GEOMORPHIC EVOLUTION OF WHITEOAK BOTTOMS, NANTAHALA RIVER VALLEY, WESTERN NORTH CAROLINA, USA

by

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(Under the Direction of DAVID S. LEIGH)

ABSTRACT

Focus is on the geomorphic evolution of Whiteoak Bottoms (WOB), a peatland in the Nantahala River valley of western North Carolina, to develop a better understanding of the evolution of this and similar rare peatlands in the region. Radiocarbon dates on seeds and bulk peat directly above basal fluvial sediments, at 190 cm, returned ages of about 14,000 cal yr BP. These ages indicate WOB is the oldest dated peatland in the Southern Blue Ridge Mountains and that such wetlands have persisted throughout the Holocene. The stratigraphy reveals a consistent pattern with basal channel cobbles being overlain by sandy channel-fill grading up into peat. Two different distinct inorganic deposits separate the lower organic deposits from the sapric deposits at the surface. Maintenance of WOB initially depended on the Nantahala River, whereas today it is the influences of groundwater and beavers that allow for the persistence of this rare landscape.

INDEX WORDS: Geomorphology, Stratigraphy, Wetlands, Southern Blue Ridge Mountains

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CHAPTER 1

INTRODUCTION

Peat-forming wetlands are rare, endangered and poorly studied landforms in the Southern Blue Ridge Mountains. Peat accumulates in landscapes where a delicate balance between climate, geology and biology create anaerobic conditions, allowing organic matter to accumulate faster than it can decompose (Gosselink and Turner, 1978). Peatlands are rare in the southern Appalachian Mountains due to the steep, well-drained nature of the landscape (Weakley and Schafale, 1994). Prehistorically, the majority of these wetlands were likely found in the wide mainstem river valleys which historically have been mostly drained for agriculture (Gaddy, 1981). Weakley and Schafale (1994) estimated that up to 83% of prehistoric wetlands in North Carolina were destroyed during the past 200 years due to anthropogenic land cover change. Conservation and restoration of these rare landforms is extremely important because of the multitude of rare and endangered plants and animals that often only exist in these wetlands (Murdock, 1994). The majority of previous research on southern Appalachian wetlands has focused on classifying and inventorying the rare vegetation of these endangered landscapes with little emphasis on the role landscape position plays on wetland occurrence (Gaddy, 1981; Murdock, 1994; Schafale and Weakley, 1990; Weakley and Schafale, 1994). Schafale and Weakley's (1990) classification of the natural communities in North Carolina admits that the classification of mountain wetlands is still somewhat tentative due to a lack of knowledge of the factors responsible for the initiation and maintenance of these unique landforms.

The objective of this project was to develop an understanding of the hydrologic and geomorphic conditions that led to the formation and persistence of Whiteoak Bottoms (WOB), a peatland in the Southern Blue Ridge Mountains of western North Carolina. This was done by determining the depth, extent and stratigraphic context of organic soil (histosol) development. A secondary goal was to establish a timeframe and rate of histosol accumulation to determine if WOB is a relic of the last glacial period or if it is a relatively young landform created by anthropogenic disturbance.

Previous research suggests that geomorphic disturbances (alluvial or colluvial), humans (deforestation and fire), or beavers may be important factors determining the occurrence and persistence of Southern Blue Ridge wetlands (Gaddy, 1981; Moorhead et al., 2000; Shafer, 1988; Weakley and Schafale, 1994). Moorhead et al. (2000) studied the soil characteristics of four southern Appalachian wetlands in North Carolina. Moorhead et al. (2000) did not discuss the factors responsible for initiation or maintenance of these wetlands but from the description of their landscape positions, it can be inferred that all but one of the wetlands are developing within depressions likely created by the rivers or streams that flow past. An in-depth understanding of the factors responsible for initiation of these wetlands could not be determined because only four to ten cores were taken from each wetland, each core only went to a depth of 1 m, and no timeframe was established. Shafer (1986) and Shafer (1988) studied the paleoenvironmental history of Flat Laurel Gap, a Southern Appalachian Bog on Pisgah Ridge near the Blue Ridge Parkway. Flat Laurel Gap is classified as a Southern Appalachian Bog northern subtype because it contains vegetation typical of more northern wetlands (Weakley and Schafale, 1994). Flat Laurel Gap was interpreted to have started forming 12,000 to 10,000 years ago when periglacial conditions caused a landslide, creating habitat favorable for ericaceous shrubs to grow (Shafer, 1986). The age of Flat Laurel Gap was inferred from thermoluminescence dating of a solifluction deposit, and not from wetland sediments, which returned an age of only 8605 ± 360 cal yr BP (Shafer, 1988). The occurrence of disjunct northern species in the Flat Laurel Gap profile as well as the modern day plant assemblage suggests Flat Laurel Gap and Southern Appalachian wetlands with similar disjunct species have persisted since the terminal Pleistocene, serving as refugia for these northern species; though there is no direct evidence of wetland persistence dating back to the terminal Pleistocene (Pittillo, 1994; Shafer, 1986; Weakley and Schafale, 1994). It has also been suggested that some of these landscapes could be quite young (e.g. Panthertown Valley bogs, Tulula bog), formed as a result of logging and catastrophic fire followed by colonization by beavers. Though, once again, the age of these wetlands is only conjecture and based solely on the fact that no disjunct northern species are found within them (Warren et al., 2004; Weakley and Schafale, 1994). A hydrogeomorphic analysis within a chronological framework is needed to help determine the factors necessary for peat-forming wetland initiation and persistence. Understanding the genesis and evolution of WOB helps to provide a framework to better understand, conserve, and restore similar peatlands within the Southern Blue Ridge Mountains.

STUDY AREA

Whiteoak Bottoms (35°04’44”N, 83°31’50”W) is located at approximately 1030 m above sea level (asl) in the Nantahala River valley in Macon County, North Carolina (Figure 1). WOB is located along the Nantahala River intermediate between the hillslope and the floodplain. The wetland is classified as a Southern Appalachian bog with wet organic or mucky mineral soils that are very acidic, not subject to flooding, and fed by seepage water (Schafale and

Weakley, 1990). Though classified as a bog, approximately 188,668 m^2 of forested hillslope overlying biotite gneiss with scattered pockets of amphibolite (Robinson et al., 1992) drain directly into WOB through a number of hillslope seeps and manmade culverts (Figure 2). In order to prevent confusion as to whether WOB is a bog or fen, it will be generically referred to as a wetland. The study area was chosen because it is located on public land (Nantahala National Forest) with easy access, is not in danger of being drained or modified, and is the largest Nantahala River bog (Schwartzman, 2010). Initial interest in the study area began in the Fall of 2008 when two initial radiocarbon ages (UGAMS #03503 and #03528 (Table 1) resulting from preliminary field work of David Leigh and Ed Schwartzman) revealed that the basal age of organic sediment at WOB was around 14,000 yr BP. These ages not only made WOB the oldest dated peatland in the Southern Blue Ridge Mountains, but also suggested that the wetland could harbor a uniquely complete record of Holocene environmental history. A forest service road runs roughly north-south approximately 60 m from the eastern edge of the wetland. According to U. S. Forest Service personnel, historically there was a failed attempt to drain WOB and convert the wetland into agriculturally productive land. During this attempt, ditches were dug along the western side of the wetland. These ditches do not currently affect the hydrology of the wetland, having become mostly filled with sediments. The far northern edge of WOB is completely underwater because of a beaver dam. This dam has grown substantially within the past year (2009 to 2010) as the beavers continue to excavate the wetland soils upstream, packing the muck onto their dam. The largest hillside seeps that flow into the wetland are also being utilized by the beavers with a number of mucky terraces raising the water table in the area immediately upstream of the tributary dams. Many of the deeper, natural pools in the wetland have been connected by beaver excavations creating canals that snake through the wetland.

The vegetation of WOB is a mosaic of shrub thickets and herb dominated openings composed of both northern bog and acid-tolerant coastal plain varieties, underlain by Sphagnum mats (Gaddy, 1981; Schafale and Weakley, 1990; Schwartzman, 2010). The wetland can be divided into three vegetational zones: a northern zone dominated by herbaceous openings, including sneezeweed (*Helenium autumnale*), marsh bedstraw (*Galium tinctorium*), taper-tip rush (*Juncus acuminatus*), swamp wedgescale (*Sphenopholis pensylvanica*), woolgrass (*Scirpus cyperinus*), marsh seedbox (*Ludwigia palustris*), and sensitive fern (*Onoclea sensibilis*); a central zone dominated by shrubs, such as swamp rose (*Rosa palustris*), maleberry (*Lyonia ligustrina*), clammy azalea (*Rhododendron viscosum*), and rosebay rhododendron (*R. maximum*), and small trees, including red maple (*Acer rubrum*) and black gum (*Nyssa sylvatica*), with scattered herbaceous openings; and a southern zone which is a mixture of herbaceous openings and shrubs (Schwartzman, 2010). WOB is classified as Southern Appalachian Bog southern subtype because it is located south of the Asheville basin and doesn't contain enough northern variety plants (only 39 percent) to place it in the northern subtype (>45 percent) (Schafale and Weakley, 1990; Weakley and Schafale, 1994).

The annual temperature at the nearest climate station, the low elevation Coweeta Hydrologic Laboratory (12/1/1942 to 12/31/2007) to the east of Whiteoak Bottoms, is 12.72^{o}C, with an average January temperature of 3.17^{o}C and average July temperature of 21.89^{o}C (SERCC, 12/1/1942 to 12/31/2007). The average annual precipitation estimated by the PRISM climate group is 218.74 cm (PRISM Climate Group, 1895-2009). The majority of rainfall is delivered from late fall until early spring with a maximum occurring in January and a minimum occurring during July and October (PRISM Climate Group, 1971-2000).

CHAPTER 2

DEPOSTIONAL HISTORY OF WHITEOAK BOTTOMS

1. Methods

1.1. *Field Methods*

Data were collected from June 2009 through June 2010 (Figure 2). Field measurements were conducted in two stages, including: (1) a topographic and stratigraphic survey of the wetland to determine the depth and extent of histosol development; and (2) an in-depth allostratigraphic analysis (Autin, 1992) of both the wetland and the surrounding landscape to determine the context of histosol development. Seven benchmarks were placed within WOB using a Trimble GeoXH sub-meter global positioning system to provide georeferenced (UTM, NAD1983) locations and elevations for subsequent surveying. Approximately 900 points were surveyed using a Topcon 211-D electronic total station to create a topographic surface (and subsurface) of the wetland. At each survey location, a 1 cm diameter tile probe was driven down through the histic and/or fine clastic sediment until gravel or cobble was penetrated. A high-resolution (close-interval spacing of 1 m) survey of wetland basal topography was conducted along three transects to better understand the underlying fluvial topography and to locate sites suitable for vibracoring. Thirty-four cores were taken to understand the stratigraphy of the wetland and floodplain, including 17 using a Russian corer (organic soils) and 17 using a hand-driven bucket auger (clastic soils). Cores were described using standard National Resource Conservation Service (NRCS) terminology (Soil Survey Division Staff, 1993) and logged in Appendix A. The hand auger, though useful for observing lithological differences, made identification of bedding structures difficult to determine. At two locations known to have the greatest accumulation of histic soils, a vibracore, utilizing three inch diameter aluminum pipes, was used to obtain relatively undisturbed cores for laboratory analysis. Cores were stored in a refrigerator to prevent further decomposition of the organic soils while awaiting laboratory analysis. Grab samples of sediment were retrieved from the first order channels of two hillslope seeps located on the edges of the northern and southern transects, and from two additional locations within the Nantahala River channel at locations south of the southern transect and on the middle transect. Grab samples were taken so that roundness of the >2mm fraction could be measured and compared to the >2mm fraction from the vibracores to determine source areas and provenance of wetland sediments.

