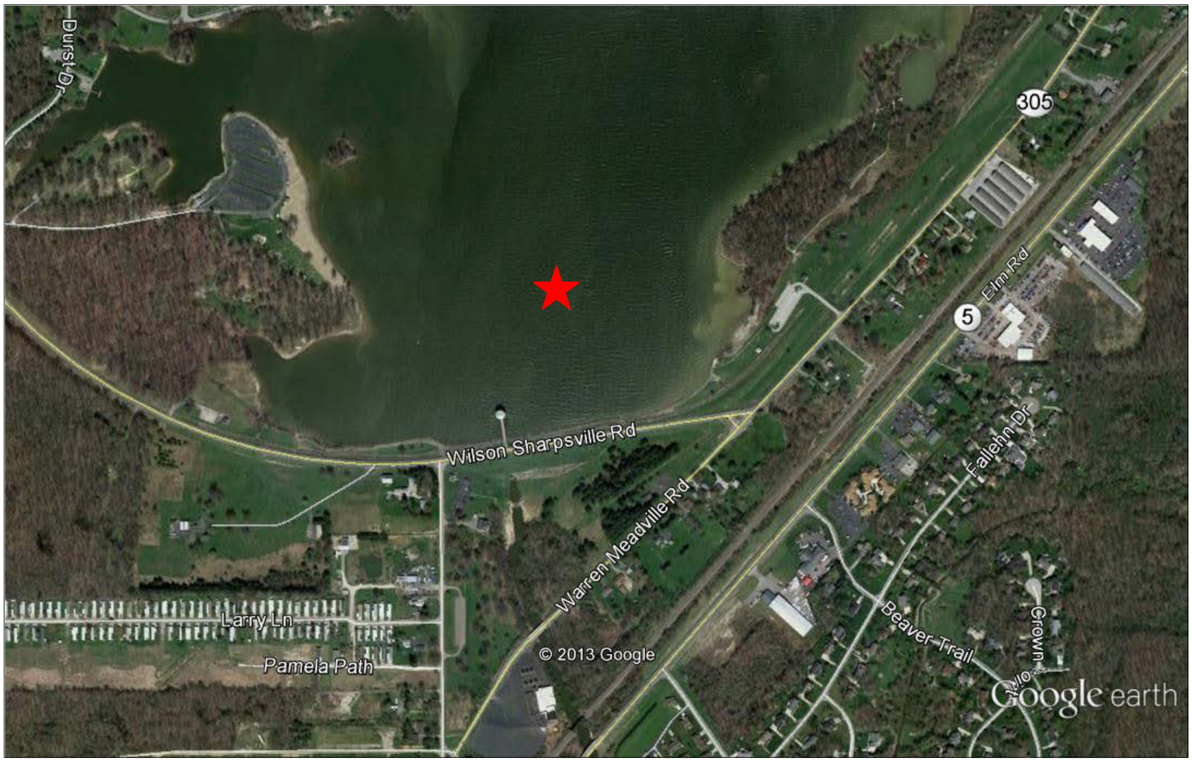

Figure 3.4: MCR Sediment Core Location (Google Earth 2013).

reservoir was surveyed in 2004 and the core was sampled 8 years later. Therefore, sampling at a depth of approximately 6.1m seemed acceptable.

The sediment core was kept vertical to avoid mixing, and once on shore it was sectioned with a knife at a 1.12 cm resolution and placed in labeled Culture dishes. The Culture dishes were then placed in two Ziploc® bags and stored at ~4°C to avoid loss of moisture. There were a total of 111 sections, but the number was reduced to 104 since only 101 sections contained reservoir sediment. Roots appeared at the 102nd section; therefore, this locates the end of the sediment core (101st section).

3.3 Laboratory Methods: Percent Moisture and Loss on Ignition

The sediment core sections were sub- sampled using a #2 cork borer. Section edges were avoided to prevent edge effects such as smearing, which is caused by extruding the sediment sections from the corer. Approximately 0.2g of wet sediment was weighed for each section and placed in labeled test tubes with Teflon® lined caps for SCP analysis. The same procedure was completed for diatoms and inorganic ash spheres (IASs), two possible future analyses. All wet weights are located in Appendix A and 4 replicates were prepared for three evenly placed sections: #'s 31, 61, and 91 for SCPs; #'s 32, 62, and 92 for IASs; and #'s 33, 63, and 93 for diatoms.

3.3.1 Percent Moisture

Most of the remaining sections (~20g) were placed in labeled aluminum weighing dishes and dried at 105°C for 24 hours in a gravity drying oven. After cooling in a desiccator, the samples were weighed and the percent moisture was calculated. The sediment was then ground with a mortar and pestle and stored in capped and labeled glass vials.

3.3.2 Loss on Ignition

The vials with sediment were allowed to dry overnight in the desiccator to remove moisture that may have been absorbed during grinding. One to 2g of dried sediment was weighed into 10mL tared crucibles and placed in a muffle furnace at 450°C for 4 hours. The crucibles were cooled in the desiccator for 24 hours before being weighed again.

3.4 Laboratory Methods: SCP Analyses

3.4.1 SCP Digestion

The SCP digestion followed Rose 1990 and 1994. The ~0.2g of sediment in test tubes were treated with 5mL of nitric acid using a Repipet®, capped with Teflon® lined caps, and immersed in a boiling water bath for 2 hours. The nitric acid digested the organic fraction of the sediment samples. The contents were quantitatively transferred into labeled 15mL polypropylene centrifuge tubes. A black residue was found on some of the test tube lips, but it did not seem like the residue contaminated the samples and it was wiped off before transferring the contents into the centrifuge tubes. The samples were washed 3 times by bringing the volume to 15mL with DI water and then mixing and centrifuging the samples for 5 minutes at 1500 rpm and decanting the DI water while avoiding loss of sample.

To remove chlorates and carbonates, the samples were digested with 3mL of hydrochloric acid and heated in a boiling bath. After two hours, the samples were washed 3 times. The final Rose (1990 and 1994) digestion step that removes silica was slightly altered. During practice digestions, it was found that two 3mL hydrofluoric acid boiling baths resulted in less background noise than one boiling bath. The samples were washed 3 times in between the two hydrofluoric acid baths.

After the two hydrofluoric acid treatments, the samples were washed with DI water 12 times each for slide preparation. When washing 5 times each during practice, the solution was still very cloudy. The decanting solution started to clear around the 8^{th} wash. To make sure SCPs were not being lost during the process, a solution slide was made and only one SCP particle was found. Therefore, it was believed that the loss of particles would not be great enough to alter the end results.

3.4.2 Slide Preparation

After the 12^{th} wash, the samples were filled to 5mL with DI water and homogenized and poured onto 22x22mm glass cover slips (#1.5) in 30mm tissue Culture dishes (Falcon 35 3001) on a hot block. The hot block was turned on low heat to increase the evaporation rate. The cover slips were mounted using Zrax® mountant on glass slides. The slides were heated on the hot plate, but at about 135°C to evaporate the toluene in the mountant. Once cooled the slides were stored and ready for analysis using a Bausch & Lomb Balplan transmission light microscope.

3.4.3 Identifying SCPs

Many images of SCPs in the literature are obtained using scanning electron microscopes as in Figure 2.0. If a transmission light microscope is used as in this study, special care must be given to the images since non-SCPs can easily be mistaken for SCPs (Figure 3.5) (Clark 2007). Clark (2007) states the following guidelines on how to identify SCPs using a transmission light microscope:

1. SCPs usually are between 1 to 50 microns in diameter.
2. They appear black/opaque, but may have holes and a lacy texture.
3. The perimeter should be very smooth and spherical.
4. If there is any doubt that a particle is not a SCP, the rule is that it is not a SCP.
5. More remote areas will have smaller diameter SCPs. This is dependent on the source, prevailing wind direction, fuel burned, and etc.
6. SCP size alters with chronological stratigraphy. Therefore, the types of fly ash particles change with the type of fuel burned (oil versus coal).
7. Focusing the microscope in and out will show a three dimensional image.

3.4.4 Counting Methods

The original slide labels were covered and re-labeled randomly to avoid bias from knowing where the sample's location was in the sediment core. Each slide was then analyzed by viewing each field along a random transect that was chosen from following a random integer generator chart of 40 numbers between 3 and 48. The first two transects (#'s 1 and 2) and the last two transects (#'s 49 and 50) of each slide and the first two and last two fields of each transect were avoided due to edge effects. This resulted in one transect and 46 fields per slide. Each field and each slide was analyzed for the total number of SCPs and the number of SCPs for three arbitrary size categories: small (<6.25µm), medium (6.25 – 12.5µm), and large (>12.5µm). The size categories were chosen due to the microscope's calibrated grid measurements. The raw SCP data for each slide is located in Appendix D.

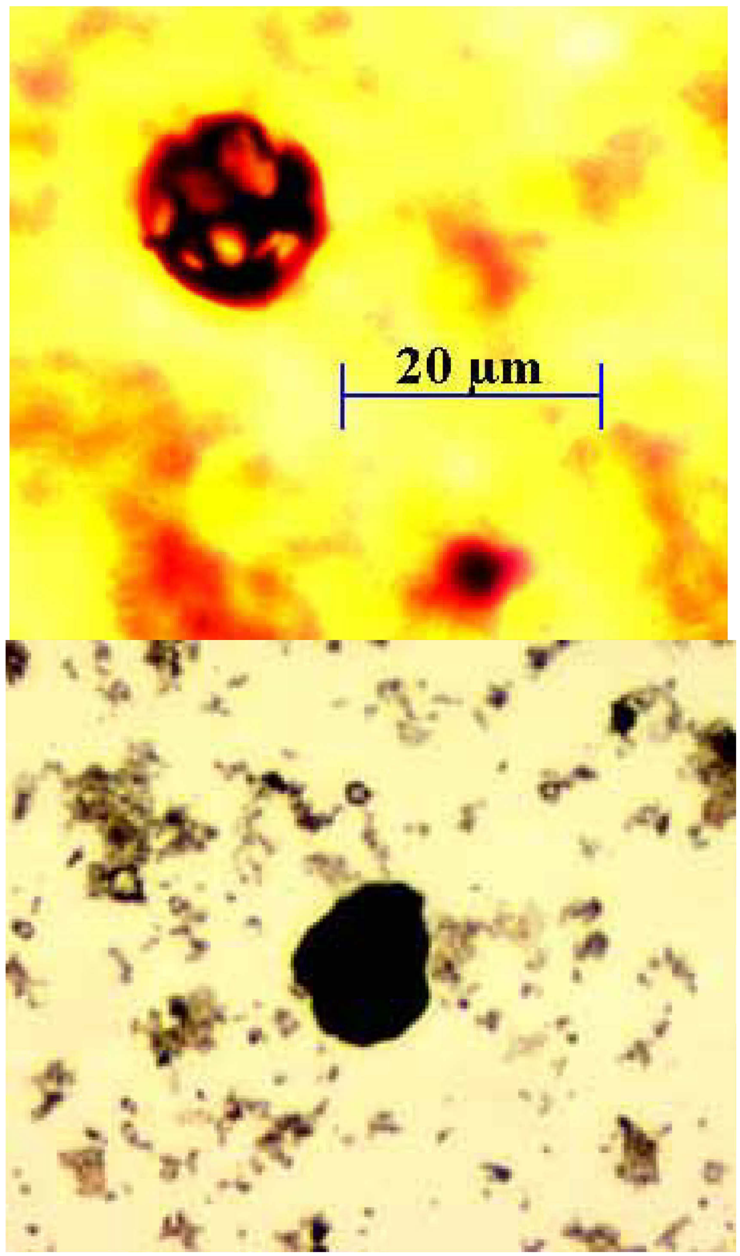

Figure 3.5 a, b: SCP (left) and a non-SCP (right) (Clark 2007).

3.5 SCP Chronology and Statistical Methods

3.5.1 Regional Historical Data Involving the Mahoning Valley Steel Mills

To create an SCP chronology, the SCP sediment abundance profile must be corresponded to regional SCP emissions or some other data that relates to SCP emissions, such as a regional historical timeline of events involving industrial fossil fuel combustion or regional, yearly steel production. Steel production levels for the Lower Mahoning River Basin from 1969 to 1984 (Figure 3.6) were obtained from the Ohio Environmental Protection Agency (OEPA) (1984). The Lower Mahoning River Basin encompasses industrial fossil fuel combustion point sources in Warren and Youngstown (OPEA 1996). The next step in constructing a SCP chronology is to determine which particle size to utilize for a comparison with the raw steel production.

3.5.2 SCP Size Classifications Associated with a Regional Influence

The long range transport of SCPs is very possible in the sediment core since MCR is relatively close to other industrial regions: Cleveland, Akron, and Canton, Ohio and Pittsburgh, Pennsylvania (Figure 3.7). Therefore, particles smaller than 5µm should not be included in the analyses. This eliminates using the small size group (SCPs < 6.25µm) and in turn the total number of SCPs. Medium (6.25-12.5µm) and large (>12.5µm) SCPs are left. Particles larger than 10µm are associated with local sources, but the MCR samples had relatively low amounts of large particles (>12.5µm) and many samples did not have any large SCPs; consequently they could not be utilized alone, thus the medium and large particles were combined for comparison with raw steel production.

3.5.3 Medium and Large SCP Data Manipulation

SCP concentrations were calculated in grams per dry weight (gDW^{-1}) (Appendix

E) then, "smoothed" using the T4253H calculation in Statistical Packages for the Social Sciences (SPSS) (Appendix F). T4253H compensates for seasonal depositional differences and core samples representing less than a year of deposition. SCP replications were used to calculate standard deviation estimates from the coefficient of variance to account for SCP identification error during counting (Appendix G).

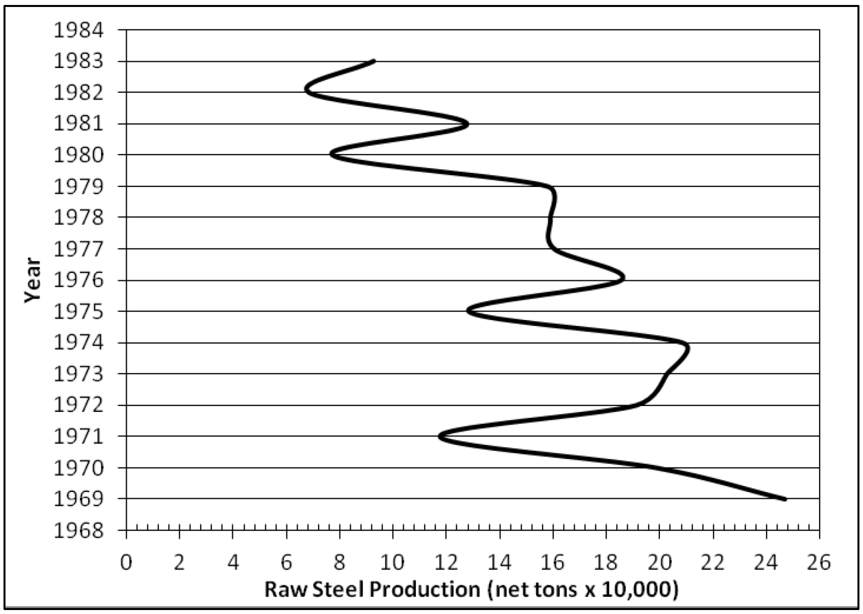

Figure 3.6: Lower Mahoning River Basin Raw Steel Production (OEPA 1984).

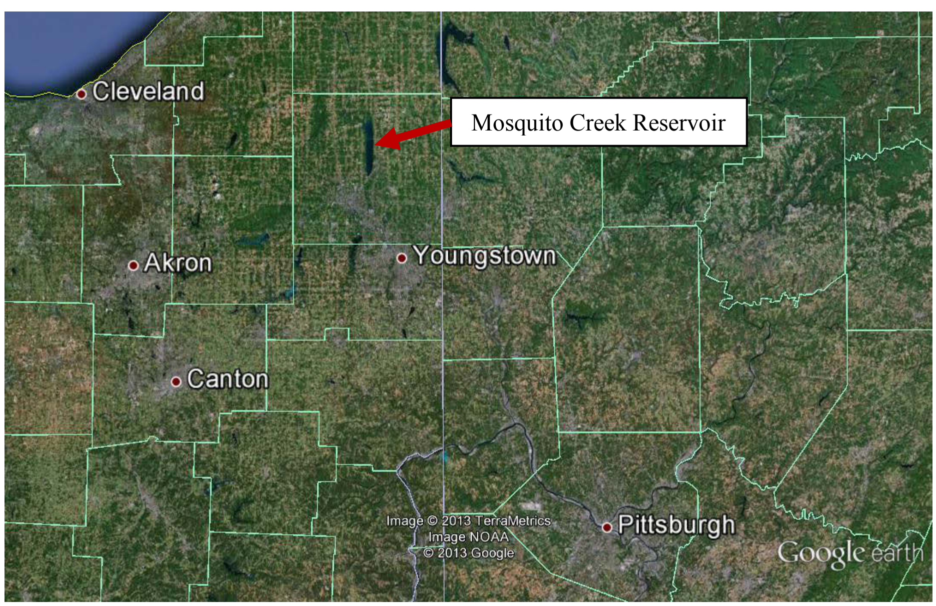

Figure 3.7: Industrial Regions Surrounding the Mahoning Valley (Google Earth 2013).

3.5.4 Statistical Methods: SCP Concentrations and Raw Steel Production

Since the steel data was reported by years and the SCP concentrations were analyzed by depth, the low and high peaks of the steel production were matched up with the low and high peaks of the SCP concentrations using Microsoft Excel. This allows the steel data to be plotted by depth and since the production levels have known dates, sediment depths can be dated. A Pearson Product-Moment Correlation Coefficient was calculated using SPSS to see if there was a correlation between the raw steel production levels and the corresponding smoothed medium and large SCP concentrations.

3.6 Laboratory Methods: Metal Analyses

The metals of concern are beryllium, calcium, cadmium, chromium, copper, lead, magnesium, potassium, nickel, sodium, vanadium, and zinc. All these metals except for lead and zinc are dispersed in the SCP matrix. Lead and zinc were included due to their association with steel production, and iron and aluminum were omitted since they occur naturally in the region's soils. Induced coupled plasma atomic emission spectrometry (ICP-AES) methods (Method 3050B, EPA 1996) were used to analyze the sediment geochemistry. Phosphorous was also analyzed using the same methods even though Method 3050B does not include phosphorous in its list of elements for recommended determinative techniques. Even though Phosphorous is not a metal, it is included in the metal analyses in this study for the sake of simplicity.

3.6.1 Metal Digestion

The MCR sediment samples for ICP- AES, Method 3050B (EPA 1996) was followed. Samples of 0.500g were weighed from the grounded sediment sections in polypropylene digestion vessels and each section was represented by two individual samples. Then 5mL (1:1) of nitric acid and DI water was added to each sample, and the samples were heated to 95°C in the Environmental Express HotBlock® for 15 minutes. After allowing the samples to cool, 5mL of nitric acid was added and the samples were refluxed at 95°C for 2 hours. Next the samples were completely cooled and 2mL of DI water and 1mL of peroxide (30%) was added. The samples were placed back in the HotBlock and heated again at 95°C for 2.5 hours. Subsequently, 5mL of concentrated hydrochloric acid was added and the samples were allowed to heat for 15 minutes after reaching 95°C. Finally, the samples were cooled completely and were diluted to 50mL.

The HotBlock could hold a maximum of 45 digestion vessels and there were 208 MCR samples; therefore, the samples were prepared in groups. A blank sample, two spiked samples, and two marine sediment samples were added to each group and treated as if they were the MCR sediment samples for quality assurance and quality control. The marine sediment is Standard Reference Material® 2702 from the National Institute of Standards & Technology (2004).

3.6.2 Metal Data Manipulation and Statistical Methods

The MCR sediment samples as well as the marine sediment and spike samples were run through the Thermo Scientific iCAP 6000 Series Induced Coupled Plasma Spectrometer®. Each element had multiple wavelengths, but only one could be used in analyses; therefore, the wavelength that showed the most typical bell curve and showed metal concentrations that fell within the standard concentrations for the marine sediment samples was chosen. As for the MCR core, each section had two samples; therefore, the concentrations at each depth were averaged and multiplied by a dilution factor of 100 since the original samples (0.500g) were diluted to 50mL. To compare these concentrations with the SCP data as well as the raw steel production levels (Table 4.1) and to calculate Pearson Product-Moment Correlation Coefficients, the metal concentrations had to be smoothed using the T4253H calculation from SPSS. The original metal concentrations for the wavelengths chosen and the smoothed concentrations are located in Appendix H. The marine sediment and spike samples were analyzed for quality assurance and control. The percent recovery calculations for the marine sediment and spikes in an addition to the calibration limits are found in Appendix I.

CHAPTER 4

RESULTS

4.0 Percent Moisture and Loss on Ignition

Moisture generally decreased with sediment age (Figure 4.0). The first section (1.12cm) consisted of 79.4% moisture and the last sediment sample was 42.1% moisture. The organic carbon content decreased with sediment age from about 6.5-7% near the surface to 4.0% at 70cm, then increased to 6.1% organic carbon (Figure 4.1).

4.1 Smoothed Medium and Large SCP Concentrations

SCPs from section 88 (98.56cm) and section 104 (116.48cm) were omitted. Sample 88 had too much background noise and SCPs could not be counted. Sample 104 was used during digestion practices since it was a soil section and not a sediment section. It did not go through the same procedures as the rest of core samples, therefore it was omitted.

Small SCPs (<6.25µm) were omitted from analyses since particles less than 5µm are associated with long range transport. Particle diameters of 10µm and greater are associated with local sources, but there were very low concentrations of large particles (>12.5µm) in the MCR core. Therefore, medium and large SCPs were combined for analyses. Figure 4.2 shows the smoothed medium and large SCP concentrations as well as the standard deviation estimates due to identification and counting errors. There is a noticeable decrease in concentrations since the damming of the reservoir in 1944 signified by the 101st section (113.12cm). Concentrations were as high as 115.05 SCPs gDW^{-1} (115.36cm) in the soil sections and as high as 102.57 SCPs gDW^{-1} (113.12cm) in the sediment sections. Concentrations were the lowest, 8.86 SCPs gDW^{-1}, at 66.08cm. In

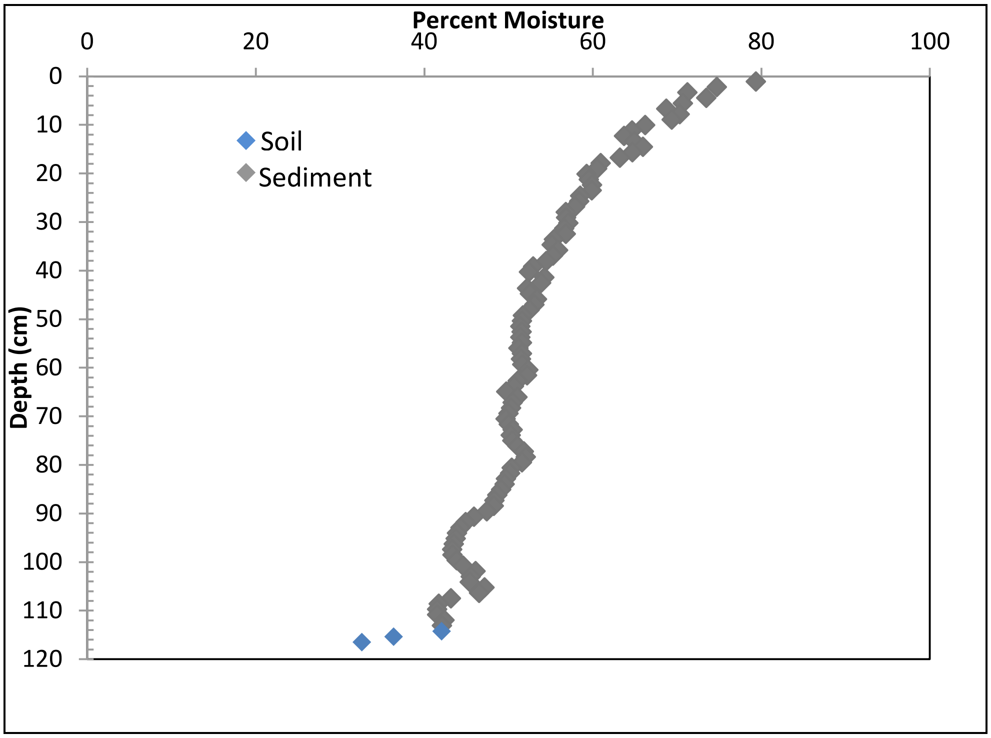

Figure 4.0: MCR Sediment Core – Percent Moisture.

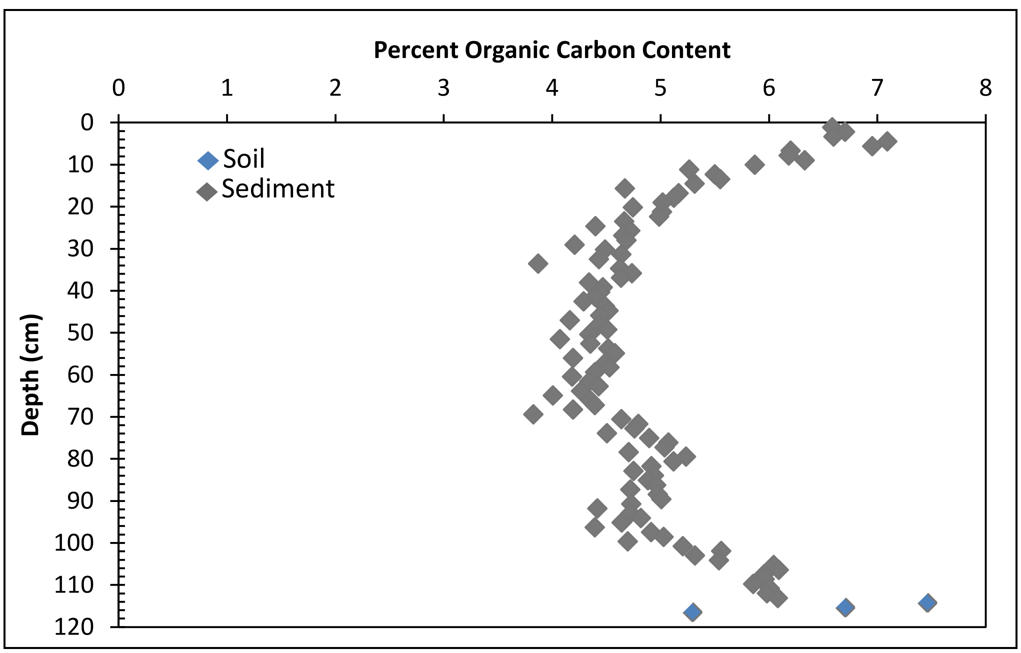

Figure 4.1: MCR Sediment Core – Percent Organic Carbon Content.

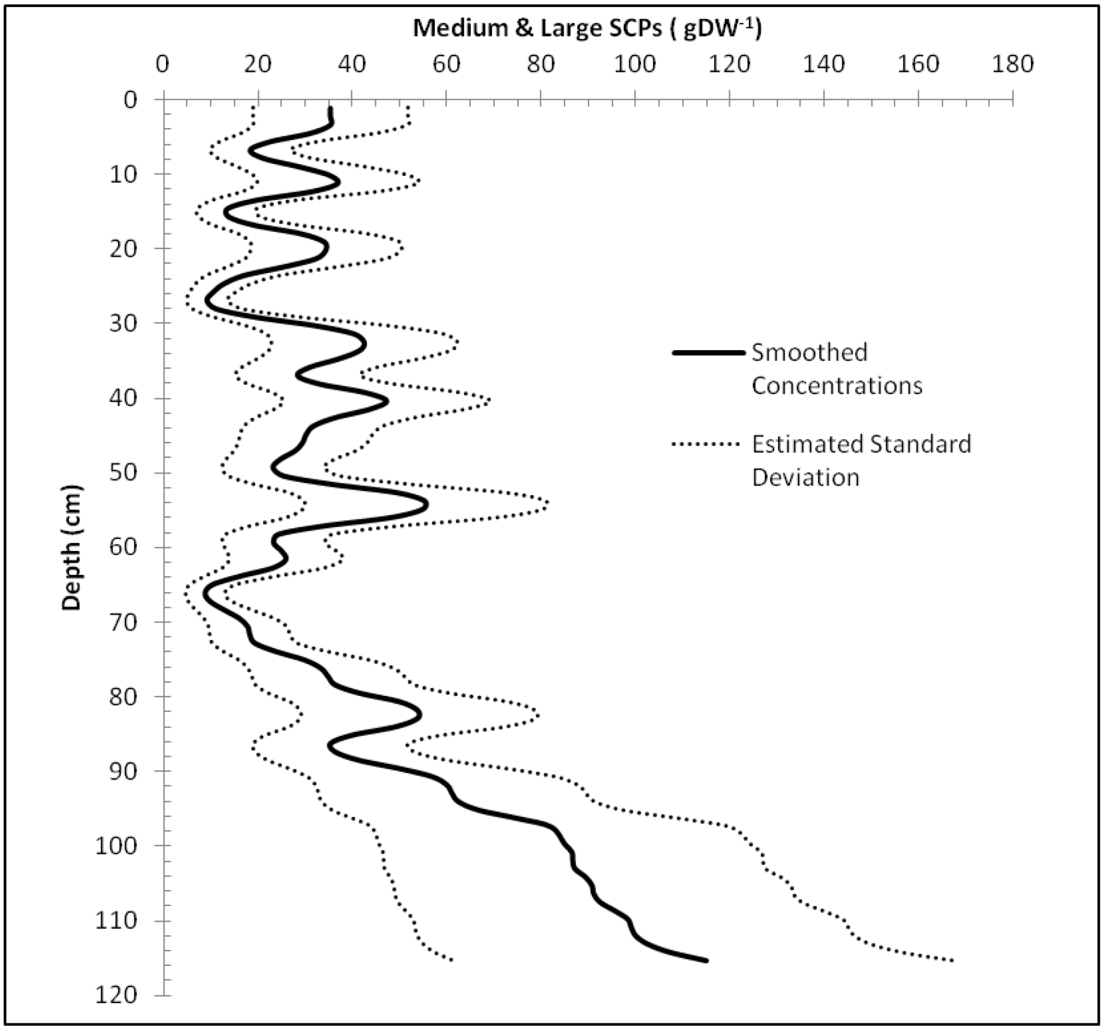

Figure 4.2: Smoothed Medium and Large SCP Concentrations.

addition to the general decrease in concentrations since 1944, there are obvious high and low peaks.

4.3 SCP Chronology

The OEPA report (1984) listed yearly production levels between 1969 and 1983. However, the SCP data is described by depth and sedimentation rates are not constant from year to year. In order to compare the two sets of data, the characteristic high and low peaks of the raw steel production levels were aligned with the high and low peaks of the SCP data. This allowed the raw steel data to be plotted by depth (Figure 4.3 a, b).

Notice that the original contour of raw steel production is unchanged. This is important, because manipulating the data by moving the peaks of raw steel production to match up with other SCP peaks completely morphs the original pattern.

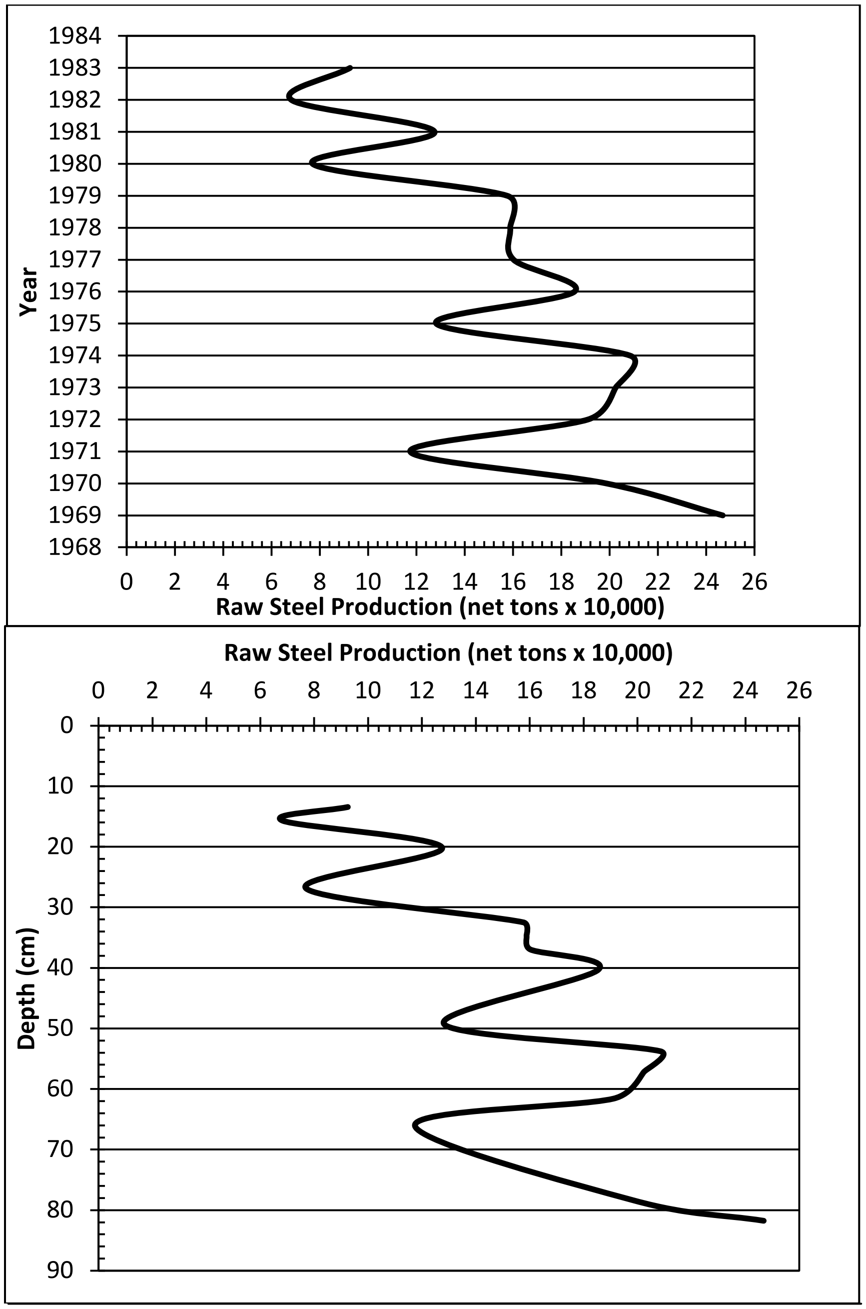

Figure 4.3 a, b: Raw Steel Production described by Year and Depth.

Since the steel data can now be plotted by depth, a direct comparison with SCP concentrations can be done (Figure 4.4). A Pearson Product-Moment Correlation Coefficient was calculated to determine if there was a relationship between raw steel production for the Lower Mahoning River Basin and smoothed medium and large SCP concentrations from Table 4.0. There was a very strong, positive correlation ($r = 0.827$, $N = 15$, $p<0.001$) (Figure 4.5). The $r = 0.827$ and $p<0.001$ supports a SCP chronology; and since the dates (years) of the productions levels are known, the sediment core can be dated (Figure 4.6 and Figure 4.7). The two previously known dates include 2012 at a depth of 1.12cm and 1944 at 113.12cm. The Pearson Correlation outputs are located in Appendix J.

Table 4.0: Corresponding Variables for Raw Steel and Smoothed Medium and Large SCP Concentrations.

Sediment Depth (cm)	Year	Raw Steel (net tons)	SCPs (gDW^{-1})
13.44	1983	92500	19.71
15.68	1982	68200	13.9
20.16	1981	127500	34.4
26.88	1980	77000	9.24
32.48	1979	157600	42.56
34.72	1978	158800	37.08
36.96	1977	160200	28.46
40.32	1976	185400	47.3
49.28	1975	128200	23.24
53.76	1974	208400	55.39
57.12	1973	202500	33.79
61.60	1972	191000	25.96
66.08	1971	117400	8.86
78.40	1970	198600	36.43
81.76	1969	246800	53.8

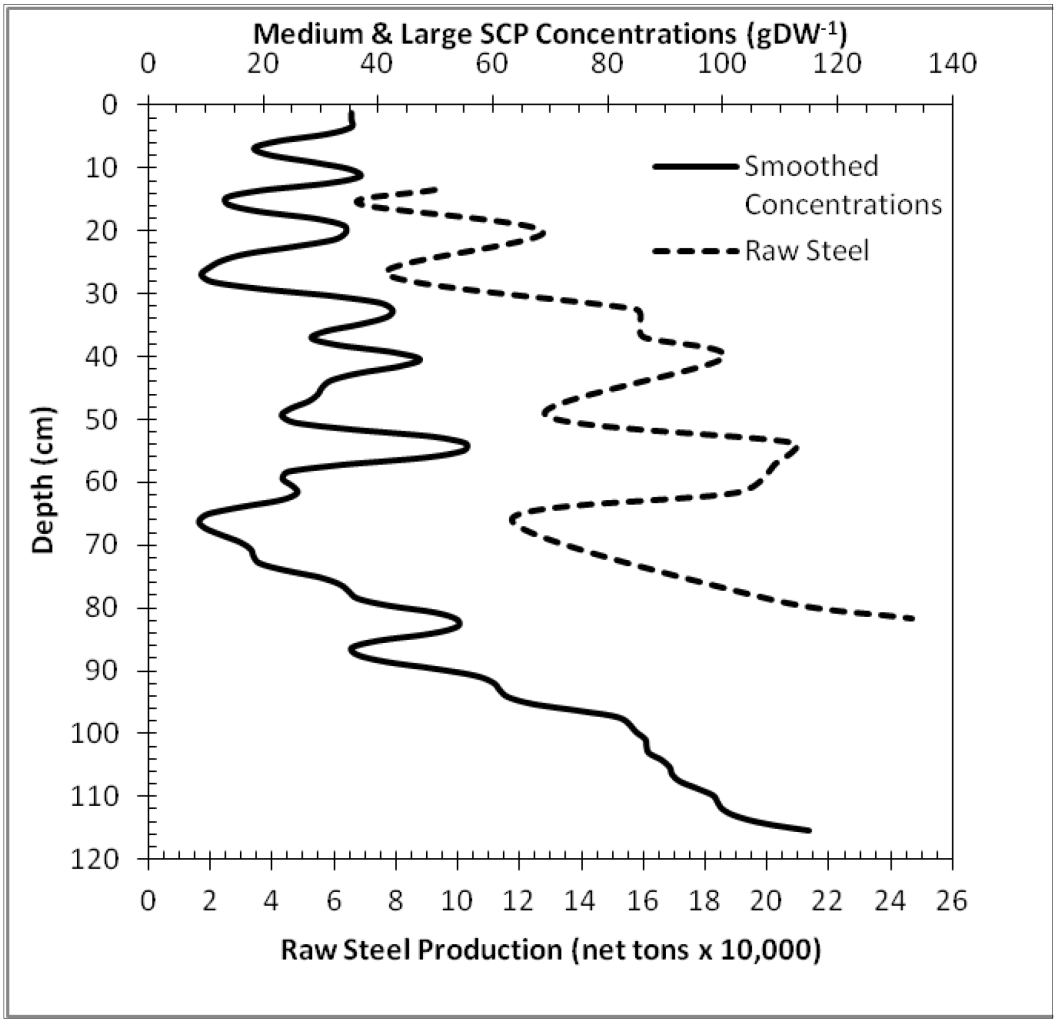

Figure 4.4: Raw Steel Production and Smoothed Medium & Large SCP Concentrations.

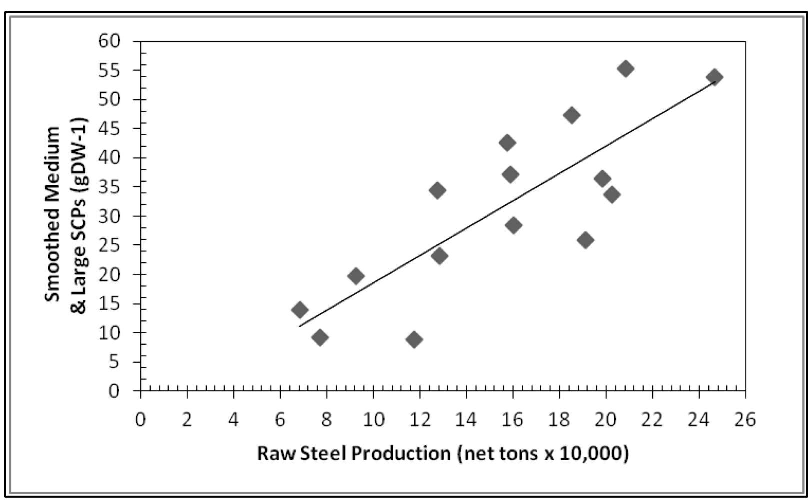

Figure 4.5: Raw Steel Production vs. Smoothed Medium & Large SCP Concentrations.

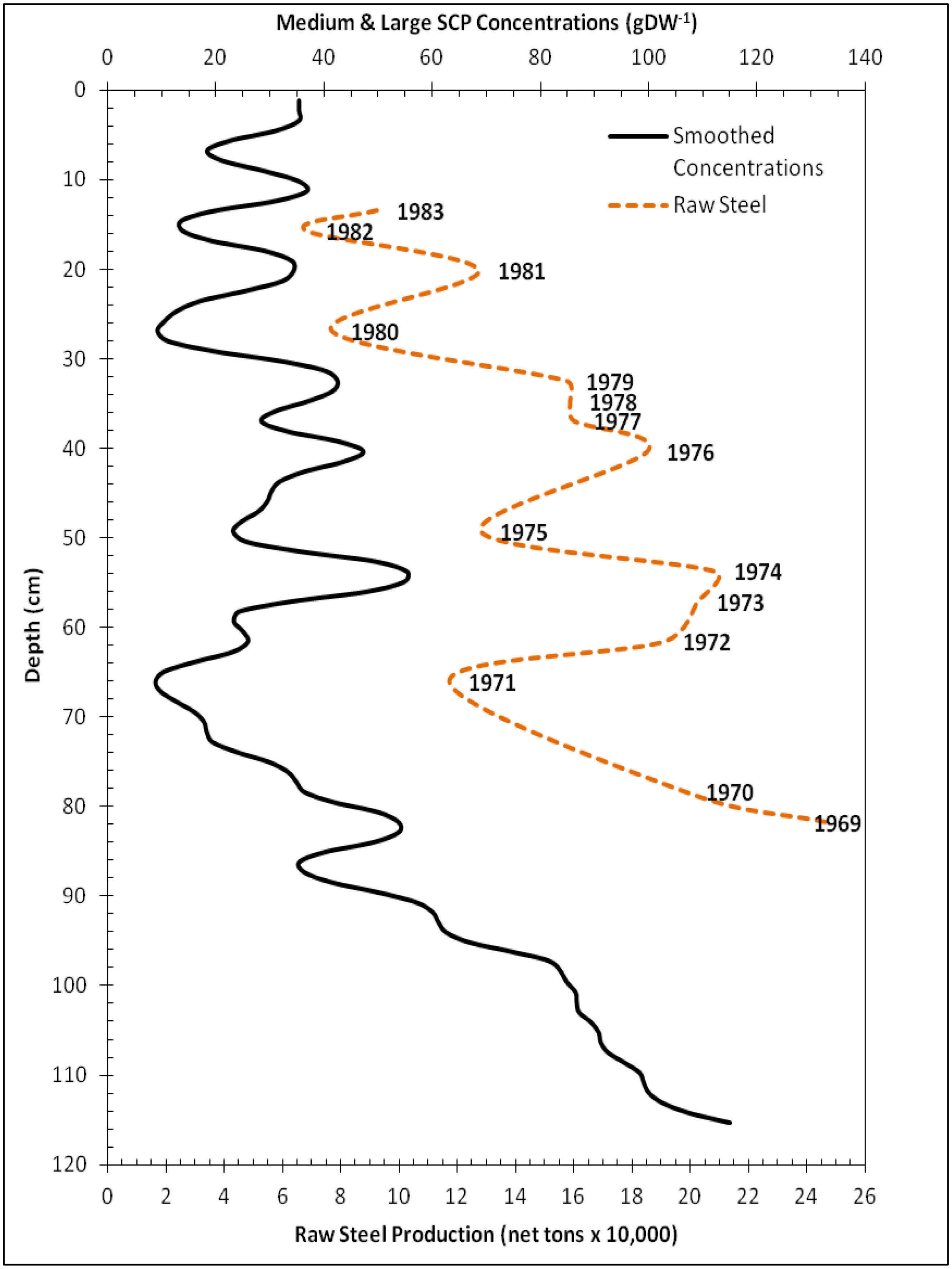

Figure 4.6: Raw Steel Production and Smoothed Medium & Large SCP Concentrations with Dates.

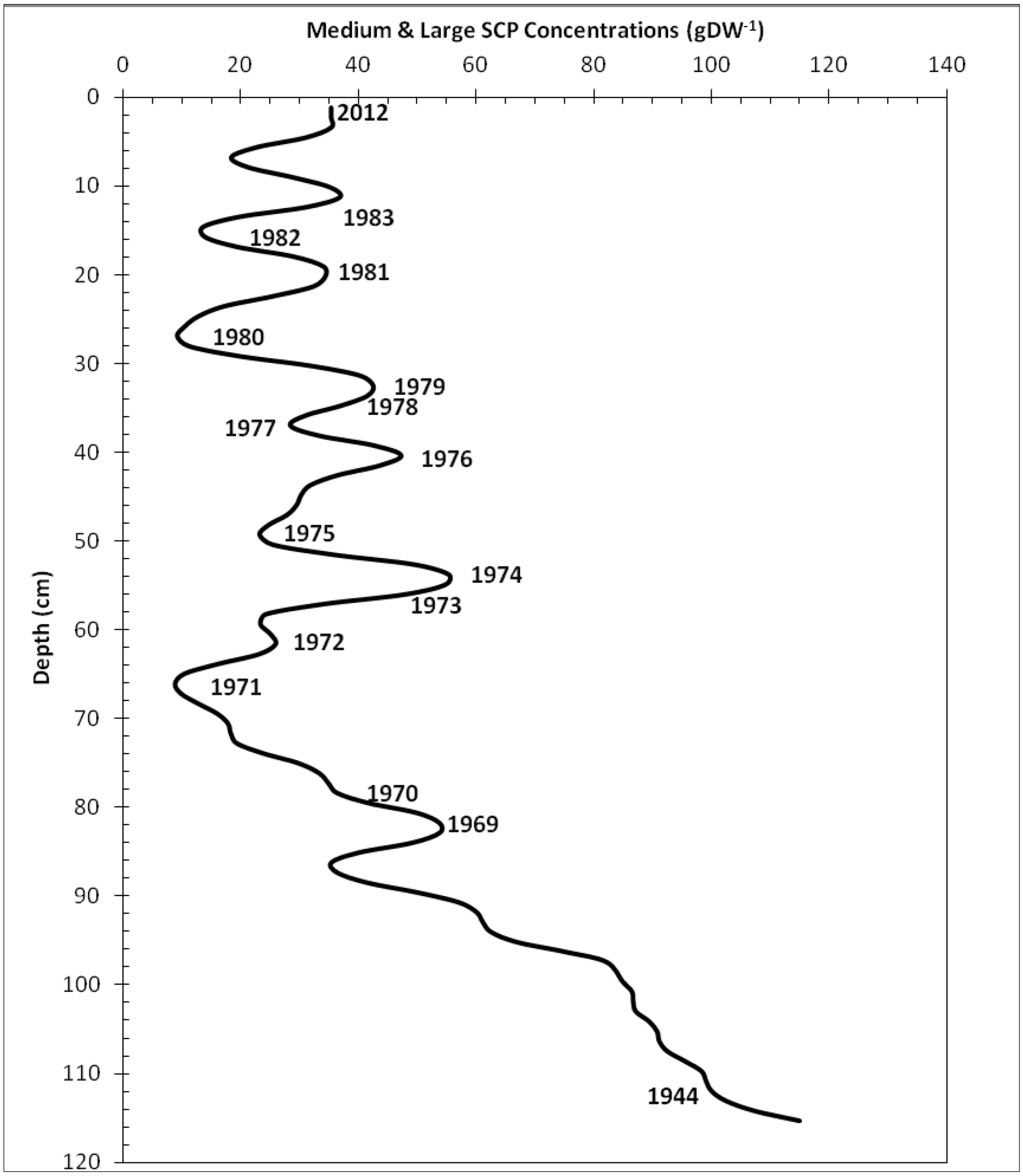

Figure 4.7: SCP Chronology.