1.2. *Laboratory Methods*

The aluminum pipes holding the cores were cut longitudinally with a circular saw taking care not to penetrate the cores. The cores were then sliced in half with a guitar string and cleaned of metal shavings before being photographed and described using standard NRCS terminology (Appendix A). Core descriptions are based on compressed length and not actual depth. Compaction was less than 25 percent for the cores used (17 percent for the northern core and 21 percent for the southern core). Bulk density was measured on one half of the core using 3 cm diameter circular plugs at 5 cm intervals or at smaller intervals to bracket major stratigraphic divisions. The other half of the core was cut into 25 cm segments for x-ray analysis. The 25 cm segments were x-rayed using a Torrex 120 (small animal x-ray machine) at 5 mA and 50 W for 50 seconds. X-rays will not penetrate clastic materials as readily as organics, showing up as shades of white on the developed film. Once x-rays were taken, both halves of the core were consolidated and split, similar to bulk density, into 5 cm intervals or at smaller intervals to bracket stratigraphic divisions for further laboratory analysis.

Organic content was determined by loss on ignition (LOI). The LOI samples were placed in a muffle furnace for 4 hrs at 550°C in order to insure complete combustion of organics (Heiri et al., 2001). Percent organic carbon was determined on ten samples from each core at the University of Georgia Ecology lab and correlated to LOI by regression. Samples for carbon analysis were chosen to represent major facies units from the cores. The inorganic residue from the LOI analyses was placed into a 1 N HCl bath for 24 hours to dissolve ash residue. Samples were then thoroughly washed to remove dissolved solids before particle size analysis was performed. Particle size was determined using the pipette and sieve method described in (Gee and Bauder, 1986) to measure <2 μ clay and >63 μ sand on the < 2 mm fraction (>2 mm fraction being sieved out prior to pipetting). A roundness analysis of the 4 to 16 mm portion of the >2 mm fraction was done on the grab samples and the vibracores by separating 30 randomly selected particles into 12 categories based on sphericity and angularity utilizing the method of (Powers, 1953). Radiocarbon ages were determined on seeds, twigs and charcoal by the University of Georgia Center for Applied Isotope Studies (CAIS) using an accelerator mass spectrometer following an acid-alkali-acid pretreatment of the samples and graphite target preparation.

The data obtained from the topographic surveys were compiled in Microsoft Excel™ and are logged in Appendix B. Basal topography was determined by subtracting the tile probe depth from the surface topography. The data were then imported to ArcMap 9.3™ and triangulated irregular networks (TIN) were created to interpolate between data points and allow for easier analysis of surface topography, histosol accumulation, and basal topography. From these interpolated surfaces, volumes of histosol development and carbon accumulation were calculated based on stratigraphic data (thickness, lateral extent, bulk density) obtained from the cores.

2. Results

2.1. *Topography and Hydrology*

Results of the transect surveys and TIN creation are shown in Figure 3. The surface topography exhibits a general decrease in elevation from south to north, in accord with the slope of the alluvial Nantahala River valley, as well as a slight downward slope from the eastern hillslope towards the river in the west. Latitudinally, the hummock and pool topography create fluctuations in elevation of up to 60 cm (Figure 3A). The largest pools are present on the north and middle transects; while the size of the hummocks (10 to 20 cm higher than surrounding lawns) is relatively similar across all three transects. Histosol thickness is greatest along the eastern border as well as areas that meander through the middle of the wetland that are not in accord with the surface topography. The greatest accumulation of histosols was determined to be at the 55 m distance mark on the northern transect and at the 17 m distance mark on the southern transect (Figure 3B). It was on these thick sections that the vibracores were taken (Figure 2). Histosol development was measured over an area of 19,920 m^2 (1.99 ha). The average depth of histosol accumulation is 1.2 m with a maximum depth of 2.61 m found near the center of the wetland on the northern transect. It was determined that at least 23,300 m^3 of sediment have accumulated in the wetland above the basal gravels within the surveyed bounds of the wetland.

The TIN of basal topography shows the same pattern as the TIN of histosol thickness with a number of low-lying depressions meandering through the middle and eastern side of the wetland (Figure 3C). These low-lying meandering patterns show up on all of the transects as relatively deep (1.5 to 2 m) depressions (Figure 3). These depressions are approximately 10 to 15 m wide, are longitudinally continuous, and have a slope ranging from 0.005 to 0.006. The radius of curvature of these meandering features ranges from 16 m in the west to 24 m on the eastern side along the hillslope. For comparison, the Nantahala River is on average 15 to 20 m across, 1.5 to 2 m deep, and has a slope of approximately 0.005 to 0.007.

The wetland's water table is at or within 10 to 15 cm of the surface during the summer and less than 10 cm during the winter. From the hillslope and wetland, the water table slopes gently down towards the river. A seasonally fluctuating water table was inferred by the presence of redoximorphic features in the clastic sediments (soil profiles N8, N9 & N11; M6 & 7; S8) of T1 and T0. Though the deepest depressions beneath WOB are at approximately the same elevation as the bed of the current river channel, the absence of a redoximorphic surface that slopes towards the wetland suggests little if any influence from the river on the hydrology of the wetland. The slope of the water table clearly indicates a hillslope source of groundwater to the wetland.

2.2. *Stratigraphy*

Whiteoak Bottoms is located on the first prominent terrace (T1) of the Nantahala River (Figure 4). T1 is underlain by coarse facies of gravels and cobbles (T1a). The facies within T1 (overlying T1a) can be divided into the following units: T1b-Lower T1 sandy facies; T1c-Upper T1 silty facies; T1d-Lower T1 sand and gravel facies; T1e-Lower T1 peat facies; T1f-Middle T1 mucky silt facies; T1g-Middle T1 angular gravel facies; and T1h-Upper T1 mucky peat facies (Figure 4). T1 abuts the hillslope in the east and is separated from the river by the floodplain

(T0) on the western sides of the north and middle transects; and T1 extends to the river on the southern transect. The active floodplain of the Nantahala River (T0) also is underlain by coarse facies of gravels and cobbles, designated T0a. T0a is overlain by two units: T0b-Lower T0 sandy facies; and T0c-Upper T0 silty facies. T0 is bordered to the east by T1 and on the west by the river. There is only an incipient T0 on the southern transect; which can be found on the west side of the river, but was not cored. The facies described below were separated based on readily discernable erosional or depositional boundaries.

2.2.1. *T1a-Basal T1 cobbles and gravels*

The basal unit of T1 is composed of well-rounded gravels and cobbles and is designated T1a. T1a underlies all of T1 and ends abruptly at the hillslope. The thickness and lower boundary of T1a are unknown, though T1a likely overlies the weathered saprolite that typically blankets the rest of the landscape. There are abrupt and unconformable upper boundaries with T1b (N7 to 9; M5 to 7; and S8 to 12) and T1e (N1, 2, 4 and 5; and M2 and 3).

2.2.2 *T1b-Lower T1 sandy facies*

Overlying T1a is a massive sandy unit (T1b). The color of this unit ranges from dark yellowish brown (10YR 3/4) to olive yellow (2.5Y 6/6). The color of T1b also shows evidence of being totally submerged beneath the water table all year (gleyed) (N7; M5; and S8 & 9) or seasonally (redox features) (N8 & 9; M6 & 7; S8). The distinguishing characteristic of T1b is the texture, which is mostly sandy loam with loamy sand occurring in some cores directly overlying T1a. The obviously different parent materials of T1b and T1c and a lack of pedogenic development led to T1b being designated as the soil horizon "2C" in the majority of soil cores.

T1b varies in thickness from 0.25 to 1.0 m. T1b unconformably overlies T1a to the west of the wetland.

2.2.3. *T1c-Upper T1 silty facies*

A massive silty unit (T1c) overlies T1b. The color of this unit ranges from black (10YR 2/1) at the surface to dark yellowish brown (10YR 3/6) at its base. A, B, and C horizons make up this unit. Much better developed B horizons (Bw horizons) are present in the cores nearest the bog (N8 & 9; M5 & 6; S5 to 7) and decrease in thickness and pedogenic development (N7; M7; S8 & 9) towards the river. The texture of this unit is mostly silt loam, though there are some loamy silt and loam textures within this unit (M6; S8 to 10). T1c is thickest on the northern transect (avg. 1 m) and thinnest on the southern transect (0.25 m).

2.2.4. *T1d-Lower T1 sand and gravel facies*

Overlying T1a in the deepest parts of the wetland is a massive sand and gravel unit (T1d). This unit was captured in the bottom of both of the vibracores. Gravel from this unit has a moderate degree of sphericity, are sub-angular to angular, and range in size from 2 to 15 mm (Figure 5). From the bottom of the unit the color tends to get darker (5Y 3/2 to 10YR 3/1) with height. Texture of this unit is sandy ranging from gravelly sand to sandy loam with a fining-upward trend. T1d is laterally discontinuous, only occurring in the deep depressions that meander through the wetland. The thickness of the unit varies from 0.25 m to 1 m thick. An unconformable boundary separates T1d from T1a (below) and T1e (above).

2.2.5. *T1e-Lower T1 peat facies*

Overlying T1d is an organic unit (T1e) that is composed of alternating sequences of woody and mossy peat that range in thickness from 15 to 50 cm. The histic soil horizons within this unit are very dark brown (10YR 2/2) to black (10YR 2/1). This unit is very organic with LOI ranging from 11 percent (at the bottom) up to 78 percent. The prevalence of mica minerals increases with depth. Between 75 to 100 cm within the northern vibracore and 77 to 100 cm within the southern vibracore, there is thin inorganic bedding within the organic matrix that is readily visible in the x-ray images (Figure 5). This inorganic bedding thins away from the river as revealed in the Russian cores along the 1 m interval transects (Appendix A). An abrupt unconformity separates T1e from T1g (above).