4.4 Metal Analyses

The original metal concentrations were smoothed and those concentrations as well as the SCP concentrations were plotted by depth in Figures 4.8 and 4.9 using C2 data analysis (University of Newcastle 2003-2011 and Steve Juggins 1991-2011). At first glance, the elements do not resemble the characteristic peaks of the SCP concentrations.

At a closer glance, some of the elements' concentrations are very low and some concentrations actually do not fluctuate that much throughout the sediment core. For instance, beryllium's concentrations only have a range of 0.28mg/kg.

Pearson Product-Moment Correlation Coefficients were calculated for comparisons between smoothed metal concentrations and raw steel production as well as smoothed medium and large SCP concentrations. For the SCP and metal comparison, only sections that were described as sediment were used (section's 1-101) with the exception of section 88 which could not be analyzed for SCPs. A strong or very strong positive correlation ($r \geq 0.6$) did not exist between the metal and SCP concentrations or the metal concentrations and raw steel production except for cadmium. Cadmium was significantly correlated to SCP concentrations ($r = 0.744$, N=100, $p < 0.001$) and raw steel production ($r = 0.602$, N=15, $p = 0.018$). Phosphorous was significantly correlated to the SCP concentrations with a positive, moderate correlation ($r = 0.527$, N=100, $p < 0.001$), but not to the raw steel production ($r = 0.370$, N=15, $p = 0.175$). The other metals either showed negative correlations to raw steel production and SCPs or had weak ($0.2 \leq r \geq 0.39$) or very week ($0 \leq r \geq 0.19$) positive correlations. The correlation outputs are located in Appendix I.

Table 4.1: Corresponding Variables for Raw Steel and Smoothed Metals Concentrations.

Year	Raw Steel (net tons)	Depth (cm)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	K (mg/kg)	M (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	V (mg/kg)	Zn (mg/kg)
1983	92500	13.44	0.90	2507.30	0.09	61.79	25.25	2824.70	4832.80	142.67	40.70	617.66	64.84	45.60	126.70
1982	68200	15.68	0.88	2482.50	0.10	61.57	25.60	2951.60	4780.90	145.94	39.88	575.81	63.36	47.59	139.57
1981	127500	20.16	0.87	2156.80	0.19	60.88	28.44	3332.60	4443.90	137.91	32.75	500.91	60.75	51.00	157.12
1980	77000	26.88	0.90	2047.50	0.23	58.46	21.92	2918.90	4291.20	145.30	40.27	512.77	56.62	42.45	125.00
1979	157600	32.48	0.89	1905.60	0.23	57.17	22.45	2967.60	4239.40	140.04	31.99	523.68	56.87	44.54	138.45
1978	158800	34.72	0.88	1858.10	0.23	57.56	23.48	3070.70	4259.80	139.82	31.94	524.12	56.98	46.40	143.29
1977	160200	36.96	0.87	1803.70	0.24	57.64	23.11	3136.10	4240.80	139.40	33.37	525.14	57.33	46.13	141.90
1976	185400	40.32	0.87	1788.40	0.28	55.41	19.63	2795.70	4057.90	139.68	39.75	531.48	56.77	41.15	117.09
1975	128200	49.28	0.78	1673.10	0.20	54.79	22.66	2462.80	4111.40	110.57	34.21	605.26	58.94	40.92	133.29
1974	208400	53.76	0.75	1617.80	0.17	54.35	23.39	2333.30	4082.30	102.04	34.86	648.66	60.04	41.97	135.16
1973	202500	57.12	0.78	1626.80	0.18	55.30	23.76	2413.80	4265.20	104.11	35.20	627.29	61.39	43.25	130.89
1972	191000	61.6	0.81	1629.50	0.23	55.85	23.66	2795.20	4325.20	113.88	35.87	637.44	63.44	45.57	149.86
1971	117400	66.08	0.84	1670.70	0.27	54.28	19.60	2331.60	4264.40	114.81	38.01	665.08	63.59	37.74	117.71
1970	198600	78.4	0.81	1577.70	0.47	51.27	19.96	2179.20	3732.40	110.32	30.87	653.43	66.97	34.98	133.67
1969	246800	81.76	0.78	1577.90	0.44	50.61	25.64	2100.90	3754.80	101.67	32.80	640.75	67.46	35.63	133.90

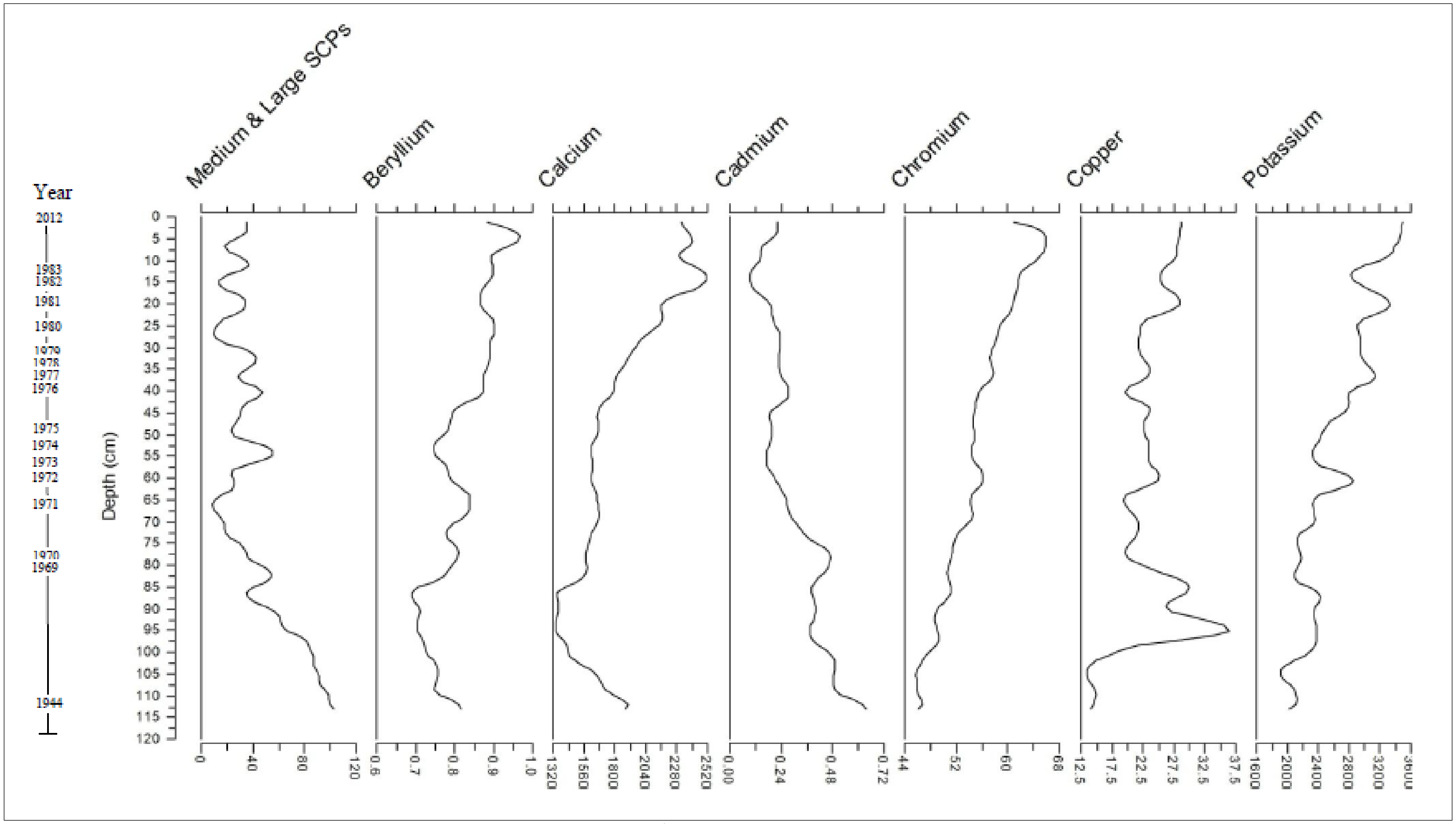

Figure 4.8: Smoothed SCPs (gDW^{-1}) & Smoothed Metal Concentrations (mg/kg).

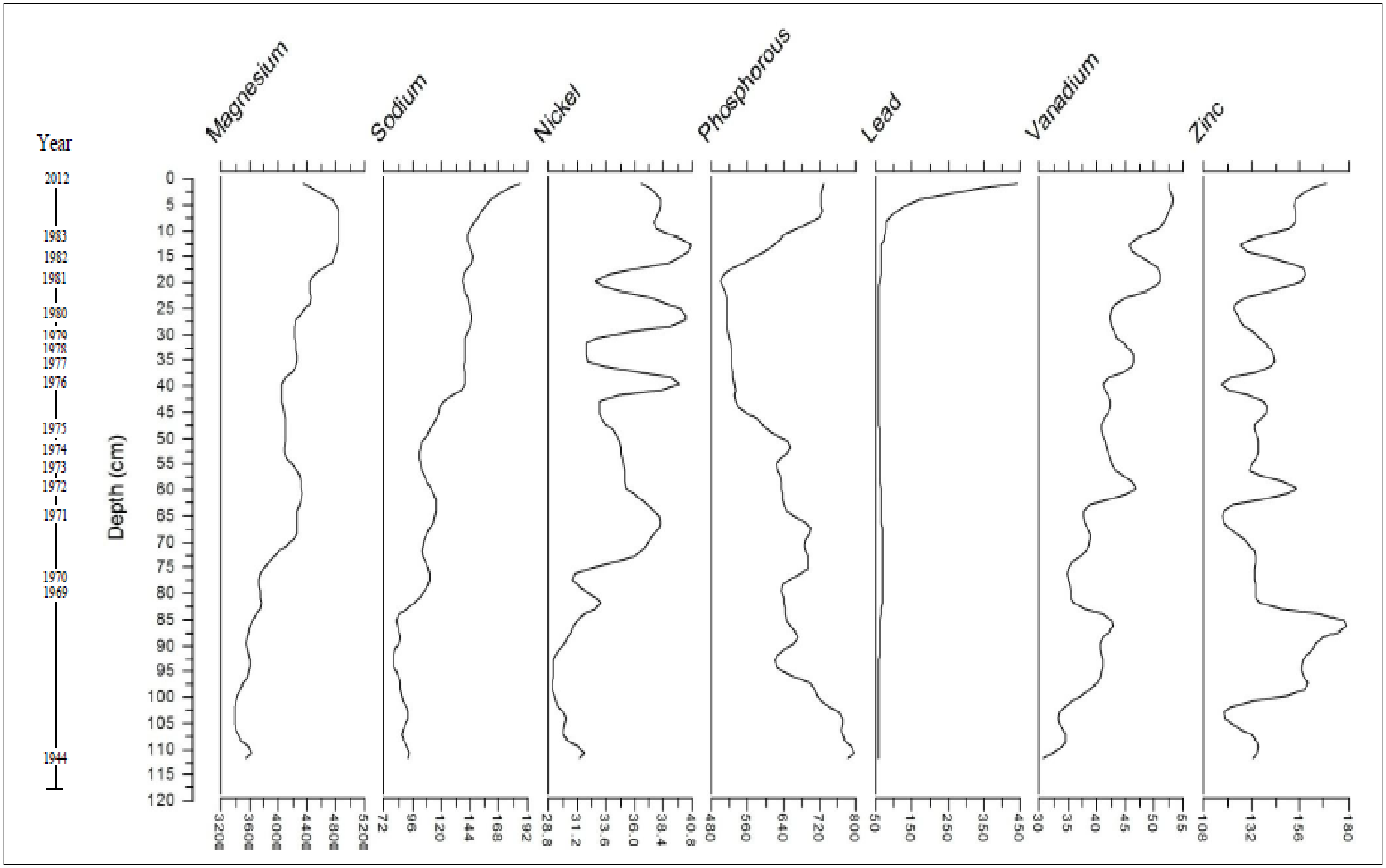

Figure 4.9: Smoothed Metal Concentrations (mg/kg).

CHAPTER 5

DISCUSSION

5.0 SCP Particle Size and Expected Source Locations

If another reservoir or lake would be sampled closer and downwind to regional sources, concentrations of large particles would be greater than in the MCR sediment core. Larger particle concentrations are probably lacking due to MCR's location in relation to SCP sources. The MCR is approximately 6 miles downwind from Warren, but it is not downwind from Youngstown and it is approximately 20 miles away. It is important to realize that this does not mean SCPs from Youngstown sources would not reach MCR, but sources in Warren are more likely the cause of large SCP (>12.5μm) deposition. Smaller particle (5-12.5μm) deposition is likely the cause of sources both from Warren and Youngstown. Particles smaller than 5 microns can be from local sources, but there is a greater chance they are transported by the wind from other industrial regions such as Cleveland, Akron, and Canton, Ohio and Pittsburgh, Pennsylvania. Larson (2003) describes SCP sizes as it relates to distinguishing between long range transport and downwind from a source, but otherwise there seems to be a research gap for distinguishing regional SCP deposition by size categories.

5.1 Historical & Modern SCP Point Sources

Historical SCP deposition in MCR was mainly influenced by the steel industry in the Mahoning Valley, and it allows the sediment core to be dated since the raw steel production dates are known. More recent and future SCP deposition may not just be influenced by the steel industry, but also by power plants. Power plants are a major player in the industrial combustion of fossil fuels (Alliksaar and Punning 1998). Figure

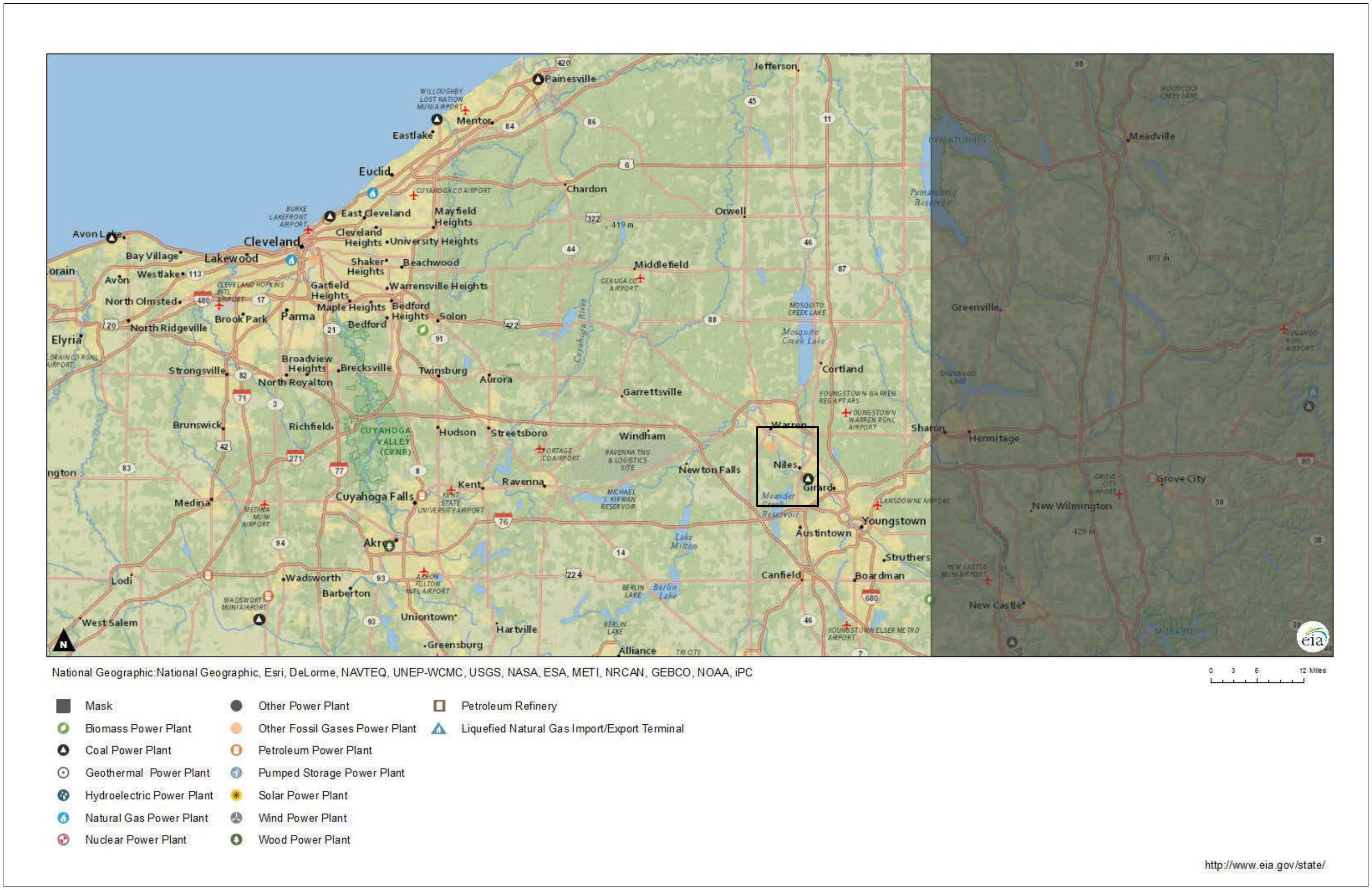

Figure 5.0: Power Plants near MCR (U.S. Energy Information Administration 2013).

5.0 shows two power plants in a black rectangle located close to MCR. Notice that there are also more power plants located in other industrial areas of Ohio and Pennsylvania. These power plants, in addition to the ones located near MCR, could be responsible for more recent and future SCP deposition.

5.2 SCP Analysis Errors

Identifying SCPs during counting followed Clark's (2007) descriptions, but there is the possibility that a non-SCP was identified as a SCP and vise versa. There is also a possibility of error during the size category identification process for small and medium SCPs. The microscope grid was calibrated and each cell was 12.5µm. The medium SCPs were 6.25-12.5µm or in other words, the medium SCP widths occupied half to a full cell. The small SCP widths (<6.25µm) were less than half a cell. Standard deviation estimates were calculated to help compensate for these errors. There could also have been loss of sediment from transferring the sediment to centrifuge tubes.

5.3 Metal Analysis Errors

Metal concentrations were analyzed due to their association with SCPs. However, smoothed metal concentrations in the MCR sediment core, except for cadmium, did not have strong positive correlations with the smoothed medium and large SCP concentrations as well as raw steel production for the Lower Mahoning River Basin. It is important to note that cadmium concentrations only ranged from 0.094 to 0.637mg/kg. Some of the other metal concentrations do not fluctuate much either. Percent recovery rates, especially for the spiked samples, show the metal concentrations and estimated concentrations are reliable. The Standard Reference Material® 2702 – Marine Sediment showed similar results, but some of the percent recovery rates for non-certified and estimated concentrations that were outside the calibration range were low. Overall, the metal analysis results do not support the hypothesis that SCPs would serve as a proxy for associated contaminants as it relates MCR. However, this may not be the case for other reservoirs in the region.

5.4 Metal Sources

Since metal concentrations in the MCR sediment do not reflect regional atmospheric deposition trends, a possible explanation is that the metal concentrations are more influenced by land-use activities and sources in the terrestrial sub-watershed. MCR is located in the Mahoning River Watershed as well as the Mosquito Creek Sub-Watershed (Figure 5.1). The Mosquito Creek Sub-Watershed occupies 90,000 acres and 12.9% of the Mahoning River Watershed. Most of the land surrounding MCR is considered cropland and pasture (Figure 5.2). Roughly 30-35% of the watershed is actively farmed and 10-15% of the watershed is shrub and pasture land. Agriculture has decreased since the MCR was built, and the Ohio Department of Agriculture estimated a 60% decrease in farmland in Trumbull County between 1945 and 1992. On the other hand, urbanization and in particular residential development has increased in the Mosquito Creek Reservoir since the 1960's. It occupies 5-10% of the watershed and could be responsible for influencing metal concentration trends due to impervious surfaces and runoff (Martin 2004). Another possible influence is industrial and municipal point source discharges. Figure 5.3 shows three sources near MCR.

5.5 Further Validation of the MCR SCP Chronology

This study shows that a SCP chronology could be used as a primary dating tool for reservoir sediment cores instead of less precise alternative such as ^{137}Cs and ^{210}Pb.

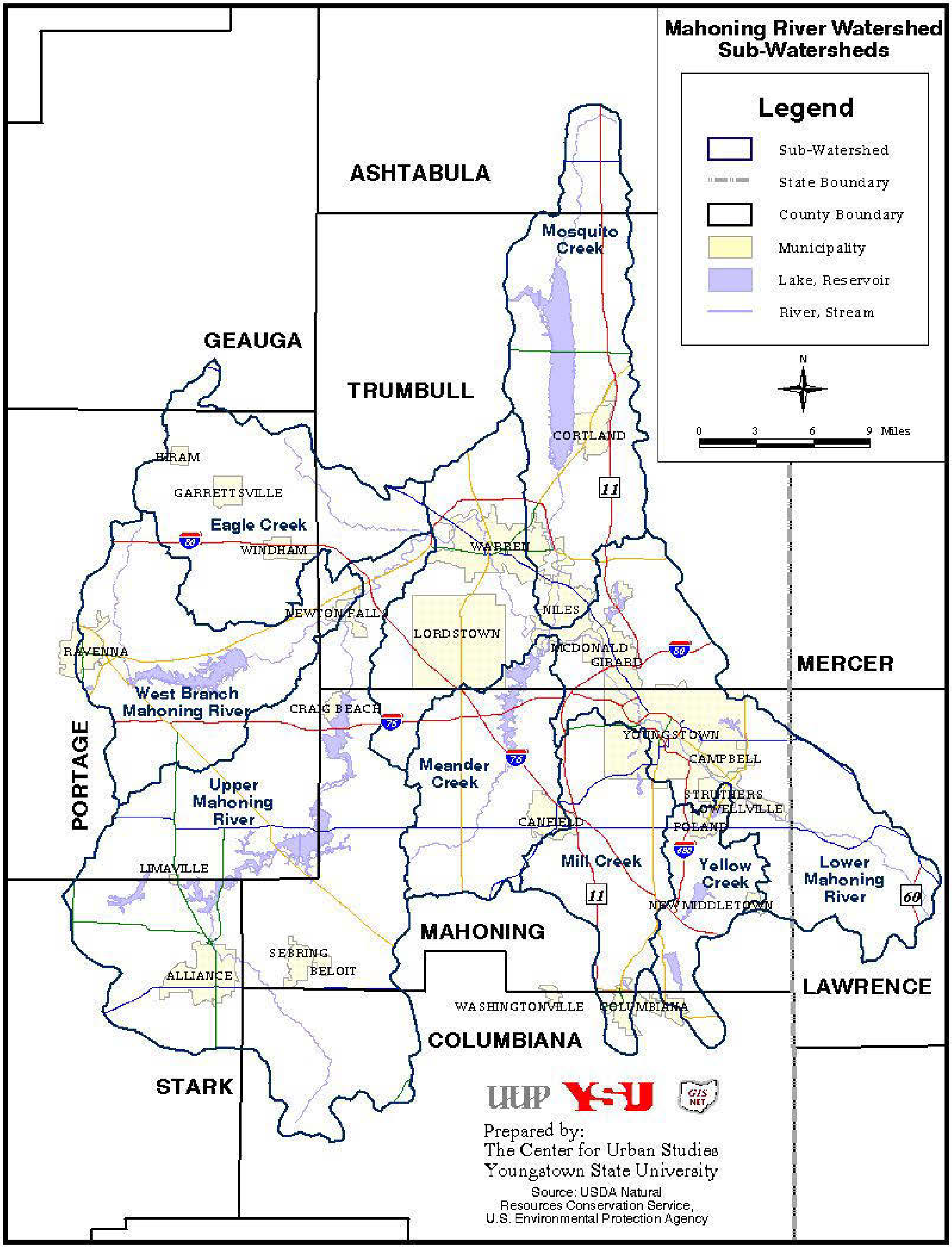

Figure 5.1: Mahoning River Watershed and Mosquito Creek Sub-Watershed (Center for Urban Studies, Youngstown State University 2001).