Radiocarbon dating of seeds, uncarbonized wood, and bulk peat (Table 1) indicate an initiation of organic sediment accumulation at 14,934 to 14,115 cal yr BP from the southern core (155 to 160 cm) and 14,185 to 13,600 cal yr BP from the northern core (185 to 195 cm). The ages from the northern core come from a pilot core retrieved in 2008 by David Leigh with a Russian corer. An age of 14,523 to 13,920 was returned from 105 to 110 cm from the northern core. At the bottom of the inorganically bedded portion of T1e from the southern core (99 to 103 cm) an age of 13,837 to 13,570 cal yr BP was returned. An age from the top of T1e in the northern core (65 to 70 cm) came back 13,426 to 13,199 cal yr BP at the abrupt unconformable boundary with T1g. In summary, the age of T1e appears to fall in the range of 14,934 to 13,199 cal yr BP, indicating relatively rapid accumulation of peat during the time immediately prior to the Younger Dryas global cooling phase (12,900-11,500 cal yr BP).

2.2.6. *T1f-Middle T1 mucky silt facies*

Overlying T1e on the southern and middle transects and the western side of the northern transect is a mucky silt unit (T1f). The color of this unit ranges from very dark gray (10YR 3/1) to dark gray (10YR 4/1). The texture of this unit is loam fining upwards into silt loam. The top of T1f is found at an average depth of 35 cm. This unit averages a thickness of 20 cm with a maximum thickness occurring on the west side of the wetland, thinning away from the river. T1f is bounded by an abrupt unconformable boundary on its western side by T1c. On the middle and southern transects, T1f is abruptly and unconformably bounded by the hillslope to the east. On the northern transect, the eastern side of T1f is abruptly and unconformably bounded by T1g. An important distinction between T1f and T1g is that T1f lacks gravel; unlike unit T1g (with abundant gravel) which occurs in a similar stratigraphic position. A radiocarbon age of wood charcoal from the southern core (45 to 50 cm) returned an age of 9,144 to 9,011 cal yr BP (Table 1).

2.2.7. *T1g-Middle T1 angular gravel facies*

Overlying T1e to the east of T1f is an angular gravel unit (T1g). This unit was found on the eastern side of the northern transect and grades from gravelly loamy sand in the east to gravelly muck in the west. Gravels from this unit range in size from 2 to 12 mm and tend to have very low sphericity and be angular to very angular (Figure 5). Color ranges from very dark grayish brown (10YR 3/2) to dark gray (10YR 4/1). T1g is found at a depth of 35 to 60 cm and averages approximately 30 to 40 cm thick. The thickness of the unit increases with proximity to the hillslope. An abrupt unconformity separates T1g from T1e (below). Radiocarbon dating of uncarbonized wood from the middle of T1g (50 to 55 cm) returned a modern, post bomb-spike age (Table 1).

2.2.8. *T1h-Upper T1 mucky peat facies*

The surficial unit within the wetland is a mucky peat unit (T1h) that overlies T1f (N5 & 6, M1 to 4, and S1 to 7) and T1g (N1-4). The color of this unit is black (10YR 2/1) to very dark grayish brown (10YR 3/2). Texture fines-upward with sandy loam or loam at its lower boundary and loam or silt loam at the surface. The top of this unit is composed of partially decomposed organic matter with the degree of decomposition tending to increase with depth. The average thickness of this unit is approximately 40 cm.

2.2.9. *T0a-Basal T0 gravels and cobbles*

The basal unit of T0 is composed of gravels and cobbles and is designated T0a. T0a underlies all of T0 and is bounded to the east along an unconformable boundary with T1a. There is no T0a on the southern transect, although there is an incipient floodplain on the western side of the river. The depth to T0a was extrapolated from the coring that was done on the floodplain (N10 to 12 and M8 to 10) and the current elevation of the bed of the Nantahala River. The top elevation of T0a gravels is about one meter below the highest T1a gravels. Within the deepest portions of T1, the basal gravels are at about the same elevation as T0a. The vertical extent and lower boundary of T0a are unknown though it likely overlies weathered saprolite. T0a abruptly and unconformably underlies T0b.

2.2.10. *T0b-Lower T0 sandy facies*

Overlying T0a is a massive sandy unit (T0b). The soils in T0b grade from loamy sand to sandy loam up (N12, M9 & 10) and away (N10 & 11) from the river. The color of this unit tends to be dark yellowish brown (10YR 3/4). T0b also shows evidence of being affected by groundwater either being gleyed (N10 & 12, M12) or containing redox features (N11). This unit tends to occur at a depth of 35 to 40 cm and averages 70 cm thick. T0b is found between T1 and the river and is characterized by C or 2C horizons. Abrupt and unconformable boundaries separate T0b from T0a (below) and T1b to the east.

2.2.11. *T0c-Upper silty facies*

Overlying T0b is a massive silt unit (T0c). Color tends to lighten with depth, being very dark brown (10YR 2/2) at the surface lightening to dark brown (10YR 3/3) at depth. The soils in T0c have over-thickened cumulic A-horizons that thin away from the river. No B-horizons were found on the middle transect but there were thin weakly expressed B-horizons on the northern transect. The soils formed in T0c are consistently less well developed than those in the similar facies of unit T1c, which is consistent with a younger age of T0 relative to T1. Textures in T0c are silt loam and tend to have many fine roots in the upper 10 to 15 cm. The thickness of T0c averages approximately 35 cm and is laterally continuous from its contact with T1 in the east to the river in the west.

2.3. *Vibracore Analysis*

Each vibracore was described and analyzed by the methods described above and logged in Appendix A. A total of 76 bulk density samples (38 from each core) and 81 LOI and PSA samples (40 from the north core and 41 from the south core) were analyzed. The results of the laboratory analyses are shown in Figure 6 and logged in Appendix C. The northern core refused on cobbles and gravels at 226 cm (187 cm compressed) and the southern core refused at 229 cm (178 cm compressed). Both cores exhibit the same general lithology of highly clastic sediments at the bottom of the core overlain by highly organic horizons which are overlain by clastic sediments that grade up into organic sediments at the surface (Figure 5). The major differences between the two vibracores are: (1) the bottom third of the northern core (110 to 183 cm) is much sandier than the southern core; (2) the southern core becomes abruptly organic (160 cm) whereas the northern core becomes organic much more gradually; and (3) overlying T1e in the northern core is T1g a gravelly, extremely inorganic unit, whereas in the southern core, a mucky silt unit (T1f) overlies T1e. In both cores, bulk density and LOI values were negatively related, as percent organic increased bulk density would decrease and vice versa.

2.3.1. *Northern Vibracore*

The bottom of the northern core is sandy loam to gravelly loamy sand (165 to 182 cm). This section of the core corresponds to T1d. The color of this section is a very dark gray (10YR 3/1). LOI results for this portion of the core are around 10 percent. The bottom gravelly unit grades up into an increasingly organic unit (110 to 165 cm) (lower portion of T1e). This section, though still sandy loam and loamy sand, is black (10YR 2/1) and has partially identifiable woody plant materials that are not present in T1d. LOI begins low (12 percent) but rises up to 23 percent at 110 cm. Above the sandy lower portion of T1e, is a black (10YR 2/1) mossy peat section (75 to 110 cm) that grades up into very dark brown (10YR 2/2) woody peat (60 to 75 cm). Within this largely homogenous zone, faint and thin (15 to 20 mm thick) bedding is visible in the x-rays, showing up as thin light (clastic) bands in the dark (organic) matrix (Figure 5). These bands correspond to relatively large fluctuations in percent sand from 20 percent at 105 cm up to 42 percent at 100 cm down to 13 percent at 95 cm. This influx of sand also shows up in the LOI record, with 46 percent at 105 cm down to 32 percent at 100 cm and then back up to 55 percent at 95 cm. Abruptly overlying the peat facies is an angular gravel and sand unit (30 to 60 cm) (T1g). This section is very dark grayish brown (10YR 3/2) at its base and black (10YR 2/1) at the top. The lowest LOI results are from this section of the core with a minimum of two percent at 55 cm. The >2 mm fraction peaks in this unit, reaching a maximum of 40 percent at 45 to 50 cm. Overlying T1g is a black (10YR 2/1) highly humified mucky peat unit (T1h) (0 to 30 cm). This unit becomes progressively more organic reaching 36 percent at the top of the core. There is a deviation from the general increasingly organic trend at 22 cm where in a very dark grayish brown (10YR 3/2) portion, LOI drops down to 13 percent before starting to increase again. There is also a slight increase in percent sand at this point from 67 percent at 25 cm up to 70 percent at 22 cm. Textures in this section are still sandy (sandy loam) but grade up into loam at the surface.

2.3.2. *Southern Vibracore*

From its base (178 cm), the southern core starts out at about one to two percent organic but then increases up to 18 percent at 160 cm. This lower inorganic unit (T1d) is dark olive gray (5Y 3/2) sand at the bottom that fines upwards, becoming very dark brown (10YR 2/2) loamy sand. Abruptly overlying this unit is a black (10YR 2/1) increasingly organic mossy and woody peat unit (64 to 160 cm) (T1e). The LOI results for this unit range from 18 percent at the bottom up to 78 percent at 113 cm and then decrease to 16 percent at 64 cm. This unit is composed of portions of hemic and fibric peat. Within this unit there are a series of increases in percent sand with corresponding decreases in percent LOI (72 to 77 cm, 81 to 86 cm, and 92 to 94 cm). These sandy layers are visible in the x-rays showing up as 20 to 45 mm thick lighter (clastic) bands within the dark (organic) matrix (Figure 5). Overlying the peaty lower unit is a mucky silt unit (T1f) (27 to 64 cm). This unit is gray (10YR 5/1) to dark gray (10YR 4/1) at its base and very dark gray (10YR 3/1) at the top. Textures of this unit are loams grading up into silt loam. LOI ranged from 10 percent up to 13 percent. The top of the core is a black (10YR 2/1) highly humified mucky peat unit (T1h) (0 to 27 cm). This unit becomes increasingly more organic from 18 percent at its base up to 26 percent at the surface. This unit is a sapric peat that becomes progressively less sandy with height.

2.3.3. *Shape analysis*

The 4 to 6 mm, 6 to 8 mm, and 8 to 16 mm fractions of the grab samples were compared to the gravel in the northern core to determine the source area and provenance of the >2mm fraction of T1d and T1g. There were no grains larger than 4 mm in the southern core so only the northern core could be used for this analysis. This size range was decided upon to insure a statistically significant number of grains and to allow classification without the aid of a microscope. Samples were taken from 41 to 60 cm to represent T1g and from 155 to 180 cm to represent T1d. Each grain was classified as one of twelve classes (Powers, 1953), based on whether it had a high or low degree of sphericity and the degree of angularity (very angular, angular, sub-angular, sub-rounded, rounded, and well-rounded). The results of the analysis are shown in Figure 5 and logged in Appendix C.

The hillslope gravels were characterized as having a low degree of sphericity and being angular to very angular. With decreasing size, the number of grains with high sphericity tended to increase, though these grains were still angular to very angular. There were no grains that were rounded or well rounded in any of the hillslope samples.