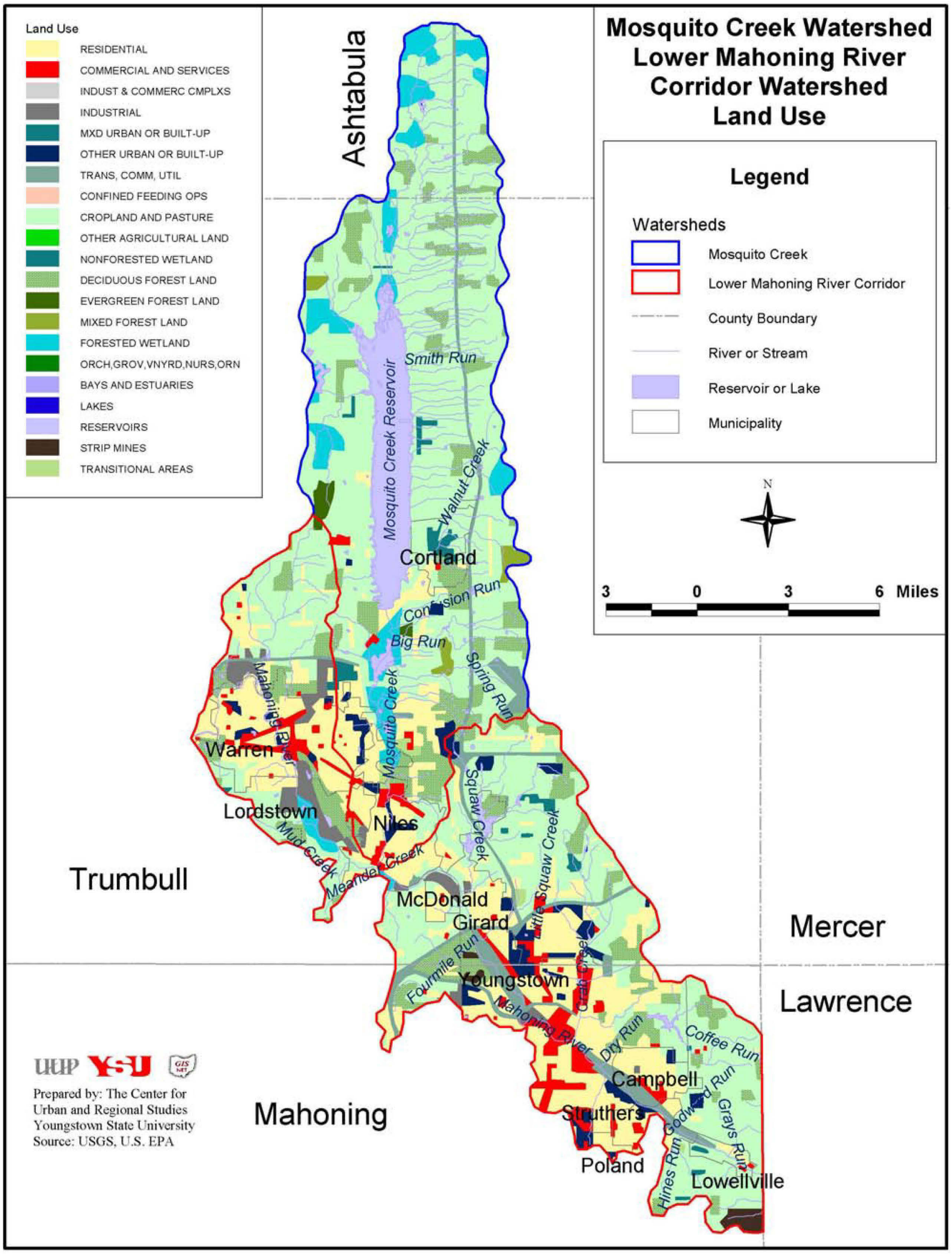

Figure 5.2: Mosquito Creek Watershed Land Use (Martin 2004).

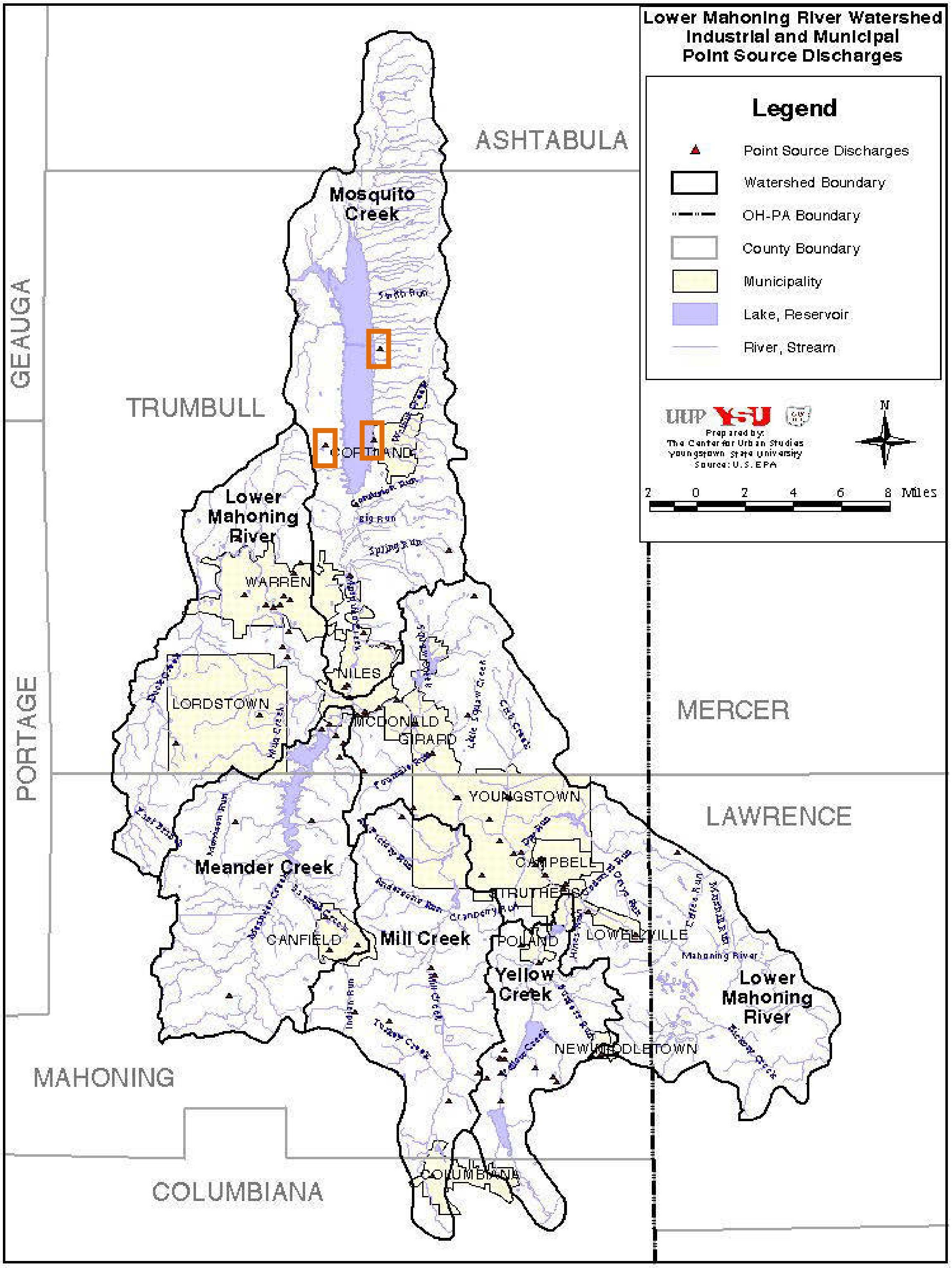

Figure 5.3: Industrial and Municipal Point Source Discharges (Center for Urban Studies, Youngstown State University 2001).

Since the chronology was not supported by sediment geochemistry, ^{137}Cs could be used for validation. ^{210}Pb focuses on the last 100 to 200 years is prone to errors if the site has highly variable sedimentation rates or a disturbed watershed (Science Museum of Minnesota 2013). This complicates dating reservoir sediment cores due to their young age and highly variable sedimentation rates. Therefore, compared to ^{210}Pb, only ^{137}Cs has been found to reliably provide a marker to date reservoir sediment cores (U.S. Geological Survey 2004). In addition to validation with ^{137}Cs, studying and describing other historical variables, such as diatom biostratigraphy and IASs, could compliment a SCP chronology.

5.6 Future Use of Model & References to Reservoir SCP Records

When using this model in the future, care should be taken when determining what size particles to utilize in a chronology. This depends on the reservoir's location in relation to atmospheric point sources, wind patterns, and other variables that effect depositional characteristics. Care should also be given if applying this method to date lake sediment cores. Lakes and reservoirs have different sedimentation rates and patterns, shapes, and nature of influent streams (U.S. Geological Survey 2004). That being said, most of the research applies SCP data to previously dated lake sediment cores. There are very few references that describe the SCP record in reservoirs. Vukić and Applyby (2003) are an exception, but they did not utilize a SCP chronology.

CHAPTER 6

CONCLUSIONS

6.0 Conclusions and Recommendations

A SCP chronology was reliable in the historical environment reconstruction process for MCR as it relates to raw steel production for the Lower Mahoning River Basin. The medium (6.25-12.5µm) and large (< 12.5µm) SCP sizes best captured a regional influence of atmospheric deposition for the Mahoning Valley. Metal concentrations in the MCR sediment did not follow the same trends as SCP deposition; therefore, they are likely more influenced by activities and sources in the terrestrial sub-watershed than by atmospheric deposition. With further validation with ^{137}Cs, this model to date reservoirs can be utilized in other industrial regions.

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APPENDIX A

SCP, Diatom, and IAS Wet Weights

Section #	Weights (g)			Section #	Weights (g)			Replicate #	Weights (g)		
	SCP	IAS	Diatom		SCP	IAS	Diatom		SCPs	IAS	Diatom
1	0.4726	0.8798	0.6995	53	0.3237	0.3053	0.3186	31B	0.2765		
2	0.6798	0.8928	0.7438	54	0.3609	0.3247	0.2745	31C	0.2469		
3	0.4125	0.1483	0.1868	55	0.3344	0.3259	0.3059	31D	0.2361		
4	0.3865	0.1685	0.1730	56	0.3365	0.3110	0.3012	31E	0.2050		
5	0.4157	0.2174	0.2031	57	0.3422	0.3115	0.3095				
6	0.3871	0.1713	0.3238	58	0.3269	0.3356	0.3313	32B		0.2372	
7	0.4830	0.1847	0.1885	59	0.3506	0.3621	0.3409	32C		0.2343	
8	0.3088	0.2195	0.2389	60	0.3334	0.3232	0.3217	32D		0.2859	
9	0.3826	0.2293	0.2344	61	0.3390	0.3146	0.3420	32E		0.2704	
10	0.3188	0.3432	0.2076	62	0.3384	0.3287	0.3378				
11	0.3193	0.3579	0.2398	63	0.3150	0.3308	0.2958	33B			0.3119
12	0.5382	0.1962	0.2213	64	0.3539	0.3521	0.2636	33C			0.2877
13	0.2340	0.2051	0.1747	65	0.3566	0.3380	0.2956	33D			0.3146
14	0.2701	0.2133	0.2023	66	0.3229	0.3099	0.3019	33E			0.2989
15	0.2911	0.2485	0.3116	67	0.3205	0.3227	0.2721				
16	0.3580	0.2876	0.2627	68	0.3302	0.3480	0.3286	61B	0.3471		
17	0.2495	0.2493	0.2467	69	0.3186	0.3171	0.3384	61C	0.2801		
18	0.2444	0.2321	0.2625	70	0.3306	0.3296	0.3272	61D	0.2839		
19	0.2784	0.1934	0.2183	71	0.3535	0.3276	0.2809	61E	0.3207		
20	0.2861	0.2435	0.2428	72	0.2886	0.3492	0.3267				
21	0.1930	0.3014	0.2342	73	0.2538	0.3596	0.3151	62B		0.2919	
22	0.3056	0.2832	0.2629	74	0.3286	0.3215	0.2573	62C		0.3325	
23	0.2938	0.2929	0.2192	75	0.3565	0.3199	0.3249	62D		0.3227	
24	0.2743	0.2719	0.2623	76	0.3405	0.3520	0.3521	62E		0.2387	
25	0.2468	0.2725	0.3042	77	0.3088	0.2957	0.2970				
26	0.3364	0.2505	0.2793	78	0.2398	0.2865	0.3501	63B			0.2797
27	0.2874	0.2893	0.2113	79	0.3392	0.3116	0.3367	63C			0.2921
28	0.2981	0.3121	0.2339	80	0.2938	0.3698	0.3141	63D			0.2691
29	0.3119	0.3844	0.2951	81	0.3275	0.3486	0.2947	63E			0.2581
30	0.3133	0.3057	0.2652	82	0.3377	0.3389	0.3278				
31	0.2812	0.2570	0.2643	83	0.3350	0.3492	0.3850	91B	0.2909		
32	0.3009	0.2311	0.2784	84	0.3737	0.5314	0.3752	91C	0.3151		
33	0.3183	0.1918	0.2779	85	0.4041	0.3773	0.3550	91D	0.3238		
34	0.3011	0.2718	0.2942	86	0.3772	0.3382	0.3577	91E	0.2881		
35	0.3094	0.3087	0.3201	87	0.3849	0.3679	0.3475				
36	0.2650	0.3318	0.3106	88	0.5521	0.3208	0.3446	92B		0.3159	

37	0.3486	0.2831	0.3258	89	0.3735	0.3707	0.3620	92C		0.3444	
38	0.2686	0.2628	0.2745	90	0.3594	0.3639	0.3824	92D		0.2896	
39	0.3612	0.2978	0.3101	91	0.3486	0.3448	0.2680	92E		0.3101	
40	0.3987	0.4013	0.2930	92	0.3949	0.3345	0.3529				
41	0.3656	0.3493	0.3465	93	0.2977	0.3187	0.2975	93B			0.3332
42	0.3147	0.3038	0.3266	94	0.3748	0.3584	0.3242	93C			0.3257
43	0.3041	0.3252	0.3291	95	0.3286	0.2943	0.3431	93D			0.3292
44	0.3120	0.3212	0.3193	96	0.3381	0.3364	0.2927	93E			0.3509
45	0.3338	0.3227	0.2826	97	0.3436	0.3162	0.3645				
46	0.3498	0.4390	0.2923	98	0.3163	0.3596	0.3662				
47	0.3293	0.2941	0.3227	99	0.2805	0.3224	0.3462				
48	0.3831	0.2913	0.3159	100	0.3443	0.3525	0.3309				
49	0.3343	0.3294	0.3085	101	0.2685	0.3808	0.3876				
50	0.3144	0.3051	0.3111	102	0.4101	0.3157	0.3134				
51	0.2862	0.2987	0.3122	103	0.4146	0.3938	0.3573				
52	0.3296	0.2054	0.3238	104	0.4727	0.4224	0.4153				

APPENDIX B

Percent Moisture Calculations

Section #	Depth (cm)	Weights (g)					Percent Dry Weight	Percent Moisture Weight
		Aluminum Pan (AP)	WET (Sediment +AP)	WET-AP (Sediment)	DRY (Sediment +AP)	DRY-AP (Sediment)	= (DRY-AP)/(WET-AP) *100	= ((WET-AP) - (DRY-AP))/(WET-AP) *100
1	1.12	0.9023	11.5556	10.6533	3.0972	2.1949	20.60	79.40
2	2.24	0.9157	13.3148	12.3991	4.0469	3.1312	25.25	74.75
3	3.36	0.9222	16.5737	15.6515	5.4195	4.4973	28.73	71.27
4	4.48	0.9221	16.6597	15.7376	5.0956	4.1735	26.52	73.48
5	5.6	0.9327	18.2963	17.3636	6.0185	5.0858	29.29	70.71
6	6.72	0.9268	18.6434	17.7166	6.4623	5.5355	31.24	68.76
7	7.84	0.9185	17.9821	17.0636	5.9822	5.0637	29.68	70.32
8	8.96	0.911	18.7876	17.8766	6.383	5.472	30.61	69.39
9	10.08	0.904	19.6288	18.7248	7.2278	6.3238	33.77	66.23
10	11.2	0.9187	21.7809	20.8622	8.2869	7.3682	35.32	64.68
11	12.32	0.9159	21.7489	20.833	8.4671	7.5512	36.25	63.75
12	13.44	0.9052	18.006	17.1008	6.8998	5.9946	35.05	64.95
13	14.56	0.9116	21.0293	20.1177	7.7571	6.8455	34.03	65.97
14	15.68	0.9079	22.2143	21.3064	8.4213	7.5134	35.26	64.74
15	16.8	0.9169	19.2234	18.3065	7.6488	6.7319	36.77	63.23
16	17.92	0.9102	25.1194	24.2092	10.3639	9.4537	39.05	60.95
17	19.04	0.9246	23.7322	22.8076	9.9251	9.0005	39.46	60.54
18	20.16	0.9162	16.872	15.9558	7.4129	6.4967	40.72	59.28
19	21.28	0.9052	24.1256	23.2204	10.2973	9.3921	40.45	59.55
20	22.4	0.9125	22.9475	22.035	9.7423	8.8298	40.07	59.93
21	23.52	0.9206	22.1401	21.2195	9.4276	8.507	40.09	59.91
22	24.64	0.9172	22.8031	21.8859	9.9929	9.0757	41.47	58.53
23	25.76	0.903	21.3857	20.4827	9.4206	8.5176	41.58	58.42
24	26.88	0.9116	23.7249	22.8133	10.5115	9.5999	42.08	57.92
25	28	0.9085	25.6216	24.7131	11.5771	10.6686	43.17	56.83
26	29.12	0.9186	21.4595	20.5409	9.7764	8.8578	43.12	56.88
27	30.24	0.9048	21.8013	20.8965	9.8625	8.9577	42.87	57.13
28	31.36	0.927	24.8475	23.9205	11.3022	10.3752	43.37	56.63
29	32.48	0.9107	21.847	20.9363	9.9505	9.0398	43.18	56.82
30	33.6	0.9288	26.1209	25.1921	12.1645	11.2357	44.60	55.40
31	34.72	0.9034	23.7577	22.8543	11.1496	10.2462	44.83	55.17
32	35.84	0.9161	21.3692	20.4531	9.9369	9.0208	44.10	55.90
33	36.96	0.9287	22.7901	21.8614	10.6978	9.7691	44.69	55.31

34	38.08	0.9207	25.0636	24.1429	11.908	10.9873	45.51	54.49
35	39.2	0.9292	24.085	23.1558	11.8219	10.8927	47.04	52.96
36	40.32	0.9178	22.9026	21.9848	11.3684	10.4506	47.54	52.46
37	41.44	0.9178	25.2561	24.3383	12.0444	11.1266	45.72	54.28
38	42.56	0.9215	22.466	21.5445	10.8505	9.929	46.09	53.91
39	43.68	0.9184	24.6753	23.7569	12.2718	11.3534	47.79	52.21
40	44.8	0.9236	26.6389	25.7153	13.1161	12.1925	47.41	52.59
41	45.92	0.9741	25.1885	24.2144	12.2564	11.2823	46.59	53.41
42	47.04	1.0053	25.2563	24.251	12.38	11.3747	46.90	53.10
43	48.16	1.0203	25.3393	24.319	12.5624	11.5421	47.46	52.54
44	49.28	0.9981	23.506	22.5079	11.8576	10.8595	48.25	51.75
45	50.4	1.1027	23.8085	22.7058	12.0857	10.983	48.37	51.63
46	51.52	1.0104	25.5238	24.5134	12.9171	11.9067	48.57	51.43
47	52.64	1.0314	26.0886	25.0572	13.1638	12.1324	48.42	51.58
48	53.76	1.0812	21.7139	20.6327	11.0992	10.018	48.55	51.45
49	54.88	1.0247	26.4538	25.4291	13.3295	12.3048	48.39	51.61
50	56	1.0346	24.0386	23.004	12.2567	11.2221	48.78	51.22
51	57.12	1.0159	24.1095	23.0936	12.1849	11.169	48.36	51.64
52	58.24	1.0051	27.7777	26.7726	13.988	12.9829	48.49	51.51
53	59.36	0.9935	24.4549	23.4614	12.3353	11.3418	48.34	51.66
54	60.48	0.9852	23.47	22.4848	11.695	10.7098	47.63	52.37
55	61.6	0.9813	24.6811	23.6998	12.2989	11.3176	47.75	52.25
56	62.72	0.9946	27.6715	26.6769	14.0374	13.0428	48.89	51.11
57	63.84	0.9974	25.4506	24.4532	13.0629	12.0655	49.34	50.66
58	64.96	1.0175	23.5822	22.5647	12.3554	11.3379	50.25	49.75
59	66.08	0.9942	26.3464	25.3522	13.3942	12.4	48.91	51.09
60	67.2	1.0505	24.2815	23.231	12.542	11.4915	49.47	50.53
61	68.32	1.0427	24.9669	23.9242	12.9273	11.8846	49.68	50.32
62	69.44	1.0231	26.6834	25.6603	13.8507	12.8276	49.99	50.01
63	70.56	1.022	22.5834	21.5614	11.8687	10.8467	50.31	49.69
64	71.68	0.9895	25.6182	24.6287	13.2871	12.2976	49.93	50.07
65	72.8	1.0228	25.5535	24.5307	13.1608	12.138	49.48	50.52
66	73.92	0.996	26.0186	25.0226	13.4375	12.4415	49.72	50.28
67	75.04	1.0653	25.7166	24.6513	13.2747	12.2094	49.53	50.47
68	76.16	0.9948	23.6502	22.6554	12.0775	11.0827	48.92	51.08
69	77.28	0.9986	26.7984	25.7998	13.4264	12.4278	48.17	51.83
70	78.4	1.02	26.264	25.244	13.1175	12.0975	47.92	52.08
71	79.52	1.0252	25.9869	24.9617	13.1039	12.0787	48.39	51.61
72	80.64	1.0121	27.4152	26.4031	14.1064	13.0943	49.59	50.41
73	81.76	0.9892	27.9075	26.9183	14.3863	13.3971	49.77	50.23
74	82.88	0.9697	25.9206	24.9509	13.5114	12.5417	50.27	49.73

75	84	0.9654	25.876	24.9106	13.5282	12.5628	50.43	49.57
76	85.12	0.9725	30.3444	29.3719	15.9114	14.9389	50.86	49.14
77	86.24	1.0347	22.8711	21.8364	12.2338	11.1991	51.29	48.71
78	87.36	1.0308	29.3349	28.3041	15.651	14.6202	51.65	48.35
79	88.48	1.0427	25.0782	24.0355	13.4759	12.4332	51.73	48.27
80	89.6	1.0099	29.2049	28.195	15.8286	14.8187	52.56	47.44
81	90.72	1.0531	27.0839	26.0308	15.1302	14.0771	54.08	45.92
82	91.84	1.0166	25.7105	24.6939	14.6093	13.5927	55.04	44.96
83	92.96	1.0086	28.4144	27.4058	16.2675	15.2589	55.68	44.32
84	94.08	1.0042	27.6439	26.6397	15.9428	14.9386	56.08	43.92
85	95.2	1.0168	27.5554	26.5386	15.9399	14.9231	56.23	43.77
86	96.32	1.0275	26.6398	25.6123	15.4899	14.4624	56.47	43.53
87	97.44	0.9559	27.371	26.4151	15.9204	14.9645	56.65	43.35
88	98.56	1.003	24.8813	23.8783	14.5199	13.5169	56.61	43.39
89	99.68	0.97	25.9709	25.0009	15.0009	14.0309	56.12	43.88
90	100.8	1.0358	24.0052	22.9694	13.7521	12.7163	55.36	44.64
91	101.92	0.9865	25.1635	24.177	14.0111	13.0246	53.87	46.13
92	103.04	1.0113	23.9928	22.9815	13.5237	12.5124	54.45	45.55
93	104.16	0.9868	20.7925	19.8057	11.7932	10.8064	54.56	45.44
94	105.28	1.0013	27.5675	26.5662	15.0303	14.029	52.81	47.19
95	106.4	1.0087	23.9214	22.9127	13.2612	12.2525	53.47	46.53
96	107.52	1.0093	29.0796	28.0703	16.9525	15.9432	56.80	43.20
97	108.64	1.0045	27.6854	26.6809	16.5519	15.5474	58.27	41.73
98	109.76	1.0036	28.2466	27.243	16.9237	15.9201	58.44	41.56
99	110.88	0.9974	24.6778	23.6804	14.8411	13.8437	58.46	41.54
100	112	1.0303	28.7048	27.6745	16.9628	15.9325	57.57	42.43
101	113.12	0.9906	27.0658	26.0752	16.0787	15.0881	57.86	42.14
102	114.24	0.9878	22.8232	21.8354	13.6421	12.6543	57.95	42.05
103	115.36	1.0033	28.0986	27.0953	18.2489	17.2456	63.65	36.35
104	116.48	1.0334	26.2428	25.2094	18.0291	16.9957	67.42	32.58

APPENDIX C
Loss on Ignition Calculations

Section #	Depth (cm)	Weights (g)			% Organic Carbon Content
		Crucible	PRE: Sediment +Crucible	POST: Sediment +Crucible	=[1-((POST-Crucible)/(PRE-Crucible))]*100
1	1.1200	5.2700	6.2316	6.1683	6.5828
2	2.2400	5.5391	6.4254	6.3660	6.7020
3	3.3600	6.0612	7.0739	7.0071	6.5962
4	4.4800	4.8970	5.8066	5.7421	7.0910
5	5.6000	5.8321	6.7612	6.6966	6.9530
6	6.7200	6.5968	7.3678	7.3200	6.1997
7	7.8400	5.7866	6.6408	6.5880	6.1812
8	8.9600	5.1398	6.0418	5.9847	6.3304
9	10.0800	5.2741	6.1533	6.1017	5.8690
10	11.2000	5.5391	6.4412	6.3937	5.2655
11	12.3200	6.0612	7.0356	6.9820	5.5008
12	13.4400	4.8969	5.7831	5.7339	5.5518
13	14.5600	5.8322	6.8181	6.7657	5.3149
14	15.6800	6.5966	7.5876	7.5413	4.6720
15	16.8000	5.7865	6.7813	6.7299	5.1669
16	17.9200	5.1397	6.2760	6.2178	5.1219
17	19.0400	5.2740	6.4551	6.3958	5.0207
18	20.1600	5.5391	6.6351	6.5831	4.7445
19	21.2800	6.0612	7.1063	7.0539	5.0139
20	22.4000	4.8970	5.9154	5.8646	4.9882
21	23.5200	5.8322	6.7884	6.7438	4.6643
22	24.6400	6.5967	7.5628	7.5203	4.3991
23	25.7600	5.7866	6.7713	6.7248	4.7223
24	26.8800	5.1395	6.2689	6.2163	4.6573
25	28.0000	5.2741	6.3542	6.3036	4.6848
26	29.1200	5.5390	6.5988	6.5542	4.2083
27	30.2400	6.0611	7.2798	7.2251	4.4884
28	31.3600	4.8970	5.9574	5.9082	4.6398
29	32.4800	5.8322	6.8364	6.7919	4.4314
30	33.6000	6.5966	7.8111	7.7641	3.8699
31	34.7200	5.7864	6.9360	6.8828	4.6277
32	35.8400	5.1394	6.2079	6.1573	4.7356
33	36.9600	5.2740	6.2597	6.2140	4.6363
34	38.0800	5.5390	6.5828	6.5375	4.3399
35	39.2000	6.0609	7.0795	7.0340	4.4669

36	40.3200	4.8968	5.9008	5.8562	4.4422
37	41.4400	5.8322	6.6176	6.5831	4.3927
38	42.5600	6.5965	7.4822	7.4442	4.2904
39	43.6800	5.7864	7.0120	6.9570	4.4876
40	44.8000	5.1394	6.2988	6.2464	4.5196
41	45.9200	5.2739	6.6328	6.5724	4.4448
42	47.0400	5.5389	6.9949	6.9343	4.1621
43	48.1600	6.0609	7.2983	7.2435	4.4286
44	49.2800	4.8967	6.1276	6.0721	4.5089
45	50.4000	5.8322	7.0802	7.0260	4.3429
46	51.5200	6.5965	7.5619	7.5226	4.0709
47	52.6400	5.7866	6.9723	6.9207	4.3519
48	53.7600	5.1398	6.1183	6.0741	4.5171
49	54.8800	5.2741	6.6651	6.6014	4.5794
50	56.0000	5.5391	6.4218	6.3848	4.1917
51	57.1200	6.0607	7.1581	7.1088	4.4924
52	58.2400	4.8971	6.0472	5.9951	4.5300
53	59.3600	5.8322	6.8218	6.7783	4.3957
54	60.4800	6.5969	7.6485	7.6045	4.1841
55	61.6000	5.7866	6.8341	6.7886	4.3437
56	62.7200	5.1398	6.0297	5.9903	4.4275
57	63.8400	5.2741	6.1320	6.0954	4.2662
58	64.9600	5.5391	6.5498	6.5093	4.0071
59	66.0800	6.0611	7.1912	7.1420	4.3536
60	67.2000	4.8970	5.8601	5.8178	4.3921
61	68.3200	5.8322	6.8244	6.7828	4.1927
62	69.4400	6.5968	7.6028	7.5643	3.8270
63	70.5600	5.7866	7.0068	6.9502	4.6386
64	71.6800	5.1397	6.1634	6.1143	4.7963
65	72.8000	5.2740	6.4062	6.3523	4.7606
66	73.9200	5.5391	6.6512	6.6011	4.5050
67	75.0400	6.0612	7.1973	7.1417	4.8939
68	76.1600	4.8971	5.9950	5.9393	5.0733
69	77.2800	5.8322	6.9999	6.9411	5.0355
70	78.4000	6.5968	7.5209	7.4774	4.7073
71	79.5200	5.7866	7.0720	7.0047	5.2357
72	80.6400	5.8322	6.9260	6.8700	5.1198
73	81.7600	5.2740	6.3340	6.2819	4.9151
74	82.8800	6.5969	7.6811	7.6296	4.7500
75	84.0000	6.0608	7.1421	7.0887	4.9385
76	85.1200	4.8971	5.9515	5.9000	4.8843

77	86.2400	5.1397	6.0911	6.0439	4.9611
78	87.3600	5.5394	6.6068	6.5564	4.7218
79	88.4800	5.7866	6.8578	6.8045	4.9757
80	89.6000	5.8322	6.9406	6.8851	5.0072
81	90.7200	5.2742	6.5721	6.5107	4.7307
82	91.8400	6.5969	7.7942	7.7413	4.4183
83	92.9600	6.0612	7.3230	7.2634	4.7234
84	94.0800	4.8970	6.3888	6.3169	4.8197
85	95.2000	5.1397	6.4758	6.4138	4.6404
86	96.3200	5.4478	6.8794	6.8165	4.3937
87	97.4400	5.8323	7.0739	7.0129	4.9130
88	98.5600	5.2740	6.5770	6.5115	5.0269
89	99.6800	5.7865	7.1040	7.0421	4.6983
90	100.8000	6.0611	7.2465	7.1848	5.2050
91	101.9200	4.8968	6.1776	6.1064	5.5590
92	103.0400	5.1397	7.1082	7.0035	5.3188
93	104.1600	5.2741	7.2217	7.1138	5.5402
94	105.2800	5.1397	6.7285	6.6325	6.0423
95	106.4000	4.8969	6.4157	6.3232	6.0903
96	107.5200	6.0611	7.7200	7.6212	5.9558
97	108.6400	5.7865	7.2608	7.1729	5.9622
98	109.7600	5.8322	7.4223	7.3292	5.8550
99	110.8800	5.1397	6.4194	6.3425	6.0092
100	112.0000	4.8969	6.3901	6.3008	5.9804
101	113.1200	5.2740	6.8280	6.7335	6.0811
102	114.2400	5.7868	7.5933	7.4585	7.4619
103	115.3600	5.8322	7.1179	7.0317	6.7045
104	116.4800	6.0612	7.8458	7.7513	5.2953

APPENDIX D

Raw SCP Counts

Section #	Depth (cm)	Code	SCP Counts				Section #	Depth (cm)	Code	SCP Counts			
			Small	Medium	Large	Total				Small	Medium	Large	Total
1	1.12	AK	11	1	0	12	59	66.08	CN	12	0	1	13
2	2.24	CW	21	8	4	33	60	67.20	CB	12	5	2	19
3	3.36	CG	12	6	0	18	61	68.32	C	8	1	0	9
4	4.48	AW	8	1	2	11	62	69.44	J	7	2	1	10
5	5.60	S	19	2	0	21	63	70.56	DJ	5	11	1	17
6	6.72	BP	1	2	0	3	64	71.68	BF	1	2	0	3
7	7.84	F	8	3	0	11	65	72.80	BA	15	2	1	18
8	8.96	DM	7	2	0	9	66	73.92	DC	10	4	0	14
9	10.08	CK	14	6	0	20	67	75.04	AO	12	6	3	21
10	11.20	BJ	10	5	2	17	68	76.16	BR	11	1	4	16
11	12.32	N	5	0	0	5	69	77.28	AG	12	2	4	18
12	13.44	DO	35	7	0	42	70	78.40	CY	10	3	0	13
13	14.56	BG	9	0	0	9	71	79.52	CF	11	11	2	24
14	15.68	CC	6	1	0	7	72	80.64	AP	8	2	1	11
15	16.80	Y	11	2	2	15	73	81.76	BI	6	8	1	15
16	17.92	O	9	2	0	11	74	82.88	CE	12	4	4	20
17	19.04	DG	19	3	1	23	75	84.00	AD	6	7	1	14
18	20.16	CO	24	4	0	28	76	85.12	CR	20	13	1	34
19	21.28	H	25	3	0	28	77	86.24	BC	19	2	3	24
20	22.40	BN	10	1	0	11	78	87.36	BZ	10	2	0	12
21	23.52	CZ	23	8	1	32	79	88.48	L	18	5	2	25
22	24.64	Z	3	1	0	4	80	89.60	DB	9	7	3	19
23	25.76	CM	13	3	0	16	81	90.72	AY	7	10	1	18
24	26.88	U	8	0	0	8	82	91.84	CJ	13	7	1	21
25	28.00	BH	17	0	0	17	83	92.96	CA	19	12	1	32
26	29.12	DL	13	6	0	19	84	94.08	A	21	6	6	33
27	30.24	Q	8	4	0	12	85	95.20	DF	29	9	7	45
28	31.36	CT	5	2	1	8	86	96.32	BV	33	11	2	46
29	32.48	CH	14	7	1	22	87	97.44	AB	37	17	3	57
30	33.60	AU	26	7	0	33	88	98.56	n/a	n/a	n/a	n/a	n/a
31	34.72	BQ	17	4	0	21	89	99.68	DK	25	18	8	51

32	35.84	W	7	1	1	9	90	100.80	BL	40	9	5	54
33	36.96	DD	15	5	0	20	91	101.92	CL	40	12	5	57
34	38.08	B	7	0	0	7	92	103.04	AS	17	5	4	26
35	39.20	CV	23	6	0	29	93	104.16	BT	33	15	5	53
36	40.32	CP	11	5	2	18	94	105.28	AV	23	13	5	41
37	41.44	AQ	27	13	2	42	95	106.40	CU	30	11	5	46
38	42.56	BM	11	2	1	14	96	107.52	T	21	8	6	35
39	43.68	BK	21	4	0	25	97	108.64	DA	27	17	8	52
40	44.80	AR	21	5	1	27	98	109.76	BW	28	11	8	47
41	45.92	CX	11	6	0	17	99	110.88	AJ	11	3	5	19
42	47.04	CD	10	5	0	15	100	112.00	I	12	12	17	41
43	48.16	BD	14	3	0	17	101	113.12	BY	25	10	5	40
44	49.28	DI	13	3	0	16	102	114.24	V	21	14	10	45
45	50.40	AE	17	4	0	21	103	115.36	BS	22	18	14	54
46	51.52	BX	36	13	3	52	104	116.48	M	59	15	8	82
47	52.64	D	7	0	0	7	31B	34.72	K	5	3	1	9
48	53.76	DN	32	9	2	43	31C	34.72	BE	2	1	0	3
49	54.88	AT	17	9	0	26	31D	34.72	CQ	14	3	1	18
50	56.00	E	37	9	0	46	31E	34.72	AF	0	2	0	2
51	57.12	BB	8	4	0	12	61B	68.32	DH	11	6	2	19
52	58.24	CS	10	3	0	13	61C	68.32	BO	7	2	0	9
53	59.36	AM	10	2	1	13	61D	68.32	AC	7	2	2	11
54	60.48	CI	12	6	0	18	61E	68.32	G	13	4	3	20
55	61.60	AL	20	4	0	24	91B	101.92	AX	12	11	4	27
56	62.72	DE	13	9	0	22	91C	101.92	AI	20	7	6	33
57	63.84	BU	21	2	1	24	91D	101.92	P	12	4	3	19
58	64.96	R	12	0	0	12	91E	101.92	X	4	7	2	13

APPENDIX E

Medium & Large SCP Concentration Calculations

Section #	Depth (cm)	SCP Wet Weight (g) from Appendix A	Percent Dry Weight	Dry Ratio	Grams of Dry Weight	Large SCP Counts	Medium SCP Counts	Total Large & Medium SCP Counts	Medium & Large SCP Concentrations (No. of SCPs gDW^{-1})
				=Percent Dry Weight / 100	= SCP Wet Weight / Dry Ratio				= Total Large & Medium SCP Counts / Grams of Dry Weight
1	1.12	0.4726	20.60	0.206	0.0974	0	1	1	10.27
2	2.24	0.6798	25.25	0.2525	0.1717	4	8	12	69.90
3	3.36	0.4125	28.73	0.2873	0.1185	0	6	6	50.62
4	4.48	0.3865	26.52	0.2652	0.1025	2	1	3	29.27
5	5.6	0.4157	29.29	0.2929	0.1218	0	2	2	16.43
6	6.72	0.3871	31.24	0.3124	0.1209	0	2	2	16.54
7	7.84	0.483	29.68	0.2968	0.1433	0	3	3	20.93
8	8.96	0.3088	30.61	0.3061	0.0945	0	2	2	21.16
9	10.08	0.3826	33.77	0.3377	0.1292	0	6	6	46.44
10	11.2	0.3188	35.32	0.3532	0.1126	2	5	7	62.17
11	12.32	0.3193	36.25	0.3625	0.1157	0	0	0	0.00
12	13.44	0.5382	35.05	0.3505	0.1887	0	7	7	37.10
13	14.56	0.234	34.03	0.3403	0.0796	0	0	0	0.00
14	15.68	0.2701	35.26	0.3526	0.0952	0	1	1	10.50
15	16.8	0.2911	36.77	0.3677	0.107	2	2	4	37.37
16	17.92	0.358	39.05	0.3905	0.1398	0	2	2	14.31
17	19.04	0.2495	39.46	0.3946	0.0985	1	3	4	40.63
18	20.16	0.2444	40.72	0.4072	0.0995	0	4	4	40.20
19	21.28	0.2784	40.45	0.4045	0.1126	0	3	3	26.64
20	22.4	0.2861	40.07	0.4007	0.1146	0	1	1	8.72
21	23.52	0.193	40.09	0.4009	0.0774	1	8	9	116.32
22	24.64	0.3056	41.47	0.4147	0.1267	0	1	1	7.89
23	25.76	0.2938	41.58	0.4158	0.1222	0	3	3	24.56
24	26.88	0.2743	42.08	0.4208	0.1154	0	0	0	0.00
25	28	0.2468	43.17	0.4317	0.1065	0	0	0	0.00
26	29.12	0.3364	43.12	0.4312	0.1451	0	6	6	41.36
27	30.24	0.2874	42.87	0.4287	0.1232	0	4	4	32.47
28	31.36	0.2981	43.37	0.4337	0.1293	1	2	3	23.20
29	32.48	0.3119	43.18	0.4318	0.1347	1	7	8	59.40
30	33.6	0.3133	44.60	0.446	0.1397	0	7	7	50.10

31	34.72	0.2812	44.83	0.4483	0.1261	0	4	4	31.73
32	35.84	0.3009	44.10	0.441	0.1327	1	1	2	15.07
33	36.96	0.3183	44.69	0.4469	0.1422	0	5	5	35.15
34	38.08	0.3011	45.51	0.4551	0.137	0	0	0	0.00
35	39.2	0.3094	47.04	0.4704	0.1455	0	6	6	41.22
36	40.32	0.265	47.54	0.4754	0.126	2	5	7	55.57
37	41.44	0.3486	45.72	0.4572	0.1594	2	13	15	94.12
38	42.56	0.2686	46.09	0.4609	0.1238	1	2	3	24.24
39	43.68	0.3612	47.79	0.4779	0.1726	0	4	4	23.17
40	44.8	0.3978	47.41	0.4741	0.1886	1	5	6	31.81
41	45.92	0.3656	46.59	0.4659	0.1703	0	6	6	35.22
42	47.04	0.3147	46.90	0.469	0.1476	0	5	5	33.87
43	48.16	0.3041	47.46	0.4746	0.1443	0	3	3	20.79
44	49.28	0.312	48.25	0.4825	0.1505	0	3	3	19.93
45	50.4	0.3338	48.37	0.4837	0.1615	0	4	4	24.77
46	51.52	0.3498	48.57	0.4857	0.1699	3	13	16	94.17
47	52.64	0.3293	48.42	0.4842	0.1594	0	0	0	0.00
48	53.76	0.3831	48.55	0.4855	0.186	2	9	11	59.14
49	54.88	0.3343	48.39	0.4839	0.1618	0	9	9	55.64
50	56	0.3144	48.78	0.4878	0.1534	0	9	9	58.68
51	57.12	0.2862	48.36	0.4836	0.1384	0	4	4	28.90
52	58.24	0.3296	48.49	0.4849	0.1598	0	3	3	18.77
53	59.36	0.3237	48.34	0.4834	0.1565	1	2	3	19.17
54	60.48	0.3609	47.63	0.4763	0.1719	0	6	6	34.90
55	61.6	0.3344	47.75	0.4775	0.1597	0	4	4	25.05
56	62.72	0.3365	48.89	0.4889	0.1645	0	9	9	54.70
57	63.84	0.3422	49.34	0.4934	0.1688	1	2	3	17.77
58	64.96	0.3269	50.25	0.5025	0.1643	0	0	0	0.00
59	66.08	0.3506	48.91	0.4891	0.1715	1	0	1	5.83
60	67.2	0.3334	49.47	0.4947	0.1649	2	5	7	42.44
61	68.32	0.3399	49.68	0.4968	0.1688	0	1	1	5.92
62	69.44	0.3384	49.99	0.4999	0.1692	1	2	3	17.73
63	70.56	0.315	50.31	0.5031	0.1585	1	11	12	75.73
64	71.68	0.3539	49.93	0.4993	0.1767	0	2	2	11.32
65	72.8	0.3566	49.48	0.4948	0.1764	1	2	3	17.00
66	73.92	0.3229	49.72	0.4972	0.1605	0	4	4	24.91
67	75.04	0.3205	49.53	0.4953	0.1587	3	6	9	56.70
68	76.16	0.3302	48.92	0.4892	0.1615	4	1	5	30.95
69	77.28	0.3186	48.17	0.4817	0.1535	4	2	6	39.10
70	78.4	0.3306	47.92	0.4792	0.1584	0	3	3	18.94
71	79.52	0.3535	48.39	0.4839	0.1711	2	11	13	76.00

72	80.64	0.2886	49.59	0.4959	0.1431	1	2	3	20.96
73	81.76	0.2538	49.77	0.4977	0.1263	1	8	9	71.25
74	82.88	0.3286	50.27	0.5027	0.1652	4	4	8	48.43
75	84	0.3565	50.43	0.5043	0.1798	1	7	8	44.50
76	85.12	0.3405	50.86	0.5086	0.1732	1	13	14	80.84
77	86.24	0.3088	51.29	0.5129	0.1584	3	2	5	31.57
78	87.36	0.2398	51.65	0.5165	0.1239	0	2	2	16.15
79	88.48	0.3392	51.73	0.5173	0.1755	2	5	7	39.89
80	89.6	0.2938	52.56	0.5256	0.1544	3	7	10	64.76
81	90.72	0.3275	54.08	0.5408	0.1771	1	10	11	62.11
82	91.84	0.3377	55.04	0.5504	0.1859	1	7	8	43.04
83	92.96	0.335	55.68	0.5568	0.1865	1	12	13	69.70
84	94.08	0.3737	56.08	0.5608	0.2096	6	6	12	57.26
85	95.2	0.4041	56.23	0.5623	0.2272	7	9	16	70.41
86	96.32	0.3772	56.47	0.5647	0.213	2	11	13	61.04
87	97.44	0.3849	56.65	0.5665	0.2181	3	17	20	91.72
88	98.56	0.5521	56.61	0.5661	0.3125	n/a	n/a	n/a	n/a
89	99.68	0.3735	56.12	0.5612	0.2096	8	18	26	124.04
90	100.8	0.3594	55.36	0.5536	0.199	5	9	14	70.36
91	101.92	0.3486	53.87	0.5387	0.1878	5	12	17	90.52
92	103.04	0.3949	54.45	0.5445	0.215	4	5	9	41.86
93	104.16	0.2977	54.56	0.5456	0.1624	5	15	20	123.13
94	105.28	0.3748	52.81	0.5281	0.1979	5	13	18	90.94
95	106.4	0.3286	53.47	0.5347	0.1757	5	11	16	91.06
96	107.52	0.3381	56.80	0.568	0.192	6	8	14	72.90
97	108.64	0.3436	58.27	0.5827	0.2002	8	17	25	124.86
98	109.76	0.3163	58.44	0.5844	0.1848	8	11	19	102.79
99	110.88	0.2805	58.46	0.5846	0.164	5	3	8	48.79
100	112	0.3443	57.57	0.5757	0.1982	17	12	29	146.30
101	113.12	0.2685	57.86	0.5786	0.1554	5	10	15	96.55
102	114.24	0.4101	57.95	0.5795	0.2377	10	14	24	100.98
103	115.36	0.4146	63.65	0.6365	0.2639	14	18	32	121.27
104	116.48	0.4727	67.42	0.6742	0.3187	8	15	23	72.17
31B	34.72	0.2765	44.83	0.44832	0.1239	1	3	4	32.27
31C	34.72	0.2469	44.83	0.44832	0.1106	0	1	1	9.03
31D	34.72	0.2361	44.83	0.44832	0.1058	1	3	4	37.79
31E	34.72	0.205	44.83	0.44832	0.0919	0	2	2	21.76
61B	68.32	0.3471	49.68	0.49676	0.1724	2	6	8	46.40
61C	68.32	0.2801	49.68	0.49676	0.1391	0	2	2	14.37
61D	68.32	0.2839	49.68	0.49676	0.141	2	2	4	28.36
61E	68.32	0.3207	49.68	0.49676	0.1593	3	4	7	43.94