The majority of river gravels also were characterized as having a low degree of sphericity. The biggest difference between the hillslope and river samples was that the river gravels were sub-rounded to sub-angular. Another difference was unlike the hillslope gravels, the river gravels had at least one grain in each of the 12 classes.

The gravels from T1g (41 to 60 cm) tended to have a low degree of sphericity and be angular to very angular. Similar to the hillslope gravels, the number of grains with high sphericity tended to increase as size decreased. Unlike the hillslope sediments, there was one rounded grain (in the 4 to 6 mm fraction).

The gravels from T1d (155 to 180 cm) had a moderate degree of sphericity and tended to be sub-angular to angular in the 4 to 6 mm and 8 to 16 mm fraction and sub-angular to sub-rounded in the 6 to 8 mm fraction. The angularity tended to occupy the angular to sub-rounded portion of the scale though there were more rounded grains than very angular grains. No well-rounded grains were found in this section.

The T1g gravels have many of the same characteristics as the hillslope gravels. The diversity of shapes observed in the river gravels are not found in the T1g gravels. The gravels from T1d on the other hand have many of the characteristics of both the hillslope and the river gravels. The gravels in T1d are a mixture of angular and sub-angular to sub-rounded gravels. Unlike the hillslope gravels there are a lot of sub-rounded to rounded gravels in the T1d grains;

and unlike the river gravels, a significant proportion of the grains are angular (40 percent in the 8 to 16 mm fraction and 38 percent in the 4 to 6 mm fraction).

2.4. *Carbon Accumulation*

The accumulation of carbon within the histic sediments of WOB was not uniform throughout the past 15,000 years. Carbon accumulation within the wetland sediments of WOB went through three distinct stages: (1) initial infilling and deposition of extremely organic peat layers (T1d and T1e); (2) deposition of a relatively inorganic clastic rich drape upon T1e (T1f); and (3) re-initiation of organic accumulation on top of the middle inorganic layers (T1f and T1g) represented by T1h. The total volume of sediment found within the wetland (23,300 m^3) was divided into these three groups so that the total amount of carbon accumulated could be determined.

The first stage of wetland deposition, occurring between 14,934 to 9,011 cal yr BP, deposited approximately 12,000 m^3 of sediment. This deposit, which includes T1d and T1e, averages 0.624 m in thickness and 0.098 g/cm^3 in carbon content. The amount of carbon accumulated in approximately the first 6,000 years of wetland development is around 1,180 Mg (593 Mg/ha) or approximately 0.1 Mg/ha per year. The second stage, occurring after 9,144 to 9,011 cal yr BP and before the deposition of unit T1h, deposited approximately 5,500 m^3 of sediment. The amount of carbon per cubic centimeter (0.086 g/cm^3) was determined by averaging the bulk density and LOI values from only the southern core because T1f apparently was eroded from the northern core by the deposition of T1g. The total amount of carbon sequestered in this middle layer is approximately 472 Mg (237 Mg/ha). The third and most recent stage of carbon accumulation has deposited approximately 5,800 m^3 of sediment. This layer had an average of 0.086 g/cm^3 of carbon and was assumed to be 0.3 m thick. The top increasingly organic layer holds approximately 500 Mg of carbon (251 Mg/ha). In the last 9,000 years, approximately 970 Mg of carbon have been sequestered in WOB (487 Mg/ha), which is approximately 0.05 Mg/ha per year. In summary, WOB has sequestered approximately 1,080 Mg/ha of carbon since the terminal Pleistocene.

3. Discussion

3.1. *Topography and Paleochannels*

The undulating land surface and the high-resolution transect surveys show the highly complex hummock-pool topography of a normal bog/fen system (Figure 3). This topography is created by the differential decay of the various wetland species found in the wetland as well as the beaver activity that helps add complexity to the surface of the wetland (Johnson and Damman, 1991; Naiman et al., 1988). The beaver influence is especially easy to see on the northern transect (14, 53, 65 m) and the mid-south transect (6 m) where they have accentuated pools and dug trenches in the wetland (Figure 3).

The depressions that meander through the middle of the wetland and along the eastern border are interpreted as paleochannels because: (1) they are apparent on the basal topographic surface of the cobbles and gravel, (2) their dimensions are very similar to the modern channel (width and depth); (3) they are longitudinally continuous; and (4) they have a similar slope to that of the modern river channel. Though multiple channels are visible, the different ages returned from the base of the vibracores, 14,934 to 14,115 to cal yr BP for the southern core and 14,523 to 13,600 cal yr BP for the northern core, indicate that single-thread meandering river systems were active during the terminal Pleistocene. This observation is at odds with Walter and

Merritts' (2008) assertion that streams in the eastern USA were stable, multi-channel, anabranching systems prior to historic settlement and disturbance. They go on to suggest that the meandering rivers that we see today are unnatural and do not have a prehistoric analogue and are completely a consequence of anthropogenic-induced entrenchment (Walter and Merritts, 2008). Though the Nantahala River is in a different physiographic region, the similarity of the paleochannels to the modern channel suggests meandering rivers are quite natural and existed in the eastern USA as early as the terminal Pleistocene.

Interestingly, the modern vegetation does not reflect the geomorphic history. A number of studies have suggested that within a fluvial system, species occurrence is highly correlated to the fluvial landform (Bendix and Hupp, 2000; Hupp and Osterkamp, 1996; Osterkamp and Hupp, 1984). The three identified vegetation zones within the wetland (northern, middle, and southern) are a reflection of the uneven distribution of hillslope seep and road runoff contributions to the wetland, coupled with the presence of beaver terraces, creating wet herbaceous areas in the north and south and relatively dry shrubby areas in the middle. A study of the modern-day vegetation composition would not provide any indication that the wetland began in the paleochannels of the Nantahala River but the wetland's landscape position scalloped into the hillslope would suggest a fluvial history.

3.2. *Landscape Evolution*

Eight samples of seeds, carbonized and uncarbonized wood, and bulk peat from Whiteoak Bottoms resulted in radiocarbon ages ranging from 14,934 cal yr BP to approximately 1970 CE (Table 1). The ages indicate that WOB is the oldest dated wetland in the Southern Blue Ridge Mountains. The wetland sediments contain one of the first records of the terminal

Pleistocene to Holocene transition in the Southern Blue Ridge Mountains; while the clastic sediments from T1 and T0 provide insight into the depositional behavior of the Nantahala River over the past 15,000 years (Figure 7). Figure 7 shows the known timing of deposition of the identified stratigraphic facies, although it also illustrates the lack of chronological control for the middle Holocene.

The stratigraphy and radiocarbon ages indicate that during the terminal Pleistocene, between 14,934 and 13,600 cal yr BP, the paleo-Nantahala River flowed through the wetland depositing T1a. At 14,934 to 14,115 cal yr BP, the Nantahala River may have avulsed away from the southern and western paleochannels and began to occupy the paleochannels on the eastern side of the wetland (Figure 3). The Nantahala River occupied the northern core's paleochannel until 14,523 to 13,600 cal yr BP. The river then likely avulsed to the channel just to the west (Figure 3) still providing sandy sediments and sub-angular to sub-rounded gravels to the site of the northern core (T1d) (Figure 5). While these paleochannels were active, the eastern portion of T1b (lateral accretion sediments) and T1c (vertical accretion sediments) probably were being deposited along the western margin of the wetland, aggrading the western side of WOB, slowly impounding the low-lying paleochannels that ultimately became the peatland. At some time during 15,000 to 14,000 cal yr BP, avulsion and river migration to the western side of the valley stranded the WOB area as abandoned paleochannels that became the initial zone of histosol and wetland development.

Between 14,934 to 9,011 cal yr BP, T1e accumulated; likely beginning in the paleochannels and eventually spreading across the area that is now WOB. Peat accumulation may have been initiated by beaver damming of the lower end of the paleochannels or by damming of the paleochannels caused by rapid sedimentation near the active channel zone. The peat, in both vibracores, begins woody but abruptly transitions to mossy peat around 14,523 to 13,920 cal yr BP, suggesting WOB was becoming increasingly wet (Vitt and Wieder, 2009). This increased wetness could be interpreted either as an increase in precipitation or as an increase in the height of the water table caused by the damming of the WOB paleochannels, or as a combination of these factors. Paleoenvironmental studies for the Blue Ridge Mountains do not confidently indicate an increase in precipitation during this time (Delcourt and Delcourt, 1984; Kneller and Peteet, 1999). However, Leigh (2008) found that bankfull floods on rivers of the Coastal Plain were much larger during the terminal Pleistocene to middle Holocene than during the late Holocene, and that effective precipitation (runoff) was maximized during the terminal Pleistocene and first half of the Holocene. Many studies have also found that during this time period there was an increase in hillslope failures, providing an excess amount of sediment, which if connected to the fluvial system would cause stream aggradation (Delcourt and Delcourt, 2004; Eaton et al., 2003; Leigh and Webb, 2006; Shafer, 1988). Leigh and Webb (2006) indicated rapid sedimentation in the Blue Ridge Mountains during the terminal Pleistocene and first half of the Holocene. Delcourt and Delcourt's (2004) study of the stratigraphy of the Little Tennessee River, which the Nantahala River ultimately flows into, saw rapid aggradation of the valley bottom between 17,000 to 7,000 years BP; which agrees with the interpretation that T1a was likely aggrading at this time and possibly damming the lower ends of the WOB paleochannels.

As T1 continued to aggrade to the west of the wetland, around 13,837 to 13,570 cal yr BP, thin sandy beds began to be laid down within the otherwise extremely organic T1e (Figure 5). These thin beds are interpreted as overbank or flood deposits because they thin away from the river (Figure 4). The paleo-Nantahala River’s influence continues to increase between 13,426 to 9,011 cal yr BP as T1e is replaced with T1f (Figure 6). The increasing influence of inorganic sedimentation within the wetland is interpreted as evidence of a drastic increase in the magnitude of flood events during the early Holocene. T1f is interpreted as the accumulation of a large number of flood drapes that inhibited the accumulation of organic matter as had been the norm since the wetlands initiation. Other studies in the southeastern USA have found evidence of higher magnitude flood events during this time period (Goman and Leigh, 2004; LaMoreaux et al., 2009; Leigh, 2008; Leigh and Webb, 2006; Liang, 2008). Leigh and Webb (2006) studied the alluvial and colluvial stratigraphy of Raven Fork, a stream, north of the Nantahala River, within the Southern Blue Ridge Mountains of North Carolina. They found more rapid hillslope sedimentation during the early Holocene, which they attribute to a greater magnitude and perhaps frequency of extreme rain events. From their study of a peat core along the Little River on the upper Coastal Plain of North Carolina, Goman and Leigh (2004) also determined that extreme events were more prevalent during the early to middle Holocene (9,000 to 6,100 cal yr BP); with overbank flood events being five times more frequent during the early Holocene. At some point in time after 9,144 to 9,011 cal yr BP, the Nantahala River incised to the level of the modern river channel and began depositing T0a. This incision event could be related to the reduction of extreme precipitation events during the middle to late Holocene as suggested previously by Goman and Leigh (2004) and Leigh and Webb (2006), but an age from the beginning of T1b deposition and a terminal age for T1f accumulation is needed to know for sure.

The modern age returned for T1g is somewhat unusual and could be the result of a tree fall that had penetrated the wetland and embedded a branch into the wetland. The other interpretation is that T1g is modern and the sand gravelly unit is a consequence of the forest service road being constructed so close to the wetland. Moorhead et al. (2000) found a gravel layer at a depth of 30 to 50 cm at Deep Gap Fen that could be analogous to T1g. They did not go any deeper because they assumed this to be the extent of wetland sedimentation. Deep Gap Fen is located in close proximity to the Blue Ridge Highway and State Highway 421 creating the possibility that this wetland could also have been affected by road construction.

3.3. *Wetland Function of Hydrology and Carbon Sequestration*

Currently, the only sources of water to WOB are from hillslope seeps and precipitation, proven by the lack of a redoximorphic surface sloping towards the wetland and by the fact that the water table slopes from the hillslope through the wetland and down toward the river. The majority of the organic matter sequestered in WOB took place during a time when the Nantahala River probably had a much greater influence on the hydrology of the wetland. The stratigraphy of T1 to the west of the wetland, suggests the highly organic peat deposits represented by T1e were deposited during a time of large floods and possibly river bed aggradation, allowing the water table to engulf any dead plant material in the wetland, inhibiting decomposition. Currently, we do not know whether organic matter had been accumulated during the middle Holocene and then subsequently been oxidized or eroded. The presence of the highly humified sapric peat unit (T1h) at the surface of the WOB could help answer this question. T1h could be the result of historic drainage attempts, which would have created a greatly accelerated rate of decomposition in any peat that had accumulated subsequent to the initial phase of peat accumulation. T1h could also be a natural response to the significant drop in water table that occurred as the Nantahala River incised to its current elevation. Improved chronometric control is needed to determine the cause of the drastic change in peat accumulation after 9,000 yr BP. It is important to note that whatever the cause of the reduction of carbon accumulation, WOB is still an active and groundwater was sufficient to preserve what had been accumulated between 14,000 to 9,000 cal yr BP.

Carbon sequestration rates in WOB ranged from 0.1 Mg/ha per year, during the early phase of wetland development (15,000 to 9,000 yr BP), to 0.05 Mg/ha per year, during the last 9,000 yr BP. These rates are more than an order of magnitude less than observed carbon sequestration rates in forested plots (Clark et al., 2004; Dewar and Cannell, 1992; Silver et al., 2000; Weishampel et al., 2009). Dewar and Cannell (1992) studied the carbon sequestration rate of forest plantations. They found that managed forestland can sequester up to 5.6 Mg/ha per year of carbon. Though forests can sequester carbon much faster than wetlands, the total amount of carbon per hectare is maximized in peatlands (Weishampel et al., 2009). Weishampel et al. (2009) compared the amount of carbon sequestered in forested upland compared to peatlands in northern Minnesota. In their study area, the forested uplands sequestered 150 to 200 Mg of carbon per ha compared to 1,200 Mg/ha in peatlands. The amount of carbon sequestered in WOB (1,080 Mg/ha) is quite comparable to the amount stored in the peatlands studied by Weishampel et al. (2009); though slow accumulators of carbon, peat-forming wetlands appear to be a much better "long-term sink" for carbon than forests. These studies show the importance of wetland conservation, for significant disruption of the factors (climatic, geologic, or biologic) that maintain them can turn these large sinks into significant sources.

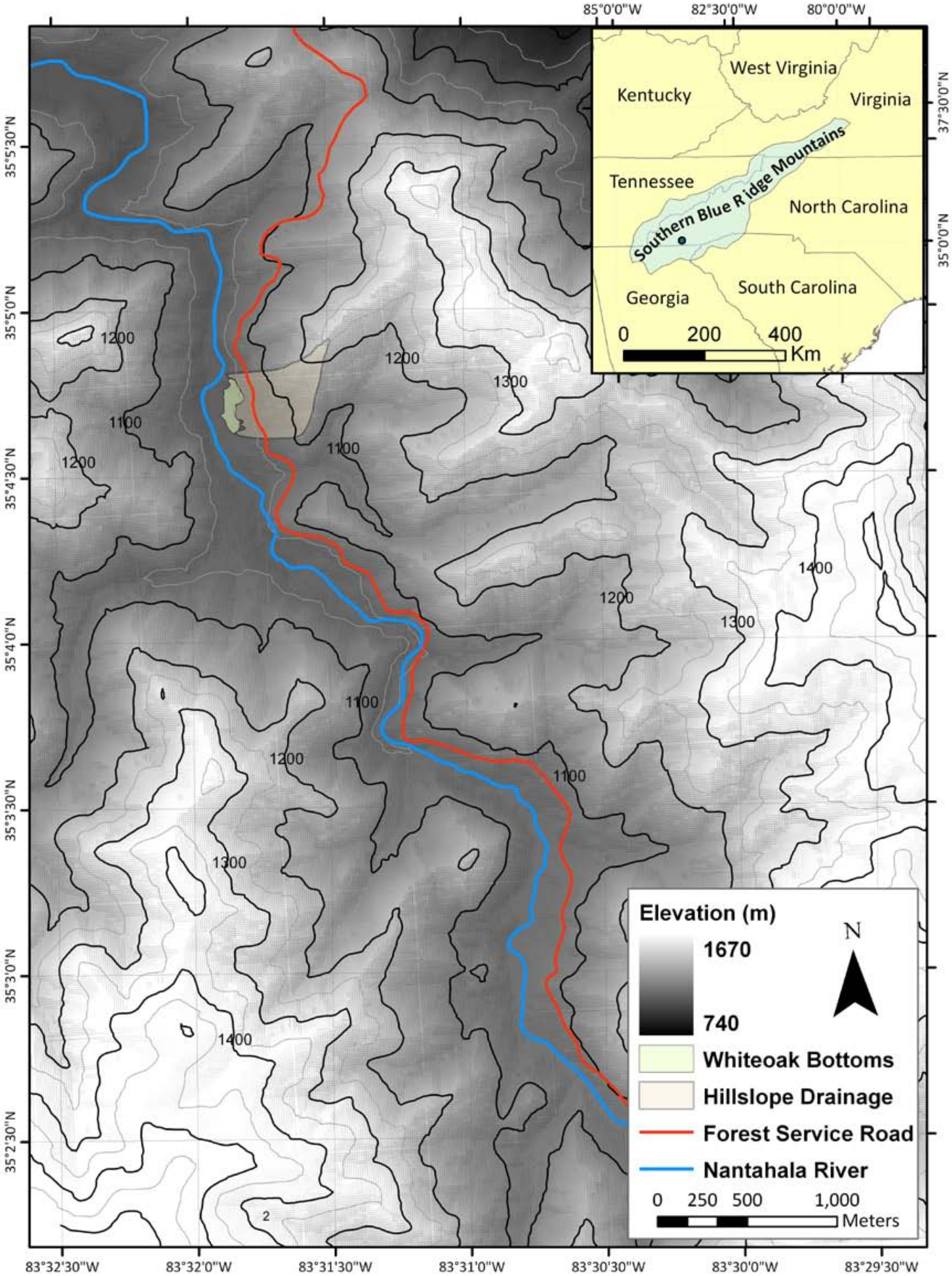

Figure 1 - The location of Whiteoak Bottoms (WOB) with the Nantahala River valley of North Carolina. The Nantahala River flows from south to north to the west of thewetland. A drainage area of approximately 188,000 m drains into Whiteoak Bottoms. Inset map shows the location of WOB within the Southern Blue Ridge Mountains.

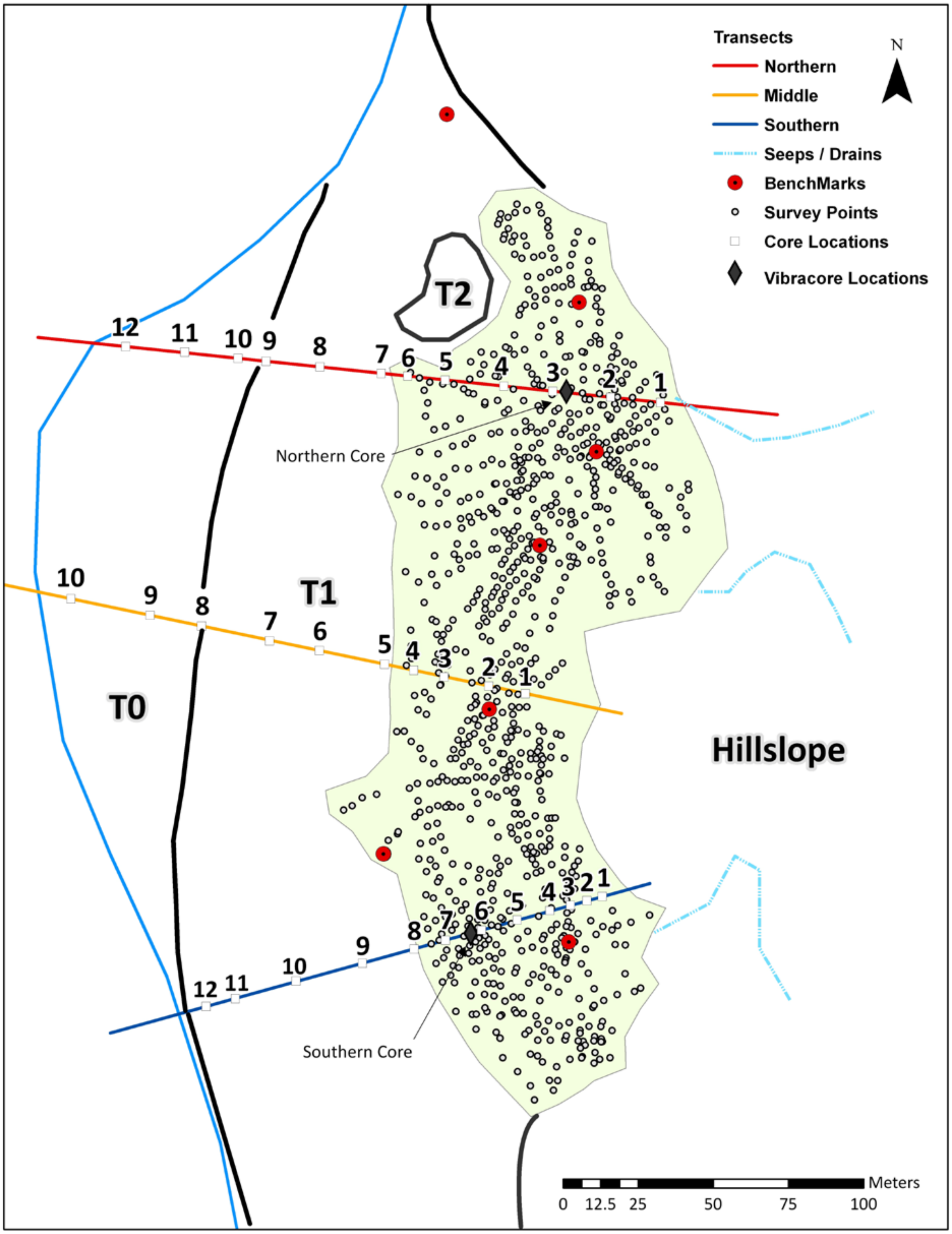

Figure 2 - Geomorphic interpretation of the Nantahala River valley at Whiteoak Bottoms. The topographic survey point and core hole locations are also shown. T0, T1, and T2 correspond to the floodplain, first terrace, and second terrace (respectively) of the Nantahala River. Whereas T0 and T1 are laterally extensive, only a fragment of T2 was identified.