91B	101.92	0.2909	53.87	0.53871	0.1567	4	11	15	95.72
91C	101.92	0.3151	53.87	0.53871	0.1697	6	7	13	76.58
91D	101.92	0.3238	53.87	0.53871	0.1744	3	4	7	40.13
91E	101.92	0.2881	53.87	0.53871	0.1552	2	7	9	57.99

APPENDIX F
Smoothed Medium and Large SCP Concentrations

Section #	Depth (cm)	Medium & Large SCP Concentrations (No. of SCPs gDW^{-1})	Smooth Medium & Large SCP Concentrations (No. of SCPs gDW^{-1})	Section #	Depth (cm)	Medium & Large SCP Concentrations (No. of SCPs gDW^{-1})	Smooth Medium & Large SCP Concentrations (No. of SCPs gDW^{-1})
1	1.12	10.27	35.40	53	59.36	19.17	23.38
2	2.24	69.90	35.40	54	60.48	34.90	25.10
3	3.36	50.62	35.40	55	61.6	25.05	25.96
4	4.48	29.27	31.15	56	62.72	54.70	23.22
5	5.6	16.43	22.66	57	63.84	17.77	16.20
6	6.72	16.54	18.42	58	64.96	0.00	10.40
7	7.84	20.93	21.27	59	66.08	5.83	8.86
8	8.96	21.16	28.75	60	67.2	42.44	9.90
9	10.08	46.44	35.15	61	68.32	5.92	12.81
10	11.2	62.17	36.93	62	69.44	17.73	16.02
11	12.32	0.00	31.26	63	70.56	75.73	17.85
12	13.44	37.10	19.71	64	71.68	11.32	18.34
13	14.56	0.00	13.64	65	72.8	17.00	19.39
14	15.68	10.50	13.90	66	73.92	24.91	23.85
15	16.8	37.37	19.31	67	75.04	56.70	29.87
16	17.92	14.31	29.06	68	76.16	30.95	33.37
17	19.04	40.63	34.12	69	77.28	39.10	34.93
18	20.16	40.20	34.40	70	78.4	18.94	36.43
19	21.28	26.64	32.39	71	79.52	76.00	41.73
20	22.4	8.72	25.37	72	80.64	20.96	49.98
21	23.52	116.32	17.18	73	81.76	71.25	53.80
22	24.64	7.89	12.84	74	82.88	48.43	53.85
23	25.76	24.56	10.56	75	84	44.50	49.24
24	26.88	0.00	9.24	76	85.12	80.84	40.04
25	28	0.00	11.18	77	86.24	31.57	35.43
26	29.12	41.36	19.56	78	87.36	16.15	36.39
27	30.24	32.47	32.04	79	88.48	39.89	41.36
28	31.36	23.20	40.42	80	89.6	64.76	50.01
29	32.48	59.40	42.56	81	90.72	62.11	57.07
30	33.6	50.10	41.58	82	91.84	43.04	60.13
31	34.72	31.73	37.08	83	92.96	69.70	61.19
32	35.84	15.07	31.00	84	94.08	57.26	62.62
33	36.96	35.15	28.46	85	95.2	70.41	66.96
34	38.08	0.00	33.17	86	96.32	61.04	75.30

35	39.2	41.22	42.59	87	97.44	91.72	82.20
36	40.32	55.57	47.30	88	98.56	n/a	n/a
37	41.44	94.12	43.81	89	99.68	124.04	84.98
38	42.56	24.24	36.54	90	100.8	70.36	86.55
39	43.68	23.17	31.88	91	101.92	90.52	86.75
40	44.8	31.81	30.30	92	103.04	41.86	87.21
41	45.92	35.22	29.53	93	104.16	123.13	89.47
42	47.04	33.87	27.89	94	105.28	90.94	90.81
43	48.16	20.79	24.79	95	106.4	91.06	91.19
44	49.28	19.93	23.24	96	107.52	72.90	92.56
45	50.4	24.77	25.48	97	108.64	124.86	95.57
46	51.52	94.17	35.75	98	109.76	102.79	98.36
47	52.64	0.00	49.58	99	110.88	48.79	99.14
48	53.76	59.14	55.39	100	112	146.30	100.07
49	54.88	55.64	54.89	101	113.12	96.55	102.57
50	56	58.68	47.95	102	114.24	100.98	107.39
51	57.12	28.90	33.79	103	115.36	121.27	115.05
52	58.24	18.77	24.30				

APPENDIX G

Coefficient of Variance Calculations

Section #	Medium & Large SCP Concentrations (No. of SCPs gDW^{-1})	Standard Deviation	Variance	Mean	Coefficient of Variance (CV)	CV Average
					= Standard Deviation / Mean	
31	31.73					
31B	32.27					
31C	9.03					
31D	37.79					
31E	21.76	11.35	128.89	26.52	0.43	
61	5.92					
61B	46.40					
61C	14.37					0.4628
61D	28.36					
61E	43.94	17.79	316.38	27.80	0.64	
91	90.52					
91B	95.72					
91C	76.58					
91D	40.13					
91E	57.99	23.12	534.62	72.19	0.32	

Section #	Depth (cm)	Smoothed Medium & Large SCP Concentrations (No. of SCPs gDW^{-1})	CV Average	Standard Deviation for Sample i (sd_i)	Upper and Lower Confidence Interval Limits for for Sample i	
				= CV Average * Smoothed Medium & Large Concentrations	= Smoothed Medium & Large SCP Concentrations + sd_i	= Smoothed Medium & Large SCP Concentrations - sd_i
1	1.12	35.4	0.4628	16.38	51.78	19.02
2	2.24	35.4	0.4628	16.38	51.78	19.02
3	3.36	35.4	0.4628	16.38	51.78	19.02
4	4.48	31.15	0.4628	14.42	45.57	16.73
5	5.6	22.66	0.4628	10.49	33.15	12.17
6	6.72	18.42	0.4628	8.52	26.94	9.90
7	7.84	21.27	0.4628	9.84	31.11	11.43

8	8.96	28.75	0.4628	13.30	42.05	15.45
9	10.08	35.15	0.4628	16.27	51.42	18.88
10	11.2	36.93	0.4628	17.09	54.02	19.84
11	12.32	31.26	0.4628	14.47	45.73	16.79
12	13.44	19.71	0.4628	9.12	28.83	10.59
13	14.56	13.64	0.4628	6.31	19.95	7.33
14	15.68	13.9	0.4628	6.43	20.33	7.47
15	16.8	19.31	0.4628	8.94	28.25	10.37
16	17.92	29.06	0.4628	13.45	42.51	15.61
17	19.04	34.12	0.4628	15.79	49.91	18.33
18	20.16	34.4	0.4628	15.92	50.32	18.48
19	21.28	32.39	0.4628	14.99	47.38	17.40
20	22.4	25.37	0.4628	11.74	37.11	13.63
21	23.52	17.18	0.4628	7.95	25.13	9.23
22	24.64	12.84	0.4628	5.94	18.78	6.90
23	25.76	10.56	0.4628	4.89	15.45	5.67
24	26.88	9.24	0.4628	4.28	13.52	4.96
25	28	11.18	0.4628	5.17	16.35	6.01
26	29.12	19.56	0.4628	9.05	28.61	10.51
27	30.24	32.04	0.4628	14.83	46.87	17.21
28	31.36	40.42	0.4628	18.71	59.13	21.71
29	32.48	42.56	0.4628	19.70	62.26	22.86
30	33.6	41.58	0.4628	19.24	60.82	22.34
31	34.72	37.08	0.4628	17.16	54.24	19.92
32	35.84	31	0.4628	14.35	45.35	16.65
33	36.96	28.46	0.4628	13.17	41.63	15.29
34	38.08	33.17	0.4628	15.35	48.52	17.82
35	39.2	42.59	0.4628	19.71	62.30	22.88
36	40.32	47.3	0.4628	21.89	69.19	25.41
37	41.44	43.81	0.4628	20.27	64.08	23.54
38	42.56	36.54	0.4628	16.91	53.45	19.63
39	43.68	31.88	0.4628	14.75	46.63	17.13
40	44.8	30.3	0.4628	14.02	44.32	16.28
41	45.92	29.53	0.4628	13.67	43.20	15.86
42	47.04	27.89	0.4628	12.91	40.80	14.98
43	48.16	24.79	0.4628	11.47	36.26	13.32
44	49.28	23.24	0.4628	10.75	33.99	12.49
45	50.4	25.48	0.4628	11.79	37.27	13.69
46	51.52	35.75	0.4628	16.54	52.29	19.21
47	52.64	49.58	0.4628	22.94	72.52	26.64
48	53.76	55.39	0.4628	25.63	81.02	29.76

49	54.88	54.89	0.4628	25.40	80.29	29.49
50	56	47.95	0.4628	22.19	70.14	25.76
51	57.12	33.79	0.4628	15.64	49.43	18.15
52	58.24	24.3	0.4628	11.25	35.55	13.05
53	59.36	23.38	0.4628	10.82	34.20	12.56
54	60.48	25.1	0.4628	11.62	36.72	13.48
55	61.6	25.96	0.4628	12.01	37.97	13.95
56	62.72	23.22	0.4628	10.75	33.97	12.47
57	63.84	16.2	0.4628	7.50	23.70	8.70
58	64.96	10.4	0.4628	4.81	15.21	5.59
59	66.08	8.86	0.4628	4.10	12.96	4.76
60	67.2	9.9	0.4628	4.58	14.48	5.32
61	68.32	12.81	0.4628	5.93	18.74	6.88
62	69.44	16.02	0.4628	7.41	23.43	8.61
63	70.56	17.85	0.4628	8.26	26.11	9.59
64	71.68	18.34	0.4628	8.49	26.83	9.85
65	72.8	19.39	0.4628	8.97	28.36	10.42
66	73.92	23.85	0.4628	11.04	34.89	12.81
67	75.04	29.87	0.4628	13.82	43.69	16.05
68	76.16	33.37	0.4628	15.44	48.81	17.93
69	77.28	34.93	0.4628	16.16	51.09	18.77
70	78.4	36.43	0.4628	16.86	53.29	19.57
71	79.52	41.73	0.4628	19.31	61.04	22.42
72	80.64	49.98	0.4628	23.13	73.11	26.85
73	81.76	53.8	0.4628	24.90	78.70	28.90
74	82.88	53.85	0.4628	24.92	78.77	28.93
75	84	49.24	0.4628	22.79	72.03	26.45
76	85.12	40.04	0.4628	18.53	58.57	21.51
77	86.24	35.43	0.4628	16.40	51.83	19.03
78	87.36	36.39	0.4628	16.84	53.23	19.55
79	88.48	41.36	0.4628	19.14	60.50	22.22
80	89.6	50.01	0.4628	23.14	73.15	26.87
81	90.72	57.07	0.4628	26.41	83.48	30.66
82	91.84	60.13	0.4628	27.83	87.96	32.30
83	92.96	61.19	0.4628	28.32	89.51	32.87
84	94.08	62.62	0.4628	28.98	91.60	33.64
85	95.2	66.96	0.4628	30.99	97.95	35.97
86	96.32	75.3	0.4628	34.85	110.15	40.45
87	97.44	82.2	0.4628	38.04	120.24	44.16
89	99.68	84.98	0.4628	39.33	124.31	45.65
90	100.8	86.55	0.4628	40.05	126.60	46.50

91	101.92	86.75	0.4628	40.15	126.90	46.60
92	103.04	87.21	0.4628	40.36	127.57	46.85
93	104.16	89.47	0.4628	41.40	130.87	48.07
94	105.28	90.81	0.4628	42.02	132.83	48.79
95	106.4	91.19	0.4628	42.20	133.39	48.99
96	107.52	92.56	0.4628	42.83	135.39	49.73
97	108.64	95.57	0.4628	44.23	139.80	51.34
98	109.76	98.36	0.4628	45.52	143.88	52.84
99	110.88	99.14	0.4628	45.88	145.02	53.26
100	112	100.07	0.4628	46.31	146.38	53.76
101	113.12	102.57	0.4628	47.47	150.04	55.10
102	114.24	107.39	0.4628	49.70	157.09	57.69
103	115.36	115.05	0.4628	53.24	168.29	61.81

APPENDIX H
Original and Smoothed Metal Concentrations

Original Concentrations (mg/kg)

Section #	**Depth (cm)**	**Be**	**Ca***	**Cd***	**Cr**	**Cu**	**K***	**Mg***	**Na**	**Ni**	**P***	**Pb**	**V**	**Zn**
1	1.12	0.89	2314.50	0.18	60.51	29.78	3499.50	4347.50	185.70	34.40	772.00	462.30	52.47	176.60
2	2.24	0.93	2311.50	0.24	63.64	25.32	3316.50	4438.50	176.70	42.98	704.55	242.40	48.47	140.15
3	3.36	0.91	2147.50	0.23	66.54	33.47	3750.50	4627.50	151.30	33.62	652.90	125.55	58.44	174.90
4	4.48	1.12	2478.00	0.32	68.03	29.42	3547.50	4908.00	163.10	37.82	721.30	910.25	55.72	160.10
5	5.6	1.01	2608.50	0.17	64.62	22.19	2751.00	4764.00	161.30	40.87	775.95	160.75	43.56	124.60
6	6.72	0.92	2266.50	0.15	65.24	28.32	3447.50	4859.50	149.90	37.67	713.25	116.08	52.29	153.45
7	7.84	0.90	2416.50	0.14	66.26	27.67	3210.50	4856.00	150.70	39.02	740.20	65.38	51.14	152.70
8	8.96	0.85	2085.00	0.19	63.78	31.03	3689.00	4440.00	147.15	31.72	630.45	63.22	55.30	180.50
9	10.08	0.93	2343.50	0.15	65.83	27.24	3260.00	4918.00	145.80	36.93	739.45	88.76	51.56	153.75
10	11.2	0.89	2315.50	0.15	63.86	27.94	3032.50	4760.00	140.25	37.33	614.10	92.31	49.77	153.50
11	12.32	0.90	2583.00	0.05	61.66	24.23	2561.00	4950.50	135.85	42.53	637.25	63.42	43.74	111.80
12	13.44	0.92	2625.50	0.07	61.25	19.77	2674.50	4906.00	157.85	43.06	632.65	62.91	43.49	110.40
13	14.56	0.83	2111.00	0.19	62.13	31.24	3504.00	4450.50	138.85	31.09	530.35	59.96	53.57	181.55
14	15.68	0.88	2433.50	0.12	61.10	26.32	3075.50	4698.50	151.40	37.82	573.55	63.51	48.94	151.35
15	16.8	0.93	2696.50	0.05	62.29	23.92	2638.50	5078.50	149.40	43.78	620.15	67.87	44.13	105.75
16	17.92	0.86	2346.00	0.13	61.27	26.94	3077.00	4745.00	136.75	38.90	531.55	63.88	49.70	149.40
17	19.04	0.87	2143.00	0.19	60.35	29.95	3447.50	4428.00	139.00	32.70	497.40	153.05	52.53	170.45
18	20.16	0.86	2100.00	0.20	61.36	30.08	3483.50	4412.00	137.00	31.08	494.20	58.65	52.18	169.35
19	21.28	0.90	2130.50	0.22	60.28	24.55	3310.50	4360.50	144.60	30.91	495.35	57.52	48.56	145.85
20	22.4	0.85	2227.50	0.14	61.14	26.89	3027.50	4689.50	136.05	37.56	537.80	60.15	49.22	137.28
21	23.52	0.95	2272.50	0.20	59.54	21.08	2594.50	4524.50	142.20	39.21	529.35	58.46	40.67	107.60
22	24.64	0.90	2041.50	0.22	58.94	23.43	3207.00	4291.50	149.85	36.02	497.95	58.01	45.23	145.85

23	25.76	0.91	2184.50	0.17	58.55	20.75	2507.50	4544.00	139.15	37.99	537.35	58.26	40.42	104.38
24	26.88	0.86	1948.50	0.24	58.50	23.63	3001.50	4206.50	143.80	42.36	492.15	54.94	44.40	137.40
25	28	0.97	2068.00	0.27	58.72	18.61	3071.00	4327.50	165.20	50.03	513.05	55.98	40.90	114.25
26	29.12	0.86	1935.50	0.23	57.98	23.74	2858.00	4213.00	131.95	32.08	513.05	56.88	43.91	145.00
27	30.24	0.95	2018.00	0.26	57.24	18.35	2695.00	4173.50	151.40	40.93	521.85	54.86	38.90	105.95
28	31.36	0.83	1844.50	0.19	58.23	28.12	3442.00	4261.00	134.60	31.60	506.15	58.43	52.01	170.40
29	32.48	0.89	1903.50	0.22	57.27	22.93	3011.50	4272.50	142.65	32.00	525.25	57.48	45.41	142.60
30	33.6	0.92	1938.00	0.26	56.91	18.64	2519.50	4133.50	140.80	32.66	533.70	56.27	38.92	111.40
31	34.72	0.86	1815.50	0.21	56.71	23.32	3032.00	4251.50	135.50	31.21	518.15	55.95	45.83	140.50
32	35.84	0.90	1862.00	0.25	59.20	23.63	3350.50	4314.50	143.75	33.87	528.15	58.69	47.48	145.65
33	36.96	0.87	1786.50	0.25	59.99	23.69	3113.00	4214.50	131.45	31.85	518.35	57.28	46.59	149.10
34	38.08	0.83	1743.50	0.18	56.58	26.47	3464.00	4289.00	134.15	30.21	521.80	58.08	50.99	162.35
35	39.2	0.90	1825.00	0.31	55.82	17.84	2791.50	4063.00	146.85	43.84	534.60	56.07	39.91	106.20
36	40.32	0.89	1812.00	0.28	54.63	17.58	2668.50	4060.00	145.45	46.54	540.10	57.10	36.45	104.35
37	41.44	0.83	1715.00	0.27	55.45	22.63	2867.50	4039.00	128.45	32.21	525.30	56.47	43.10	130.53
38	42.56	0.89	1796.00	0.29	55.04	17.86	2550.50	4052.00	139.80	38.11	552.40	56.59	37.32	107.45
39	43.68	0.78	1614.00	0.21	55.30	26.86	3311.00	4064.50	119.45	31.60	526.00	57.45	48.90	161.85
40	44.8	0.78	1638.00	0.18	52.57	25.48	2931.50	4061.00	118.40	31.81	531.60	57.10	45.53	153.20
41	45.92	0.84	1933.00	0.12	57.01	22.21	2254.50	4617.50	121.15	41.69	659.85	63.68	39.62	116.35
42	47.04	0.78	1592.00	0.26	53.72	22.29	2551.50	3905.00	113.05	28.49	549.20	54.04	41.02	142.65
43	48.16	0.83	1769.50	0.20	54.04	19.31	2334.50	4151.50	119.25	37.90	609.55	58.78	37.40	101.21
44	49.28	0.77	1665.50	0.19	55.51	24.04	2593.50	4208.50	108.80	34.09	606.65	59.21	42.32	144.30
45	50.4	0.72	1443.50	0.25	55.24	27.12	2927.50	3932.50	102.35	28.67	565.35	58.72	47.47	179.05
46	51.52	0.82	1855.50	0.17	54.70	19.47	2230.00	4399.50	117.20	39.49	687.15	63.04	39.19	102.89
47	52.64	0.75	1620.00	0.21	53.99	24.09	2261.00	4047.50	100.31	34.66	650.35	59.70	40.86	143.00
48	53.76	0.75	1618.50	0.17	54.70	23.79	2580.00	4115.50	103.90	35.07	681.50	60.28	43.48	137.50
49	54.88	0.74	1586.00	0.18	53.94	22.99	2351.50	4051.00	100.26	33.52	619.30	59.83	42.65	132.80

50	56	0.79	1755.50	0.14	54.37	20.04	2162.50	4357.50	106.60	38.99	620.10	62.27	40.16	112.75
51	57.12	0.77	1592.50	0.20	55.35	25.70	2461.00	4161.00	100.11	34.04	616.55	60.17	44.13	140.90
52	58.24	0.81	1767.50	0.14	56.07	22.68	2414.00	4577.00	114.45	38.87	658.80	64.99	42.17	113.75
53	59.36	0.79	1565.00	0.21	56.47	24.96	2854.50	4290.50	106.95	33.87	650.90	61.88	46.14	144.85
54	60.48	0.72	1403.00	0.23	56.14	27.19	2885.00	4029.50	99.98	31.12	597.30	58.98	48.49	177.80
55	61.6	0.80	1655.00	0.20	57.94	24.50	2870.00	4424.50	116.70	36.27	632.70	63.79	47.50	162.50
56	62.72	0.83	1660.00	0.24	54.12	20.50	2322.00	4343.50	115.70	36.92	637.20	64.30	38.11	117.00
57	63.84	0.84	1659.50	0.26	54.71	19.89	2442.50	4277.00	114.75	37.17	648.10	63.79	39.32	124.40
58	64.96	0.85	1570.00	0.36	52.82	16.86	2372.50	3907.50	117.75	32.71	640.50	60.60	36.62	114.25
59	66.08	0.84	1667.50	0.26	54.57	20.05	2278.00	4246.50	114.10	39.47	673.85	63.66	37.46	118.00
60	67.2	0.84	1679.50	0.29	53.69	19.42	2277.50	4224.50	109.95	37.34	650.30	63.79	37.99	117.95
61	68.32	0.83	1805.50	0.21	56.85	21.47	2416.00	4681.00	114.90	42.43	730.70	69.20	42.26	125.90
62	69.44	0.84	1688.50	0.29	55.13	21.74	2443.00	4336.50	109.10	36.01	757.45	67.17	38.72	118.55
63	70.56	0.80	1631.00	0.35	51.92	21.11	2040.50	4132.00	104.91	38.39	673.60	67.33	35.28	129.40
64	71.68	0.77	1477.00	0.34	52.63	23.02	2553.50	3920.00	101.80	32.28	663.85	61.58	40.82	154.65
65	72.8	0.78	1737.00	0.31	53.62	21.62	2184.50	4268.50	109.35	40.54	648.40	69.97	38.82	127.05
66	73.92	0.78	1615.50	0.37	51.57	20.65	2092.50	3902.00	103.02	35.18	705.75	67.78	36.69	135.00
67	75.04	0.80	1608.50	0.38	51.81	21.74	2028.00	3992.50	103.46	36.78	711.30	68.70	35.77	143.95
68	76.16	0.81	1551.00	0.47	51.30	18.84	2208.50	3764.00	111.30	31.94	697.35	66.86	34.90	130.30
69	77.28	0.82	1575.00	0.48	51.67	19.61	2168.00	3756.50	112.20	31.02	732.00	66.91	34.68	133.75
70	78.4	0.81	1576.00	0.47	50.90	19.89	2197.50	3739.00	111.35	30.64	637.70	66.52	34.32	134.25
71	79.52	0.84	1588.00	0.52	51.99	20.79	2385.50	3635.00	112.85	29.09	604.30	66.52	36.43	132.35
72	80.64	0.77	1579.00	0.43	50.75	24.04	2120.00	3767.50	101.52	33.38	637.60	68.68	36.07	136.75
73	81.76	0.76	1582.00	0.42	50.49	26.14	1994.00	3858.00	95.78	37.54	650.10	69.01	35.88	134.45
74	82.88	0.79	1509.00	0.49	49.92	25.28	2094.50	3515.50	105.50	28.60	643.95	63.85	33.87	133.90
75	84	0.77	1567.50	0.40	50.98	30.12	2119.50	3885.00	96.88	34.17	645.65	66.27	36.44	128.75
76	85.12	0.69	1446.50	0.35	51.34	31.96	2169.50	3783.00	78.88	35.25	661.65	64.98	41.11	164.50