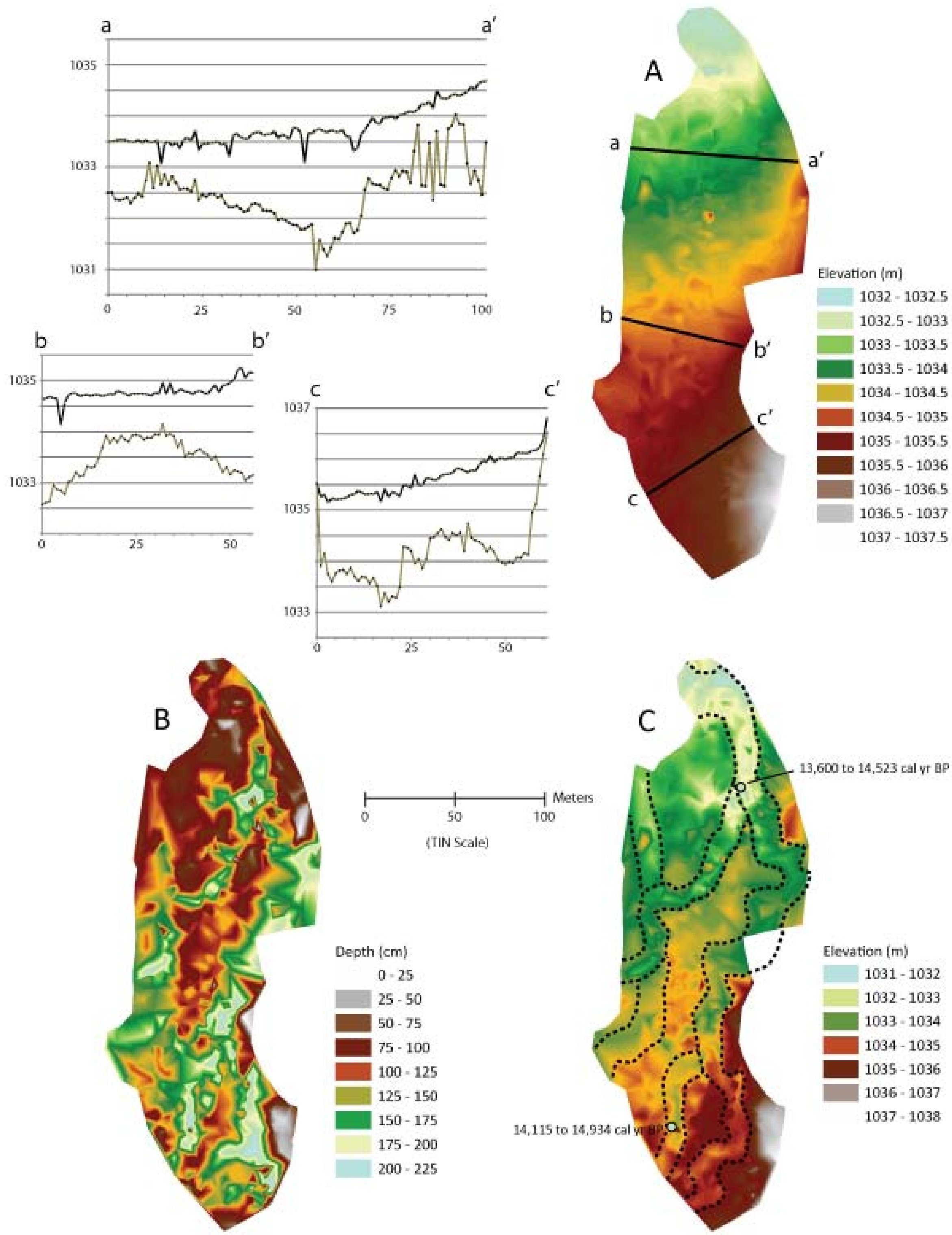

Figure 3 – The graphs in the upper left corner are the results of the close interval (1 m) topographic survey. (A) Surface topography TIN; (B) Depth of histosol development TIN; and (C) Basal topography TIN with dotted lines showing the approximate left and right banks of interpreted paleochannels. Circles indicate basal radiocarbon date locations.

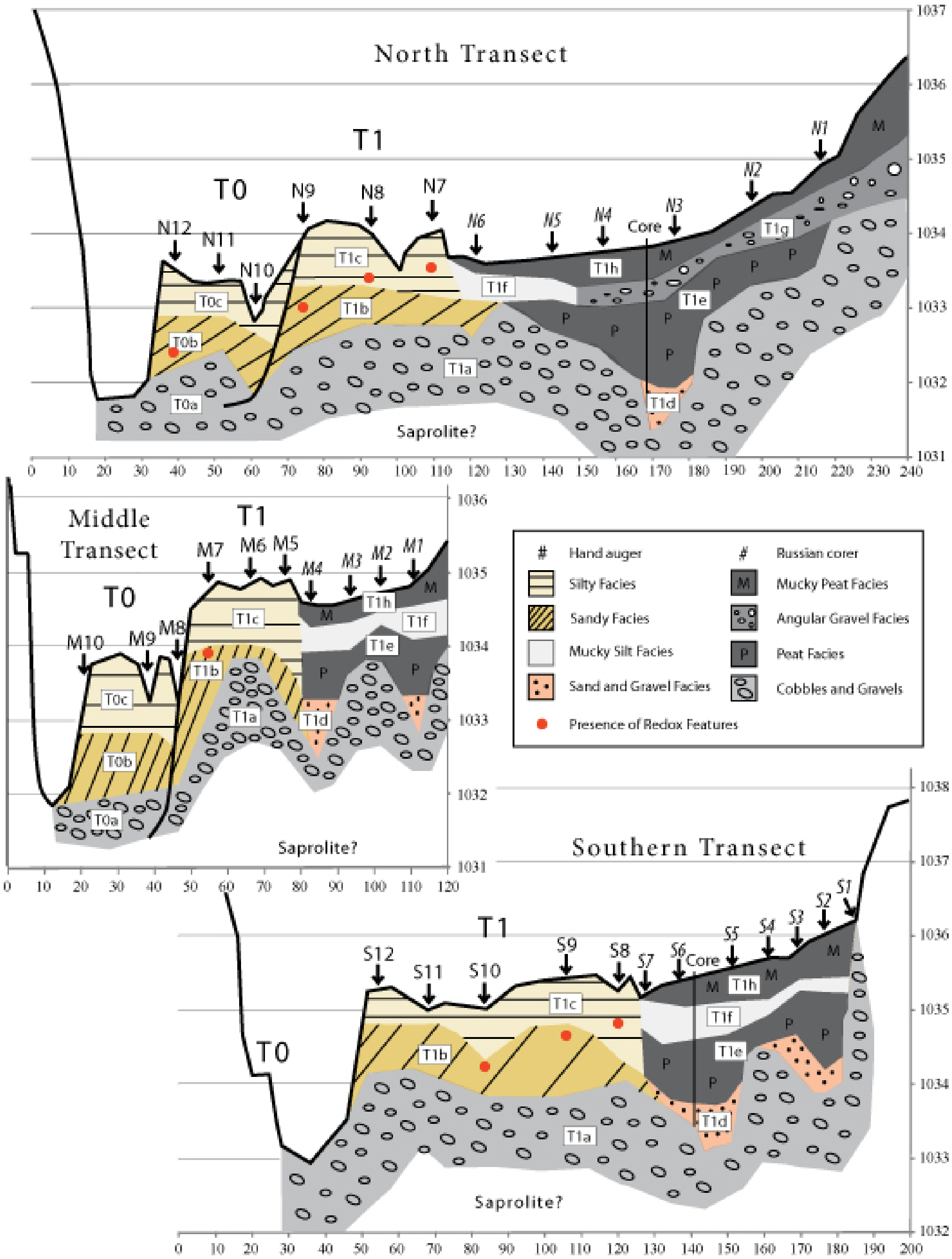

Figure 4 – Allostratigraphy of Whiteoak Bottoms and associated floodplain. The facies within T1 include: T1a- Basal T1 gravels and cobble; T1b-Lower T1 sandy facies; T1c-Upper T1 silty facies; T1d-Lower T1 sand and gravel facies; T1e-Lower T1 peat facies; T1f-Middle T1 mucky silt facies; T1g-Middle T1 angular gravel facies; and T1h-Upper T1 mucky peat facies. The facies within T0 include: T0a- Basal T0 gravels and cobbles; T0b-Lower T0 sandy facies; and T0c-Upper T0 silty facies. Red dots indicate presence of redoximorphic features.