77	86.24	0.68	1283.00	0.38	51.85	29.72	2645.50	3568.50	80.04	28.47	595.30	59.52	45.66	192.60
78	87.36	0.67	1261.00	0.39	50.89	28.48	2782.00	3536.50	81.09	26.18	620.60	59.12	46.35	194.70
79	88.48	0.77	1551.50	0.42	49.18	19.92	1992.00	3660.50	104.20	33.68	719.50	62.75	36.09	137.85
80	89.6	0.71	1438.00	0.40	49.88	26.17	2292.50	3727.50	88.13	34.10	707.85	64.36	41.24	167.20
81	90.72	0.72	1307.50	0.46	48.76	25.63	2338.50	3394.00	85.65	26.83	633.20	58.76	39.34	162.15
82	91.84	0.64	1192.00	0.42	48.45	31.13	2442.00	3338.50	71.79	26.93	614.10	56.46	43.82	188.55
83	92.96	0.72	1512.00	0.33	48.84	32.73	1891.00	3877.00	80.62	37.18	683.15	62.66	37.51	119.95
84	94.08	0.70	1369.00	0.36	50.06	35.49	2423.50	3754.00	77.77	31.24	630.05	60.32	42.93	161.85
85	95.2	0.71	1311.00	0.43	48.37	39.57	2336.50	3492.50	86.61	26.89	616.00	56.37	39.07	152.65
86	96.32	0.65	1204.00	0.37	49.06	49.12	2473.50	3461.50	68.06	27.68	601.20	54.37	44.37	184.80
87	97.44	0.74	1585.00	0.31	50.61	23.11	2078.00	4116.00	88.08	37.04	731.50	63.32	39.78	127.45
88	98.56	0.75	1460.00	0.47	46.23	17.48	2365.00	3444.00	93.59	29.24	680.20	58.36	38.64	152.50
89	99.68	0.69	1401.50	0.41	49.62	21.30	2436.50	3661.50	77.93	30.29	726.05	61.44	44.63	169.80
90	100.8	0.72	1364.00	0.49	47.54	18.33	2209.50	3453.50	81.72	26.78	714.60	59.15	38.66	161.55
91	101.92	0.79	1528.00	0.51	46.39	13.39	2120.00	3392.50	100.72	30.20	711.80	57.83	34.53	119.85
92	103.04	0.76	1504.50	0.49	45.23	13.29	1801.00	3174.50	89.89	24.78	699.90	55.80	32.99	113.95
93	104.16	0.74	1629.50	0.43	47.39	15.66	1938.00	3610.50	89.14	35.03	803.25	60.20	36.80	122.50
94	105.28	0.77	1645.00	0.50	45.31	12.71	1871.50	3375.00	95.82	30.93	806.75	56.01	32.23	121.60
95	106.4	0.78	1698.00	0.52	45.81	12.51	2090.50	3383.00	98.99	28.49	746.40	56.53	34.06	114.90
96	107.52	0.74	1718.00	0.46	46.23	14.54	1863.00	3496.00	83.86	32.13	768.90	58.78	33.26	124.05
97	108.64	0.71	1555.50	0.50	46.01	17.14	2140.00	3412.50	77.92	29.25	750.05	56.66	36.89	159.50
98	109.76	0.76	1743.00	0.48	44.24	15.16	2215.50	3464.00	89.51	28.22	766.55	57.97	35.60	139.65
99	110.88	0.79	1841.00	0.57	46.06	13.30	1892.50	3579.00	90.68	31.52	809.90	58.31	31.08	123.05
100	112	0.83	1952.50	0.63	49.47	14.23	2325.50	3741.00	96.92	34.13	800.10	60.15	34.49	130.35
101	113.12	0.84	2033.00	0.66	47.72	14.86	2032.50	3761.00	94.16	33.04	823.50	59.21	30.83	140.30
102	114.24	0.81	1783.00	0.66	43.17	13.51	1870.50	3282.00	86.82	29.54	737.50	53.88	28.69	132.45
103	115.36	0.77	1438.50	0.51	38.41	11.34	1546.00	2880.00	75.33	27.26	636.50	48.83	27.02	113.05

*Estimate- Outside the Calibration Range

Smoothed Concentrations (mg/kg)

Section #	Depth (cm)	Be	Ca*	Cd*	Cr	Cu	K*	Mg*	Na	Ni	P*	Pb	V	Zn
1	1.12	0.89	2314.50	0.22	61.06	28.72	3499.50	4347.50	185.70	36.60	728.18	442.62	52.47	169.08
2	2.24	0.92	2329.10	0.22	63.85	28.56	3481.90	4472.00	176.19	37.32	725.40	341.31	52.66	161.86
3	3.36	0.96	2366.40	0.22	65.52	28.46	3473.60	4612.60	167.54	37.82	723.81	249.98	53.06	156.77
4	4.48	0.97	2397.30	0.21	65.97	28.34	3464.60	4742.70	161.11	38.10	723.85	174.26	53.26	153.86
5	5.6	0.96	2405.40	0.18	65.97	28.16	3434.70	4818.90	157.11	38.19	724.78	132.99	53.02	153.25
6	6.72	0.94	2377.90	0.16	65.87	28.03	3393.80	4838.90	153.74	38.06	725.34	110.01	52.50	153.78
7	7.84	0.91	2322.90	0.15	65.58	27.98	3363.60	4838.90	150.34	37.79	721.40	89.35	52.12	153.98
8	8.96	0.89	2295.40	0.15	65.10	27.88	3317.30	4838.90	147.37	37.66	701.84	79.31	51.77	153.93
9	10.08	0.89	2324.20	0.14	64.30	27.42	3194.20	4840.30	144.39	37.84	668.47	77.24	50.73	150.84
10	11.2	0.90	2405.30	0.12	63.28	26.45	3004.20	4841.30	142.21	38.78	643.10	75.26	48.51	140.98
11	12.32	0.90	2482.00	0.10	62.35	25.57	2863.70	4838.90	141.59	40.12	630.25	70.09	46.36	130.44
12	13.44	0.90	2507.30	0.09	61.79	25.25	2824.70	4832.80	142.67	40.70	617.66	64.84	45.60	126.70
13	14.56	0.89	2508.00	0.10	61.62	25.24	2856.40	4814.90	144.85	40.53	599.59	63.02	46.09	129.81
14	15.68	0.88	2482.50	0.10	61.57	25.60	2951.60	4780.90	145.94	39.88	575.81	63.36	47.59	139.57
15	16.8	0.87	2409.40	0.12	61.44	26.62	3076.30	4733.80	144.94	38.74	551.93	64.05	49.42	151.24
16	17.92	0.87	2301.50	0.14	61.27	27.79	3201.10	4641.60	141.94	36.57	528.35	64.39	50.59	157.71
17	19.04	0.87	2200.50	0.17	61.06	28.42	3298.60	4516.10	138.92	33.91	508.27	63.29	51.01	159.16
18	20.16	0.87	2156.80	0.19	60.88	28.44	3332.60	4443.90	137.91	32.75	500.91	60.75	51.00	157.12
19	21.28	0.88	2157.70	0.20	60.66	27.34	3281.00	4437.00	138.58	33.39	504.52	58.83	50.21	149.80
20	22.4	0.89	2165.40	0.20	60.19	25.06	3127.70	4447.30	140.32	35.20	511.76	58.21	48.06	138.92
21	23.52	0.90	2169.30	0.20	59.53	23.11	2976.20	4455.60	141.84	37.22	515.38	58.09	45.22	129.37
22	24.64	0.90	2151.30	0.21	58.96	22.22	2917.70	4437.70	142.88	38.72	514.73	57.90	43.23	124.12
23	25.76	0.90	2102.20	0.22	58.64	21.95	2907.30	4371.00	144.25	39.80	513.43	57.30	42.56	123.60
24	26.88	0.90	2047.50	0.23	58.46	21.92	2918.90	4291.20	145.30	40.27	512.77	56.62	42.45	125.00

25	28	0.89	2009.60	0.24	58.28	21.88	2939.00	4243.50	145.30	40.25	512.77	56.36	42.36	126.07
26	29.12	0.89	1983.30	0.24	58.04	21.83	2945.70	4228.80	143.93	38.88	513.52	56.47	42.55	128.67
27	30.24	0.89	1956.40	0.23	57.68	21.80	2945.70	4229.00	141.76	35.59	516.55	56.71	43.02	132.98
28	31.36	0.89	1928.70	0.23	57.32	21.93	2946.40	4232.70	140.42	32.81	520.96	56.85	43.56	136.04
29	32.48	0.89	1905.60	0.23	57.17	22.45	2967.60	4239.40	140.04	31.99	523.68	56.87	44.54	138.45
30	33.6	0.89	1884.60	0.23	57.29	23.13	3016.00	4250.40	139.96	31.93	524.21	56.87	45.77	141.49
31	34.72	0.88	1858.10	0.23	57.56	23.48	3070.70	4259.80	139.82	31.94	524.12	56.98	46.40	143.29
32	35.84	0.88	1825.90	0.24	57.74	23.53	3116.90	4259.80	139.54	32.07	524.32	57.21	46.48	143.48
33	36.96	0.87	1803.70	0.24	57.64	23.11	3136.10	4240.80	139.40	33.37	525.14	57.33	46.13	141.90
34	38.08	0.87	1796.70	0.26	57.02	21.73	3062.50	4184.20	139.53	36.43	526.86	57.25	44.51	133.90
35	39.2	0.88	1794.70	0.27	56.06	20.20	2901.20	4105.90	139.79	39.02	529.16	57.01	42.20	122.24
36	40.32	0.87	1788.40	0.28	55.41	19.63	2795.70	4057.90	139.68	39.75	531.48	56.77	41.15	117.09
37	41.44	0.86	1758.80	0.27	55.17	20.44	2786.60	4048.50	136.52	38.10	532.85	56.69	41.42	120.90
38	42.56	0.83	1709.10	0.25	55.09	22.29	2799.50	4051.50	129.13	34.76	532.38	56.76	42.03	130.48
39	43.68	0.81	1679.10	0.22	54.97	23.56	2794.10	4056.20	122.17	33.06	532.88	56.98	42.38	138.24
40	44.8	0.80	1668.40	0.19	54.73	23.65	2741.70	4066.00	118.89	33.04	540.32	57.28	42.29	140.13
41	45.92	0.79	1662.40	0.19	54.56	23.21	2639.60	4085.70	117.55	33.09	559.81	57.73	41.84	139.21
42	47.04	0.79	1667.60	0.19	54.56	22.74	2553.30	4104.80	115.70	33.23	582.35	58.35	41.24	136.58
43	48.16	0.79	1673.10	0.20	54.67	22.58	2502.40	4111.40	113.01	33.62	594.54	58.76	40.92	133.72
44	49.28	0.78	1673.10	0.20	54.79	22.66	2462.80	4111.40	110.57	34.21	605.26	58.94	40.92	133.29
45	50.4	0.77	1662.20	0.20	54.84	22.93	2440.60	4109.20	107.68	34.59	626.85	59.24	41.16	134.53
46	51.52	0.75	1637.50	0.19	54.73	23.26	2410.60	4099.40	104.29	34.77	648.67	59.65	41.53	135.16
47	52.64	0.75	1620.70	0.18	54.49	23.39	2364.40	4086.30	102.38	34.86	656.70	59.93	41.78	135.16
48	53.76	0.75	1617.80	0.17	54.35	23.39	2333.30	4082.30	102.04	34.86	648.66	60.04	41.97	135.16
49	54.88	0.75	1620.00	0.17	54.38	23.39	2330.60	4113.90	102.10	34.95	632.58	60.24	42.30	134.09
50	56	0.77	1624.60	0.17	54.66	23.39	2350.00	4191.70	102.76	35.12	624.54	60.76	42.64	131.96
51	57.12	0.78	1626.80	0.18	55.30	23.76	2413.80	4265.20	104.11	35.20	627.29	61.39	43.25	130.89
52	58.24	0.78	1623.90	0.19	55.94	24.57	2585.70	4298.20	105.58	35.19	632.88	61.80	44.69	136.73

53	59.36	0.79	1618.20	0.20	56.20	25.08	2786.00	4310.70	107.92	35.16	636.28	62.23	46.26	148.40
54	60.48	0.79	1617.10	0.22	56.21	24.91	2864.30	4320.50	111.17	35.31	637.16	62.87	46.85	154.23
55	61.6	0.81	1629.50	0.23	55.85	23.66	2795.20	4325.20	113.88	35.87	637.44	63.44	45.57	149.86
56	62.72	0.83	1649.50	0.24	55.02	21.47	2606.40	4315.70	115.31	36.60	638.37	63.75	42.06	136.61
57	63.84	0.84	1660.70	0.26	54.37	19.87	2422.40	4291.10	115.62	37.12	641.77	63.71	38.80	122.96
58	64.96	0.84	1664.80	0.27	54.21	19.45	2344.90	4270.40	115.43	37.58	648.24	63.48	37.73	117.95
59	66.08	0.84	1670.70	0.27	54.28	19.60	2331.60	4264.40	114.81	38.01	665.08	63.59	37.74	117.71
60	67.2	0.84	1675.50	0.27	54.43	20.17	2336.90	4264.70	113.15	38.14	689.17	64.55	38.00	118.35
61	68.32	0.83	1677.00	0.28	54.53	20.94	2352.20	4266.30	110.50	37.99	701.25	66.06	38.45	120.81
62	69.44	0.82	1672.10	0.30	54.38	21.47	2366.80	4257.30	107.94	37.65	697.96	67.08	38.84	124.69
63	70.56	0.80	1657.80	0.31	53.78	21.69	2341.30	4211.20	105.98	37.31	689.75	67.37	38.93	128.23
64	71.68	0.78	1637.80	0.33	52.93	21.73	2250.10	4117.00	104.49	36.97	685.64	67.58	38.73	131.09
65	72.8	0.78	1619.90	0.35	52.27	21.65	2158.30	4013.20	103.90	36.53	688.36	67.88	38.12	133.41
66	73.92	0.78	1608.80	0.37	51.88	21.22	2127.50	3938.20	104.61	35.88	693.81	68.00	37.03	134.43
67	75.04	0.80	1597.80	0.40	51.63	20.39	2133.70	3868.80	106.97	34.41	696.53	67.73	35.78	134.19
68	76.16	0.81	1585.00	0.45	51.50	19.73	2152.70	3793.10	109.53	32.32	694.46	67.18	35.02	133.52
69	77.28	0.81	1578.20	0.47	51.42	19.56	2172.40	3745.60	110.44	31.01	679.53	66.90	34.84	133.35
70	78.4	0.81	1577.70	0.47	51.27	19.96	2179.20	3732.40	110.32	30.87	653.43	66.97	34.98	133.67
71	79.52	0.80	1580.00	0.47	50.98	21.36	2164.80	3735.10	109.00	31.22	637.74	67.22	35.35	133.82
72	80.64	0.79	1582.30	0.46	50.71	23.44	2129.10	3745.40	105.71	31.92	637.11	67.50	35.61	133.83
73	81.76	0.78	1577.90	0.44	50.61	25.64	2100.90	3754.80	101.67	32.80	640.75	67.46	35.63	133.90
74	82.88	0.77	1554.10	0.42	50.72	27.87	2094.00	3758.00	97.41	33.19	642.57	66.77	35.98	135.89
75	84	0.74	1494.00	0.39	50.98	29.53	2149.70	3740.10	91.33	32.76	643.06	65.26	37.95	147.07
76	85.12	0.71	1410.30	0.38	51.18	30.03	2290.20	3694.10	85.11	31.82	644.06	63.29	41.00	165.74
77	86.24	0.69	1354.50	0.38	51.19	29.57	2404.00	3646.50	82.67	31.21	646.14	61.74	42.64	177.27
78	87.36	0.69	1346.60	0.39	50.87	28.19	2431.60	3614.50	83.52	30.96	654.38	61.05	42.79	178.95
79	88.48	0.70	1358.20	0.40	50.15	26.72	2406.20	3589.70	85.23	30.67	666.11	60.88	42.17	174.86
80	89.6	0.71	1363.90	0.40	49.32	26.19	2359.90	3567.20	86.08	30.40	671.18	60.79	41.08	167.97

81	90.72	0.71	1361.10	0.40	48.84	27.21	2337.60	3557.10	84.75	30.14	664.21	60.55	40.56	164.31
82	91.84	0.71	1351.60	0.40	48.71	30.13	2348.30	3570.10	81.90	29.78	644.95	59.93	40.68	162.54
83	92.96	0.71	1341.00	0.39	48.71	33.56	2369.80	3595.90	80.21	29.44	627.32	59.04	40.92	159.66
84	94.08	0.71	1337.20	0.38	48.85	35.70	2380.50	3608.90	80.04	29.26	622.00	58.43	41.05	157.55
85	95.2	0.71	1343.20	0.37	49.10	36.32	2379.50	3603.90	80.85	29.22	624.05	58.27	41.03	156.95
86	96.32	0.71	1367.20	0.38	49.27	33.89	2379.80	3591.60	82.94	29.23	638.19	58.38	40.90	157.07
87	97.44	0.72	1402.70	0.39	49.28	27.58	2378.40	3563.60	84.76	29.18	669.60	58.59	40.69	158.16
88	98.56	0.72	1425.90	0.42	48.95	21.73	2356.00	3520.50	85.46	29.08	698.65	58.71	40.10	159.99
89	99.68	0.73	1434.50	0.45	48.06	18.68	2306.60	3477.20	85.75	29.12	710.01	58.71	38.89	158.86
90	100.8	0.74	1451.00	0.48	47.21	16.66	2224.70	3436.30	86.48	29.31	713.92	58.66	37.39	149.22
91	101.92	0.75	1491.10	0.49	46.75	14.97	2097.40	3409.70	88.44	29.40	722.94	58.34	35.85	132.92
92	103.04	0.76	1550.80	0.49	46.30	13.84	1976.80	3399.60	90.74	29.62	743.19	57.69	34.41	121.22
93	104.16	0.76	1613.40	0.49	45.91	13.37	1925.70	3393.60	91.67	30.06	764.38	57.12	33.48	118.19
94	105.28	0.76	1658.50	0.49	45.80	13.31	1920.80	3390.70	91.68	30.28	771.53	56.89	33.25	118.89
95	106.4	0.75	1681.70	0.48	45.85	13.58	1961.20	3394.50	90.57	30.21	770.43	56.89	33.61	121.92
96	107.52	0.75	1699.20	0.48	45.91	14.22	2044.90	3410.60	88.35	30.09	769.93	57.13	34.30	127.41
97	108.64	0.75	1727.40	0.49	45.96	14.75	2099.50	3443.20	87.25	30.03	770.64	57.61	34.75	132.50
98	109.76	0.76	1782.50	0.52	46.17	14.89	2120.00	3508.00	88.58	30.47	778.13	58.18	34.75	134.86
99	110.88	0.79	1856.10	0.57	46.58	14.79	2131.20	3586.90	91.42	31.34	791.06	58.60	34.08	135.39
100	112	0.81	1902.20	0.62	46.84	14.50	2104.80	3622.20	93.11	31.78	797.18	58.63	32.53	135.07
101	113.12	0.82	1885.70	0.64	46.12	14.05	2018.90	3550.60	91.93	31.41	782.35	57.47	30.71	133.13
102	114.24	0.81	1754.00	0.61	43.43	13.17	1849.70	3313.10	86.41	30.02	731.71	54.17	28.93	127.19
103	115.36	0.78	1516.40	0.53	39.74	11.78	1615.50	3016.60	77.55	28.16	662.75	49.64	26.89	115.29
104	116.48	0.76	1278.00	0.41	36.75	10.33	1391.50	2808.00	69.02	26.89	605.25	45.48	24.61	99.49

*Estimate- Outside the Calibration Range

APPENDIX I

Quality Assurance and Quality Control

Calibration Limits

Element	Range
Ca, Mg	0.2 to 6 ppm
P	0 to 10 ppm
K	0 to 2 ppm
Be, Cd, Cr, Cu, Mg, Na, Ni, Pb, V, Zn	0.1 to 3.5 ppm

Percent Recovery: Standard Reference Material® 2702 – Marine Sediment

Sample	Element	Mass Fraction (mg/kg)	Standard Mass Fraction (mg/kg)	%Recovery	Average % Recovery	Element	Mass Fraction (mg/kg)	Mass Fraction %	Standard Mass Fraction %	%Recovery	Average % Recovery
				= Mass Fraction / Standard Mass Fraction *100				=Mass Fraction / 10,000		= Mass Fraction % / Standard Mass Fraction % *100	
	Be*					**Ca*****					
MS A		1.7	3	56.7	51.3		2551	0.2551	0.343	74.373	70.49
MS B		1.48	3	49.3			2184	0.2184	0.343	63.673	
MS C		1.54	3	51.3			2727	0.2727	0.343	79.504	
MS D		1.57	3	52.3			2788	0.2788	0.343	81.283	
MS E		1.48	3	49.3			3069	0.3069	0.343	89.475	
MS F		1.47	3	49			2140	0.214	0.343	62.391	
MS G		1.5	3	50			2130	0.213	0.343	62.099	

MS H		1.5	3	50			2126	0.2126	0.343	61.983	
MS I		1.62	3	54			2470	0.247	0.343	72.012	
MS J		1.5	3	50			2234	0.2234	0.343	65.131	
MS K		1.51	3	50.3			2203	0.2203	0.343	64.227	
MS L		1.6	3	53.3			2390	0.239	0.343	69.679	
	Cd**					**K****					
MS A		0.53	0.817	64.87	83.54		4600	0.4600	2.054	22.395	23.97
MS B		0.67	0.817	82.01			5274	0.5274	2.054	25.677	
MS C		0.66	0.817	80.78			4035	0.4035	2.054	19.645	
MS D		0.67	0.817	82.01			4087	0.4087	2.054	19.898	
MS E		0.71	0.817	86.90			5311	0.5311	2.054	25.857	
MS F		0.7	0.817	85.68			5391	0.5391	2.054	26.246	
MS G		0.74	0.817	90.58			5272	0.5272	2.054	25.667	
MS H		0.74	0.817	90.58			5154	0.5154	2.054	25.093	
MS I		0.88	0.817	107.71			4213	0.4213	2.054	20.511	
MS J		0.66	0.817	80.78			5299	0.5299	2.054	25.798	
MS K		0.67	0.817	82.01			5397	0.5397	2.054	26.276	
MS L		0.56	0.817	68.54			5054	0.5054	2.054	24.606	
	Cr					**Mg*****					
MS A		320.9	352	91.2	96.3		6599	0.6599	0.99	66.66	65.24
MS B		353.4	352	100.4			6403	0.6403	0.99	64.68	
MS C		324.6	352	92.2			7216	0.7216	0.99	72.89	
MS D		329	352	93.5			7338	0.7338	0.99	74.12	
MS E		363.4	352	103.2			6396	0.6396	0.99	64.61	
MS F		360.9	352	102.5			6373	0.6373	0.99	64.37	