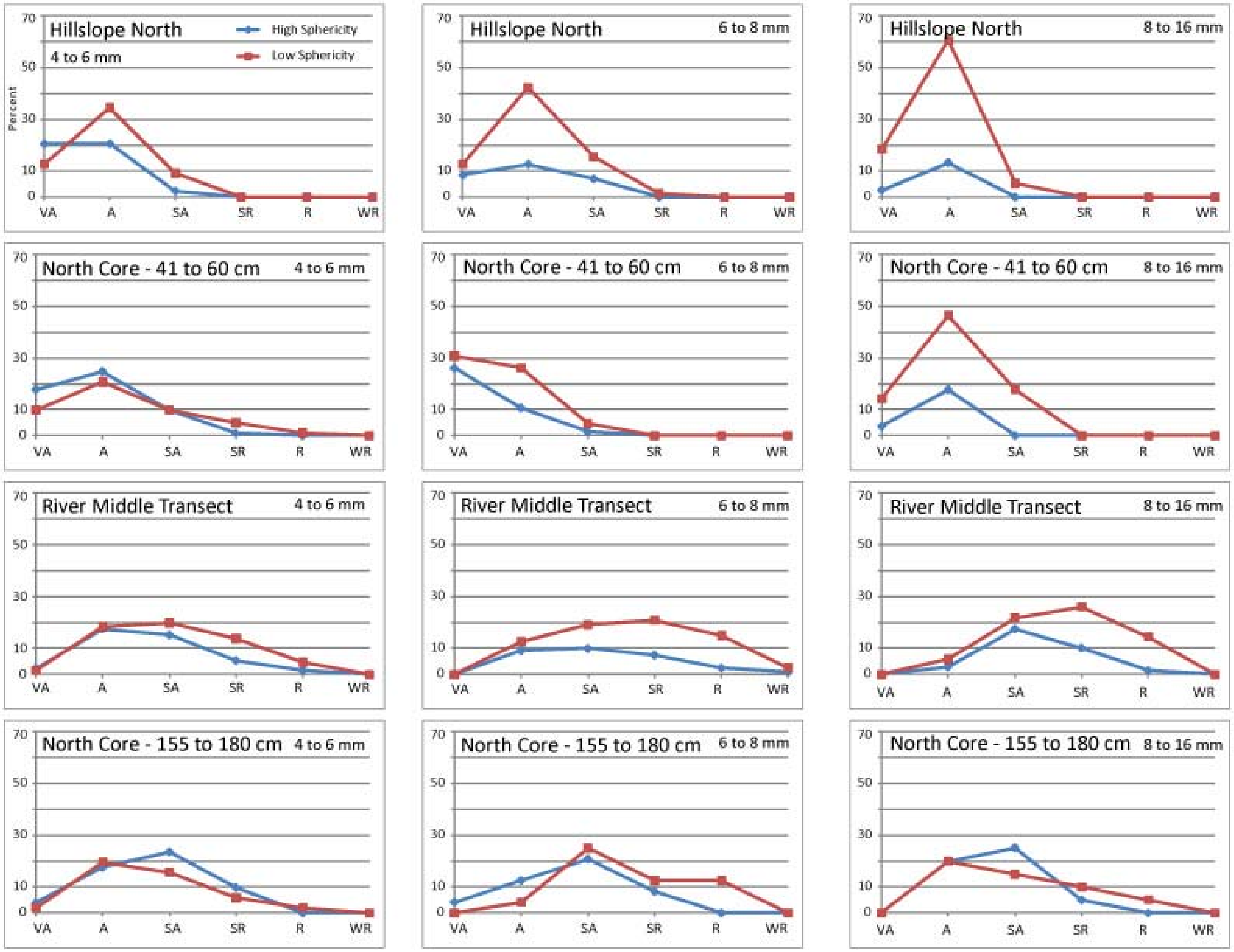

Figure 5 – The results of the shape analysis, numbers given are percent of whole. (VA-Very Angular; A-Angular; SA-Sub-Angular; SR-Sub-Rounded; R-Rounded; WR-Well-Rounded)

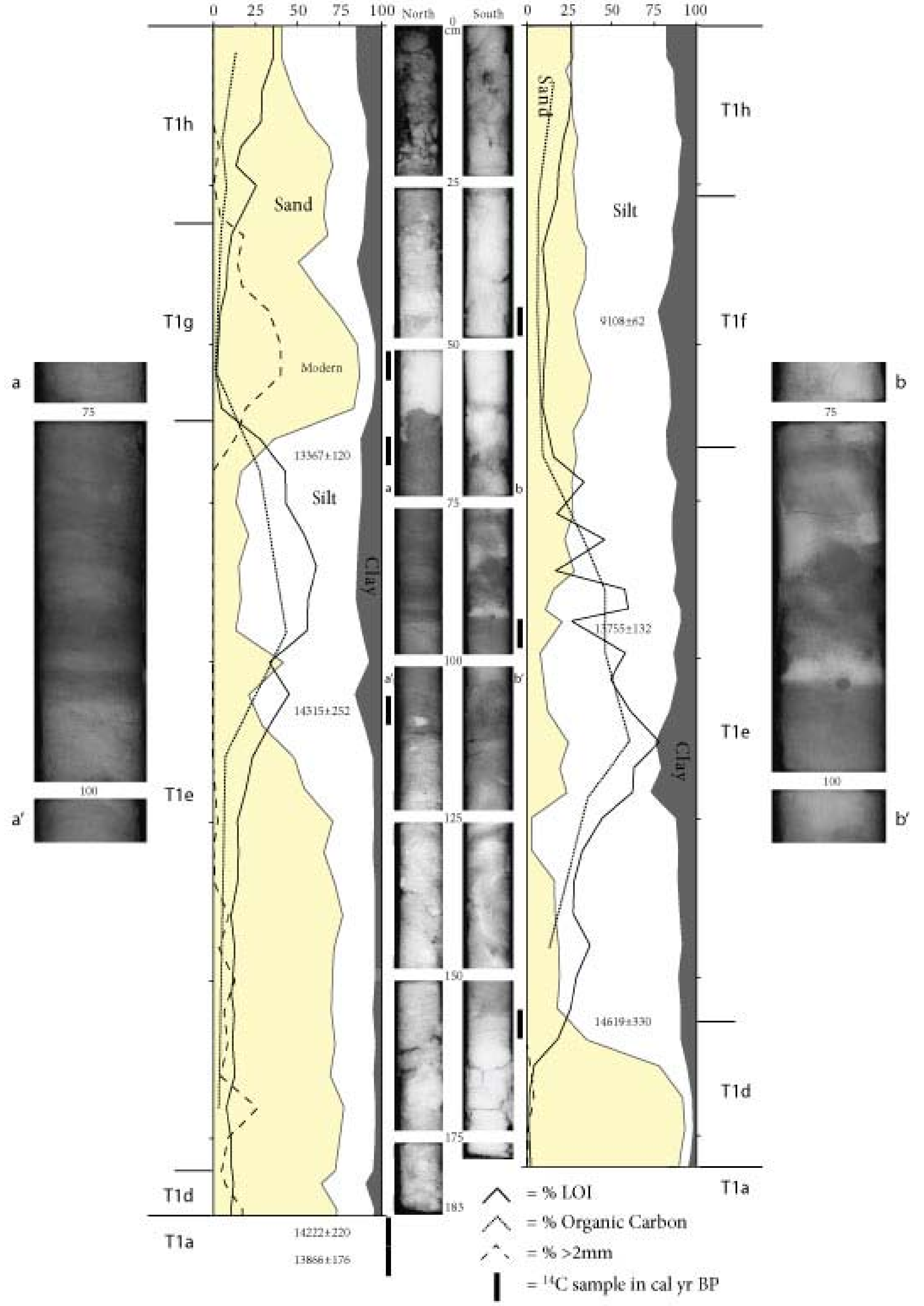

Figure 6 – The results of the PSA, LOI, x-ray, organic carbon, and radiocarbon dating. Stratigraphic units are also listed to provide easier interpretation. A zoomed in view of the inorganically bedded portion of T1e is shown to the left and right of the cores.

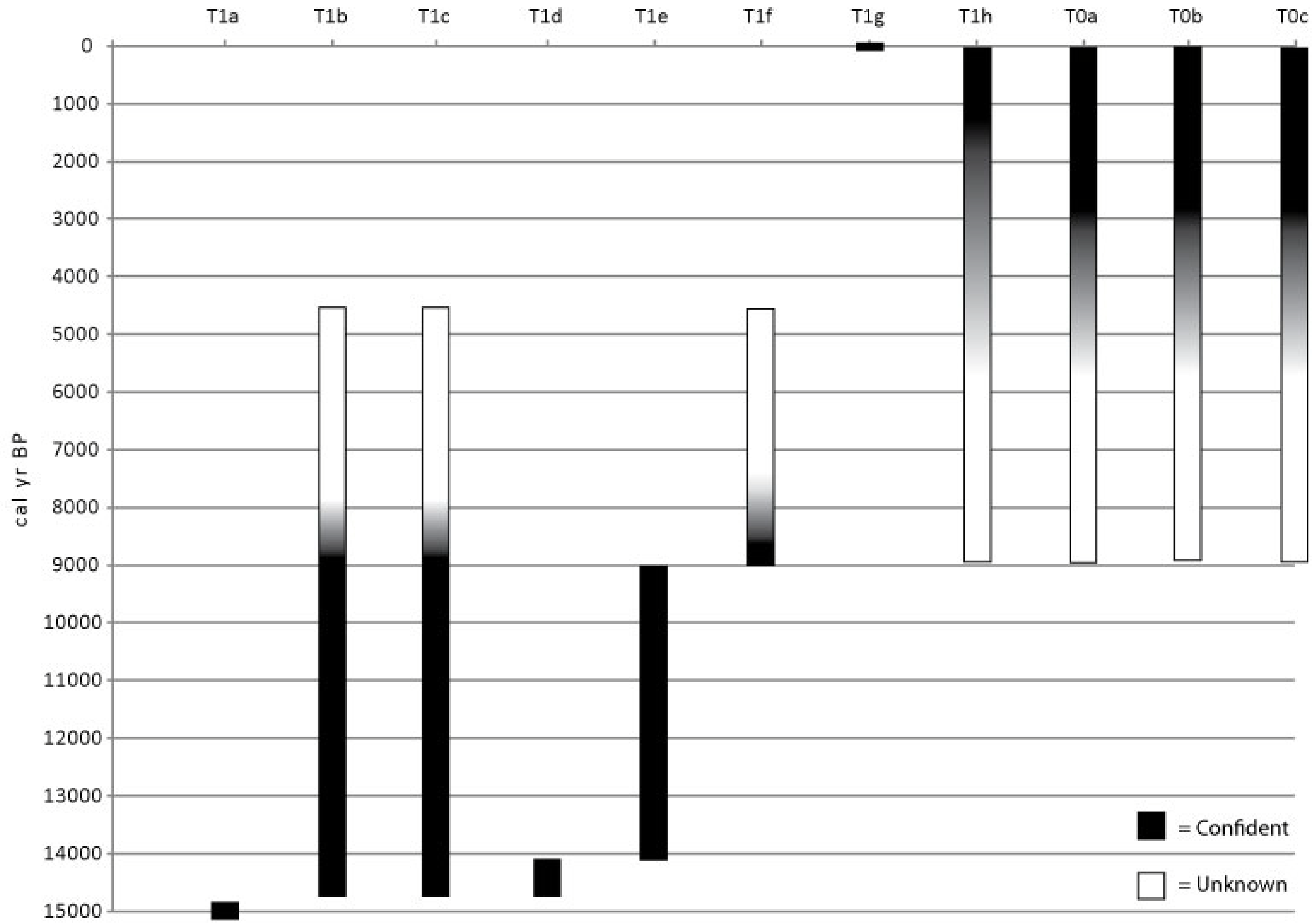

Figure 7 - Time deposition chart, the darker the shade the more confidence in the age.