MS G		351.7	352	99.9			6314	0.6314	0.99	63.78	
MS H		346.7	352	98.5			6192	0.6192	0.99	62.55	
MS I		303.8	352	86.3			6105	0.6105	0.99	61.67	
MS J		343.4	352	97.6			6073	0.6073	0.99	61.34	
MS K		345.6	352	98.2			6231	0.6231	0.99	62.94	
MS L		322.8	352	91.7			6260	0.626	0.99	63.23232	
	Ni					**Na**					
MS A		60.54	75.4	80.3	71.6		5381	0.5381	0.681	79.016	69.38
MS B		52.82	75.4	70.1			4618	0.4618	0.681	67.812	
MS C		65.32	75.4	86.6			4901	0.4901	0.681	71.968	
MS D		66.52	75.4	88.2			5001	0.5001	0.681	73.436	
MS E		47.62	75.4	63.2			4635	0.4635	0.681	68.062	
MS F		47.65	75.4	63.2			4487	0.4487	0.681	65.888	
MS G		48.26	75.4	64.0			4457	0.4457	0.681	65.448	
MS H		47.37	75.4	62.8			4455	0.4455	0.681	65.419	
MS I		56.56	75.4	75.0			4551	0.4551	0.681	66.828	
MS J		50.9	75.4	67.5			4669	0.4669	0.681	68.561	
MS K		52.25	75.4	69.3			4647	0.4647	0.681	68.238	
MS L		52.35	75.4	69.4			4891	0.4891	0.681	71.821	
	Pb					**P****					
MS A		156.4	132.8	117.8	113.9		1168	0.1168	0.1552	75.2577	73.89
MS B		150.4	132.8	113.3			1063	0.1063	0.1552	68.4923	
MS C		165	132.8	124.2			1292	0.1292	0.1552	83.2474	
MS D		168	132.8	126.5			1324	0.1324	0.1552	85.3093	
MS E		148.9	132.8	112.1			1126	0.1126	0.1552	72.5516	

MS F		146.8	132.8	110.5			1115	0.1115	0.1552	71.8428	
MS G		146.3	132.8	110.2			1105	0.1105	0.1552	71.1985	
MS H		145.4	132.8	109.5			1090	0.109	0.1552	70.2320	
MS I		146	132.8	109.9			1167	0.1167	0.1552	75.1933	
MS J		146	132.8	109.9			1090	0.109	0.1552	70.2320	
MS K		147.5	132.8	111.1			1087	0.1087	0.1552	70.0387	
MS L		148.2	132.8	111.6			1134	0.1134	0.1552	73.0670	
	V										
MS A		286.5	357.6	80.1	85.9						
MS B		319.8	357.6	89.4							
MS C		272.5	357.6	76.2							
MS D		280.9	357.6	78.6							
MS E		337.6	357.6	94.4							
MS F		334.2	357.6	93.5							
MS G		333.7	357.6	93.3							
MS H		326.7	357.6	91.4							
MS I		257.1	357.6	71.9							
MS J		320.2	357.6	89.5							
MS K		320.3	357.6	89.6							
MS L		296.8	357.6	83.0							
	Zn										
MS A		477.5	485.3	98.4	112.4						
MS B		565.3	485.3	116.5							
MS C		494.1	485.3	101.8							
MS D		487.7	485.3	100.5							

MS E		802.2	485.3	165.3								
MS F		565.1	485.3	116.4								
MS G		565.5	485.3	116.5								
MS H		564.5	485.3	116.3								
MS I		427.1	485.3	88.0								
MS J		551.7	485.3	113.7								
MS K		548.9	485.3	113.1								
MS L		497.4	485.3	102.5								

*Non-certified Elements
**Estimates- Outside the Calibration Range
***Non-certified Elements and Estimates- Outside the Calibration Range

Percent Recovery: Spiked Samples

Sample #	Spike vs. No Spike	Be (ppm)	% Recovery	Average % Recovery	Cd (ppm)	% Recovery	Average % Recovery
			=Spike/(1+ No Spike) *100			=Spike/(1+ No Spike) *100	
11	Spike	0.9023	89.43	97.35	0.8345	83.37	92.86
	No Spike	0.00899			0.00101		
17	Spike	0.9636	95.53		0.8694	86.79	
	No Spike	0.00865			0.00172		
20	Spike	1.026	101.70		1.04	103.79	
	No Spike	0.00888			0.00199		
16	Spike	0.9231	91.49		0.8409	83.89	
	No Spike	0.00891			0.00237		
31	Spike	1.049	103.98		0.9216	91.95	
	No Spike	0.00883			0.00232		
36	Spike	0.8838	87.61		0.8173	81.51	
	No Spike	0.00874			0.00276		
41	Spike	0.9277	92.04		0.8618	86.02	
	No Spike	0.00794			0.00186		
53	Spike	1.032	102.39		1.038	103.59	
	No Spike	0.00787			0.00202		
63	Spike	0.8984	89.13		0.853	85.03	
	No Spike	0.00797			0.00313		
71	Spike	1.04	103.17		1.06	105.51	
	No Spike	0.00801			0.00467		
80	Spike	1.048	104.06		1.042	103.78	
	No Spike	0.00708			0.00402		
99	Spike	1.085	107.65		0.9965	99.08	
	No Spike	0.00789			0.00571		
Sample #	**Spike vs. No Spike**	**Cr (ppm)**	**% Recovery**	**Average % Recovery**	**Cu (ppm)**	**% Recovery**	**Average % Recovery**
11	Spike	1.825	112.41	107.54	1.524	121.37	110.35
	No Spike	0.62353			0.25571		
17	Spike	1.709	106.11		1.41	109.80	
	No Spike	0.61064			0.28421		
20	Spike	1.674	104.50		1.241	99.23	
	No Spike	0.60194			0.25058		
16	Spike	1.792	113.39		1.496	122.80	
	No Spike	0.58042			0.21827		
31	Spike	1.537	97.55		1.15	93.13	
	No Spike	0.57562			0.23484		
36	Spike	1.709	109.97		1.447	120.96	

	No Spike	0.55412			0.19631		
41	Spike	1.814	117.36		1.556	126.29	
	No Spike	0.54562			0.23205		
53	Spike	1.621	103.78		1.242	99.30	
	No Spike	0.56196			0.25079		
63	Spike	1.723	112.04		1.521	124.99	
	No Spike	0.53783			0.21688		
71	Spike	1.621	107.36		1.284	105.80	
	No Spike	0.50983			0.21363		
80	Spike	1.576	105.54		1.257	99.61	
	No Spike	0.49323			0.26193		
99	Spike	1.472	100.42		1.159	100.96	
	No Spike	0.46579			0.14793		
Sample #	**Spike vs. No Spike**	**Ni (ppm)**	**% Recovery**	**Average % Recovery**	**Pb (ppm)**	**% Recovery**	**Average % Recovery**
11	Spike	1.114	79.50	91.73	1.425	83.78	94.20
	No Spike	0.40119			0.70088		
17	Spike	1.188	88.72		1.442	88.31	
	No Spike	0.33907			0.63289		
20	Spike	1.42	105.03		1.613	101.95	
	No Spike	0.35203			0.58213		
16	Spike	1.155	83.17		1.412	90.24	
	No Spike	0.3888			0.56471		
31	Spike	1.246	94.44		1.434	91.35	
	No Spike	0.31936			0.56984		
36	Spike	1.071	76.64		1.39	88.67	
	No Spike	0.39752			0.56769		
41	Spike	1.119	84.08		1.44	91.29	
	No Spike	0.33093			0.57733		
53	Spike	1.388	102.69		1.649	101.65	
	No Spike	0.35163			0.6223		
63	Spike	1.084	78.95		1.496	89.38	
	No Spike	0.37306			0.67368		
71	Spike	1.414	107.76		1.746	104.41	
	No Spike	0.31218			0.67218		
80	Spike	1.367	104.83		1.642	102.12	
	No Spike	0.30399			0.60786		
99	Spike	1.248	95.02		1.542	97.22	
	No Spike	0.31341			0.58604		

Sample #	Spike vs. No Spike	V (ppm)	% Recovery	Average % Recovery	Zn (ppm)	% Recovery	Average % Recovery
11	Spike	1.84	125.72	113.16	2.989	129.71	118.02
	No Spike	0.46357			1.30444		
17	Spike	1.713	113.44		2.795	107.85	
	No Spike	0.5101			1.59164		
20	Spike	1.519	102.60		2.188	91.58	
	No Spike	0.48056			1.38918		
16	Spike	1.801	126.35		2.894	126.56	
	No Spike	0.42546			1.2867		
31	Spike	1.398	95.49		2.188	89.93	
	No Spike	0.46402			1.43293		
36	Spike	1.732	122.70		2.869	132.16	
	No Spike	0.41153			1.17093		
41	Spike	1.847	130.22		3.276	136.95	
	No Spike	0.41841			1.39212		
53	Spike	1.48	101.19		4.102	165.14	
	No Spike	0.4626			1.48395		
63	Spike	1.73	124.52		3.093	135.52	
	No Spike	0.38934			1.2823		
71	Spike	1.489	110.01		2.53	108.21	
	No Spike	0.35353			1.33815		
80	Spike	1.479	104.83		2.481	92.59	
	No Spike	0.41082			1.67966		
99	Spike	1.352	100.83		2.355	100.05	
	No Spike	0.34083			1.35386		

APPENDIX J

Pearson Product-Moment Correlation Coefficient Outputs

SCP and Raw Steel Correlation Output

		Lower Mahoning River Basin Raw Steel Production (net tons)	Smoothed Medium & Large SCP Concentrations (gDW-1)
	Pearson Correlation	1	.827**
	Sig. (2-tailed)		.000
	N	15	15
	Pearson Correlation	.827**	1
	Sig. (2-tailed)	.000	
	N	15	15

**. Correlation is significant at the 0.01 level (2-tailed).

Smoothed SCP and Smoothed Metal Concentrations Correlation Outputs

		Be3130_1	Ca3179_1	Cd2288_1	Cr2835_1	Cu3247_1	K_7698_1	Mg2025_1	Na5895_1	Ni2303_1	P_2136_1	Pb2169_1	V_2893_1	Zn4810_1	MedLarSCPSm
Be3130_1	Pearson Correlation	1	.878**	-.586**	.843**	.031	.798**	.818**	.946**	.731**	-.349**	.336**	.621**	-.212*	-.527**
	Sig. (2-tailed)		.000	.000	.000	.762	.000	.000	.000	.000	.000	.001	.000	.035	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Ca3179_1	Pearson Correlation	.878**	1	-.595**	.828**	.113	.760**	.819**	.860**	.681**	-.189	.373**	.676**	-.051	-.372**
	Sig. (2-tailed)	.000		.000	.000	.261	.000	.000	.000	.000	.060	.000	.000	.617	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cd2288_1	Pearson Correlation	-.586**	-.595**	1	-.864**	-.441**	-.750**	-.888**	-.700**	-.710**	.575**	-.146	-.804**	-.028	.744**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.000	.146	.000	.781	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cr2835_1	Pearson Correlation	.843**	.828**	-.864**	1	.435**	.912**	.962**	.903**	.761**	-.425**	.370**	.896**	.126	-.709**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.213	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cu3247_1	Pearson Correlation	.031	.113	-.441**	.435**	1	.464**	.345**	.186	.092	-.313**	.248*	.633**	.700**	-.349**
	Sig. (2-tailed)	.762	.261	.000	.000		.000	.000	.063	.363	.002	.013	.000	.000	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
K_7698_1	Pearson Correlation	.798**	.760**	-.750**	.912**	.464**	1	.813**	.889**	.555**	-.499**	.422**	.939**	.307**	-.532**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.002	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Mg2025_1	Pearson Correlation	.818**	.819**	-.888**	.962**	.345**	.813**	1	.839**	.833**	-.393**	.252*	.808**	-.018	-.749**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.000	.000	.012	.000	.859	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Na5895_1	Pearson Correlation	.946**	.860**	-.700**	.903**	.186	.889**	.839**	1	.725**	-.438**	.487**	.752**	-.053	-.588**
	Sig. (2-tailed)	.000	.000	.000	.000	.063	.000	.000		.000	.000	.000	.000	.599	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Ni2303_1	Pearson Correlation	.731**	.681**	-.710**	.761**	.092	.555**	.833**	.725**	1	-.295**	.209*	.495**	-.326**	-.740**
	Sig. (2-tailed)	.000	.000	.000	.000	.363	.000	.000	.000		.003	.037	.000	.001	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
P_2136_1	Pearson Correlation	-.349**	-.189	.575**	-.425**	-.313**	-.499**	-.393**	-.438**	-.295**	1	.261**	-.401**	.050	.527**
	Sig. (2-tailed)	.000	.060	.000	.000	.002	.000	.000	.000	.003		.009	.000	.624	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Pb2169_1	Pearson Correlation	.336**	.373**	-.146	.370**	.248*	.422**	.252*	.487**	.209*	.261**	1	.427**	.323**	-.096
	Sig. (2-tailed)	.001	.000	.146	.000	.013	.000	.012	.000	.037	.009		.000	.001	.342
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
V_2893_1	Pearson Correlation	.621**	.676**	-.804**	.896**	.633**	.939**	.808**	.752**	.495**	-.401**	.427**	1	.478**	-.523**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Zn4810_1	Pearson Correlation	-.212*	-.051	-.028	.126	.700**	.307**	-.018	-.053	-.326**	.050	.323**	.478**	1	.067
	Sig. (2-tailed)	.035	.617	.781	.213	.000	.002	.859	.599	.001	.624	.001	.000		.507
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
MedLarSCPSm	Pearson Correlation	-.527**	-.372**	.744**	-.709**	-.349**	-.532**	-.749**	-.588**	-.740**	.527**	-.096	-.523**	.067	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.342	.000	.507	
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Raw Steel and Smoothed Metal Concentrations Correlation Outputs

		Raw Steel (net tons)	Be3130_1	Ca3179_1	Cd2288_1	Cr2835_1	Cu3247_1	K_7698_1	Mg2025_1	Na5895_1	Ni2303_1	P_2136_1	Pb2169_1	V_2893_1	Zn4810_1
Raw Steel (net tons)	Pearson Correlation	1	-.676**	-.789**	.602*	-.776**	-.115	-.524*	-.762**	-.689**	-.585*	.370	.216	-.456	.089
	Sig. (2-tailed)		.006	.000	.018	.001	.682	.045	.001	.004	.022	.175	.439	.087	.752
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Be3130_1	Pearson Correlation	-.676**	1	.724**	-.300	.724**	.030	.772**	.568*	.965**	.364	-.726**	-.395	.502	-.023
	Sig. (2-tailed)	.006		.002	.278	.002	.914	.001	.027	.000	.183	.002	.146	.057	.936
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Ca3179_1	Pearson Correlation	-.789**	.724**	1	-.640*	.905**	.484	.620*	.858**	.777**	.532*	-.423	-.039	.631*	.105
	Sig. (2-tailed)	.000	.002		.010	.000	.067	.014	.000	.001	.041	.116	.889	.012	.709
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Cd2288_1	Pearson Correlation	.602*	-.300	-.640*	1	-.807**	-.397	-.524*	-.873**	-.420	-.506	.242	.349	-.757**	-.128
	Sig. (2-tailed)	.018	.278	.010		.000	.143	.045	.000	.119	.054	.386	.202	.001	.650
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Cr2835_1	Pearson Correlation	-.776**	.724**	.905**	-.807**	1	.502	.830**	.924**	.806**	.453	-.574*	-.313	.872**	.282
	Sig. (2-tailed)	.001	.002	.000	.000		.057	.000	.000	.000	.090	.025	.256	.000	.308
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Cu3247_1	Pearson Correlation	-.115	.030	.484	-.397	.502	1	.383	.454	.135	-.110	-.197	.192	.622*	.687**
	Sig. (2-tailed)	.682	.914	.067	.143	.057		.158	.089	.631	.697	.481	.493	.013	.005
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
K_7698_1	Pearson Correlation	-.524*	.772**	.620*	-.524*	.830**	.383	1	.616*	.855**	.114	-.857**	-.584*	.889**	.485
	Sig. (2-tailed)	.045	.001	.014	.045	.000	.158		.014	.000	.685	.000	.022	.000	.067
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Mg2025_1	Pearson Correlation	-.762**	.568*	.858**	-.873**	.924**	.454	.616*	1	.615*	.581*	-.257	-.094	.758**	.155
	Sig. (2-tailed)	.001	.027	.000	.000	.000	.089	.014		.015	.023	.355	.738	.001	.581
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Na5895_1	Pearson Correlation	-.689**	.965**	.777**	-.420	.806**	.135	.855**	.615*	1	.373	-.809**	-.494	.627*	.077
	Sig. (2-tailed)	.004	.000	.001	.119	.000	.631	.000	.015		.171	.000	.061	.012	.785
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Ni2303_1	Pearson Correlation	-.585*	.364	.532*	-.506	.453	-.110	.114	.581*	.373	1	.007	-.033	.118	-.557*
	Sig. (2-tailed)	.022	.183	.041	.054	.090	.697	.685	.023	.171		.980	.908	.674	.031
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
P_2136_1	Pearson Correlation	.370	-.726**	-.423	.242	-.574*	-.197	-.857**	-.257	-.809**	.007	1	.757**	-.620*	-.280
	Sig. (2-tailed)	.175	.002	.116	.386	.025	.481	.000	.355	.000	.980		.001	.014	.311
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Pb2169_1	Pearson Correlation	.216	-.395	-.039	.349	-.313	.192	-.584*	-.094	-.494	-.033	.757**	1	-.425	-.003
	Sig. (2-tailed)	.439	.146	.889	.202	.256	.493	.022	.738	.061	.908	.001		.115	.992
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
V_2893_1	Pearson Correlation	-.456	.502	.631*	-.757**	.872**	.622*	.889**	.758**	.627*	.118	-.620*	-.425	1	.617*
	Sig. (2-tailed)	.087	.057	.012	.001	.000	.013	.000	.001	.012	.674	.014	.115		.014
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Zn4810_1	Pearson Correlation	.089	-.023	.105	-.128	.282	.687**	.485	.155	.077	-.557*	-.280	-.003	.617*	1
	Sig. (2-tailed)	.752	.936	.709	.650	.308	.005	.067	.581	.785	.031	.311	.992	.014	
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Original SCP and Original Metal Concentration (Non-Smoothing) Correlation Outputs

Correlations

		Be3130	Ca3179	Cd2288	Cr2835	Cu3247	K_7698	Mg2025	Na5895	Ni2303	P_2136	Pb2169	V_2893	Zn4810	MedLar SCPs
Be3130	Pearson Correlation	1	.849**	-.460**	.760**	-.154	.531**	.735**	.904**	.588**	-.212*	.441**	.330**	-.352**	-.293**
	Sig. (2-tailed)		.000	.000	.000	.127	.000	.000	.000	.000	.034	.000	.001	.000	.003
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Ca3179	Pearson Correlation	.849**	1	-.575**	.787**	-.030	.533**	.815**	.836**	.581**	-.102	.332**	.447**	-.216*	-.225*
	Sig. (2-tailed)	.000		.000	.000	.765	.000	.000	.000	.000	.312	.001	.000	.031	.025
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cd2288	Pearson Correlation	-.460**	-.575**	1	-.802**	-.327**	-.605**	-.858**	-.638**	-.515**	.496**	-.064	-.671**	.029	.529**
	Sig. (2-tailed)	.000	.000		.000	.001	.000	.000	.000	.000	.000	.529	.000	.774	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cr2835	Pearson Correlation	.760**	.787**	-.802**	1	.344**	.820**	.913**	.856**	.495**	-.390**	.351**	.792**	.111	-.497**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.274	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cu3247	Pearson Correlation	-.154	-.030	-.327**	.344**	1	.462**	.202*	.025	-.152	-.318**	.173	.635**	.661**	-.247*
	Sig. (2-tailed)	.127	.765	.001	.000		.000	.044	.804	.131	.001	.084	.000	.000	.013
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
K_7698	Pearson Correlation	.531**	.533**	-.605**	.820**	.462**	1	.609**	.728**	.108	-.525**	.316**	.920**	.476**	-.435**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.287	.000	.001	.000	.000	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Mg2025	Pearson Correlation	.735**	.815**	-.858**	.913**	.202*	.609**	1	.771**	.674**	-.271**	.261**	.619**	-.130	-.455**
	Sig. (2-tailed)	.000	.000	.000	.000	.044	.000		.000	.000	.006	.009	.000	.199	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Na5895	Pearson Correlation	.904**	.836**	-.638**	.856**	.025	.728**	.771**	1	.552**	-.386**	.357**	.543**	-.154	-.433**
	Sig. (2-tailed)	.000	.000	.000	.000	.804	.000	.000		.000	.000	.000	.000	.125	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Ni2303	Pearson Correlation	.588**	.581**	-.515**	.495**	-.152	.108	.674**	.552**	1	-.061	.116	.051	-.546**	-.223*
	Sig. (2-tailed)	.000	.000	.000	.000	.131	.287	.000	.000		.547	.250	.612	.000	.026
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
P_2136	Pearson Correlation	-.212*	-.102	.496**	-.390**	-.318**	-.525**	-.271**	-.386**	-.061	1	.191	-.420**	-.112	.411**
	Sig. (2-tailed)	.034	.312	.000	.000	.001	.000	.006	.000	.547		.057	.000	.268	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Pb2169	Pearson Correlation	.441**	.332**	-.064	.351**	.173	.316**	.261**	.357**	.116	.191	1	.336**	.163	-.085
	Sig. (2-tailed)	.000	.001	.529	.000	.084	.001	.009	.000	.250	.057		.001	.105	.402
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
V_2893	Pearson Correlation	.330**	.447**	-.671**	.792**	.635**	.920**	.619**	.543**	.051	-.420**	.336**	1	.610**	-.396**
	Sig. (2-tailed)	.001	.000	.000	.000	.000	.000	.000	.000	.612	.000	.001		.000	.000
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Zn4810	Pearson Correlation	-.352**	-.216*	.029	.111	.661**	.476**	-.130	-.154	-.546**	-.112	.163	.610**	1	-.097
	Sig. (2-tailed)	.000	.031	.774	.274	.000	.000	.199	.125	.000	.268	.105	.000		.335
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
MedLar SCPs	Pearson Correlation	-.293**	-.225*	.529**	-.497**	-.247*	-.435**	-.455**	-.433**	-.223*	.411**	-.085	-.396**	-.097	1
	Sig. (2-tailed)	.003	.025	.000	.000	.013	.000	.000	.000	.026	.000	.402	.000	.335	
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

APPENDIX K
Sedimentation Rates

Yearly Sedimentation Rates (1969-1983)

Sediment Depth (cm)	Year	Time Period	Sedimentation Rates (cm/yr)
13.44	1983	1982-1983	2.24
14.56			
15.68	1982	1981-1982	4.48
16.80			
17.92			
19.04			
20.16	1981	1980-1981	6.72
21.28			
22.40			
23.52			
24.64			
25.76			
26.88	1980	1979-1980	5.60
28.00			
29.12			
30.24			
31.36			
32.48	1979	1978-1979	2.24
33.60			
34.72	1978	1977-1978	2.24
35.84			
36.96	1977	1976-1977	3.36
38.08			
39.20			
40.32	1976	1975-1976	8.96
41.44			
42.56			
43.68			
44.80			
45.92			
47.04			
48.16			
49.28	1975	1974-1975	4.48
50.40			
51.52			
52.64			
53.76	1974	1973-1974	3.36
54.88			

56.00			
57.12	1973	1972-1973	4.48
58.24			
59.36			
60.48			
61.60	1972	1971-1972	4.48
62.72			
63.84			
64.96			
66.08	1971	1970-1971	12.32
67.20			
68.32			
69.44			
70.56			
71.68			
72.80			
73.92			
75.04			
76.16			
77.28			
78.40	1970	1969-1970	3.36
79.52			
80.64			
81.76	1969		