Table 1 - Radiocarbon ages					
Lab number	Depth (cm)	Material	$\delta^{13}C$ corrected age (^{14}C yr BP)	Calibrated 2-σ range (cal yr BP)	Calibrated intercepts (cal yr BP)
Northern Core					
	50-55	Uncarb. Wood			
CAIS-6406	65-70	Uncarb. Wood	11450±40	13199-13426	13367±120
CAIS-6407	105-110	Seeds	12250±40	13920-14523	14315±252
UGAMS-03503	185-190	Peat	12190±30	13893-14185	14222±220
UGAMS-03528	190-195	Seeds	11940±70	13600-13992	13866±176
Southern Core					
	45-50	Wood Charcoal	8160±35	9011-9144	9108±62
CAIS-6408	99-103	Uncarb. Wood	11850±40	13570-13837	13755±132
CAIS-6409	155-160	Uncarb. Wood	12400±40	14115-14934	14619±330

CHAPTER 3

CONCLUSION

Whiteoak Bottoms is the oldest dated wetland in the Southern Blue Ridge Mountains. Initiation of peat deposition began circa 14,934 to 13,600 cal yr BP in the paleochannels of the Nantahala River. The presence of paleochannels beneath the surface of the relatively flat wetland highlights the fact that the subsurface of these landforms can be highly variable and the depth and extent of histosol development cannot be assumed uniform. The peat deposit transitions from woody to mossy peat indicating a steadily rising water table linked to river aggradation possibly caused by climatic conditions that favored more runoff and sedimentation. WOB was cut off from the influence of the Nantahala River until 13,426 to 9,011 cal yr BP when sedimentation within the wetland became increasingly inorganic. We suggest that the increase in inorganic bedding in the stratigraphy of the wetland is evidence of an increased frequency of overbank flood events during the early Holocene. The past 9,000 years have seen a drastic reduction in the amount of organic matter being sequestered in the wetland. We believe that it was the incision of the Nantahala River to its current elevation that caused this drastic change in wetland dynamics, though better chronometric control is needed to be sure. Presently, it is the hillslope seeps and beaver activity that are the most important mechanisms maintaining the persistence of the wetland at Whiteoak Bottoms. This study illustrates the importance landscape position and hydrology has had on the evolution of this wetland. Currently and for the past 15,000 years, the hydrology has been such that more than 1,000 Mg/ha of carbon have been sequestered in the wetland. Significant disturbance of the hydrology of this wetland has the potential to turn this carbon sink into a significant source of carbon.

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Appendix A

Core Descriptions

Table A1. Description of core N1 on the northern transect.

Core: N1
Distance: 218 m   Probe Depth: 40 cm

Depth	Color	Description
0-19	10YR 2/2	Highly humified muck, many fine roots
19-40	10YR 4/2	Sand gravel, avg. < 4 cm, largest 1 cm
40+	na	Cobble

Table A2. Description of core N2 on the northern transect.

Core: N2
Distance: 198 m   Probe Depth: 120 cm

Depth	Color	Description
0-7	10YR 2/2	Mucky, few roots
7-24	10YR 2/2	Mucky, many fine roots
24-37	10YR 2/2	Gravelly muck, fine irregular gravel
37-64	7.5YR 2.5/2	Peat, few fine roots
64-84	10YR 2/2	Peat, mica prevalent
84-92	10YR 2/2	Peat, mica prevalent, gravel intrusions
92-120	na	Clastic, based on tile probe
120+	na	Gravel and Cobble, based on tile probe

Table A3. Description of core N3 on the northern transect.

Core: N3

Distance: 175 m   Probe Depth: 200 cm

Depth	Color	Description
0-62	10YR 2/2	Highly humified, many fine roots
62-90	10YR 2/2	Gravelly muck, fine gravel
90-114	7.5YR 2.5/3	Peaty, slightly woody, many fine roots
114-145	7.5YR 2.5/3	Woody peat, many fine roots
145-163	7.5YR 2.5/3	Slightly woody, many fine roots
163-178	7.5YR 2.5/3	Woody peat, slightly clastic, few mica
178-193	7.5YR 2.5/3	Higly decomposed peat, some clastic, mica prevalent, some woody debris
193-200	na	Clastic, based on tile probe
200+	na	Gravel and Cobble, based on tile probe

Table A4. Description of core N4 on the northern transect.

Core: N4

Distance: 156 m   Probe Depth: 130 cm

Depth	Color	Description
0-36	10YR 2/2	Heavily decomposed mucky peat, many fine roots
36-52	10YR 2/2	Extremely humified peat
52-80	10YR 2/2	Heavily humified, few small gravel, few small pieces of wood
80-97	7.5YR 2.5/2	Mucky clay, few mica
97-120	10YR 2/2	Mucky clay, few pieces of wood, prevalent mica
120-130	na	Clastic, based on tile probe
130+	na	Gravel and Cobble, based on tile probe

Table A5. Description of core N5 on the northern transect.
Core: N5
Distance: 142 m Probe Depth: 76 cm

Depth	Color	Description
0-9	10YR 3/1	Highly decomposed muck, frozen
9-48	10YR 3/1	Highly decomposed muck, many fine roots
48-56	5YR 4/2	Mucky clay, mica common
56-76	na	Clastic, based on tile probe
76+	na	Gravel and Cobble, based on tile probe

Table A6. Description of core N6 on the northern transect.
Core: N6
Distance: 121 m Probe Depth: 100 cm

Depth	Color	Description
0-20	10YR 2/1	Highly decomposed muck, frozen
20-46	10YR 2/2	Mucky clay, many fine roots, many small roots
46-95	na	Clastic, based on tile probe
95+	na	Gravel and Cobble, based on tile probe

Table A7. Description of core N7 on the northern transect.

Core: N7

Distance: 109 m

Depth	Horizon	Color	Description
0-20	A	10YR 2/1	Organic clayey silt, many roots
20-27	A2	10YR 2/2	Organic clayey silt, many roots
27-34	AB or EB	7.5YR 3/3	Silt loam, few roots
34-53	Bh or Ab	10YR 3/2	Silt loam
53-85	C	10YR 3/6	Silt loam, redox features
85-108	C2	2.5Y 5/2	Silt loam, redox features common 2.5Y 6/8
108-126	2C	2.5Y 4/1	Sandy loam, few very fine gravel
126+	3C	na	Cobble

Table A8. Description of core N8 on the northern transect.

Core: N8

Distance: 92 m

Depth	Horizon	Color	Description
0-12	A	10YR 2/1	Silt loam, many fine roots, many small roots, granular very friable
12-51	E or BA	10YR 3/4	Silt loam, few fine roots, granular, very friable, some wetness
51-72	Bh or Ab	10YR 3/3	Silt loam, few fine roots, possibly a buried A horizon
72-122	C	2.5YR 6/6	Sandy loam, redox features common 10R 4/6
122+	2C	na	Cobble

Table A9. Description of core N9 on the northern transect

Core: N9

Distance: 69 m

Depth	Horizon	Color	Description
0-11	O	10YR 2/2	Slightly humified organic layer, many fine roots, few small roots
11-20	A	10YR 2/2	Silt loam, many fine roots
20-30	Bw	10Y 3/3	Silt loam, subangular around rootlets, friable
30-45	BC	2.5Y 3/3	Silt loam, subangular around rootlets, friable
45-95	C	10YR 4/6	Silt loam, massive
95-115	2C	10YR 5/6	Sandy loam, redox features common 10R 4/6, small gravel at bottom
115+	3C	na	Cobble

Table A10. Description of core N10 on the northern transect.
Core: N10
Distance: 61 m

Depth	Horizon	Color	Description
0-12	A	10YR 2/2	Silt loam, many fine roots
12-34	BC	10YR 3/3	Silt loam
34-60	2C	10YR 3/4	Sandy loam
60-100	2C2	2.5Y 3/3	Loamy Sand
100+	3C	na	Cobble

Table A11. Description of core N11 on the northern transect
Core: N11
Distance: 48 m

Depth	Horizon	Color	Description
0-8	O	10YR 2/2	O-horizon, leaves and roots
8-23	A	10YR 3/2	Silt loam, many fine roots, small roots common
23-33	Bw	10YR 3/3	Silt loam, few small roots
33-54	BC	2.5Y 3/3	Silt loam
54-96	2C	2.5Y 5/6	Sandy loam
96+	3C	na	Cobble

Table A12. Description of core N12 on the northern transect.
Core: N12
Distance: 39 m

Depth	Horizon	Color	Description
0-11	A	10YR 2/2	Silt loam, many fine roots
11-33	Bw	10YR 3/2	Silt loam
33-55	BC	10YR 3/4	Sandy loam, medium roots common
55-107	C	10YR 5/6	Sandy loam
107-121	C2	10YR 4/3	Loamy sand, probably where WT is
121-136	C3	10YR 4/2	Loamy sand, 4 cm cobble inclusion
136+	2C	na	Cobble

Table A13. Description of core M1 on the middle transect.

Core: M1

Distance: 113 m Probe Depth: 180 cm

Depth	Color	Description
0-14	10YR 2/1	Slightly decomposed muck, many fine roots, medium roots common
14-76	7.5YR 4/2	Clayey muck, many fine roots down to 37 cm, redox common 7.5YR 6/8, mica
76-95	5Y 6/1	Mucky clay, mica
95-127	10YR 2/2	Woody peat, some small pieces of wood
127-135	7.5YR 4/2	Clayey muck
135-139	7.5YR 4/2	Gravelly muck, very fine gravel
139-150	7.5YR 4/2	Clayey muck
150-173	2.5Y 4/1	Mucky clay
173-180	7.5YR 6/8	Sand
180+	na	Gravel and Cobble, based on tile probe

Table A14. Description of core M2 on the middle transect.

Core: M2

Distance: 101 m Probe Depth: 100 cm

Depth	Color	Description
0-23	2.5Y 3/2	Mostly decomposed muck, many fine roots
23-48	10YR 3/1	Clayey muck
48-77	10YR 2/1	Mucky clay
77-100	na	Clastic, based on tile probe
100+	na	Gravel and Cobbles, based on tile probe

Table A15. Decription of core M3 on the middle transect

Core: M3

Distance: 39 m Probe Depth: 120 cm

Depth	Color	Description
0-35	7.5YR 2.5/1	Mostly decomposed muck, many fine roots
35-43	7.5YR 2.5/1	Highly decomposed, some gravel
43-77	10YR 3/2	Clayey muck
77-88	10YR 3/2	Highly decompsed, with gravel
88-115	7.5YR 2.5/1	Peat, some woody debris
115-120	na	Clastic, based on tile probe
120+	na	Gravel and Cobbles, based on tile probe

Table A16. Description of core M4 on the middle transect.
Core: M4
Distance: 82 m Probe Depth: 200 cm

Depth	Color	Description
0-18	10YR 2/2	Highly decomposed mucky peat, many fine roots
18-39	10YR 3/1	Clayey muck, few fine roots
39-70	10YR 3/1	Clayey muck
70-115	10YR 3/1	Peat
115-200	na	Clastic, based on tile probe
200+	na	Gravels and Cobbles, based on tile probe

Table A17. Description of core M5 on the middle transect.
Core: M5
Distance: 78 m

Depth	Horizon	Color	Description
0-44	A	10YR 2/2	Silt loam, many fine roots
44-63	AB	10YR 3/3	Silt loam
63-77	B	10YR 3/6	Sandy loam
77-104	B2	10YR 3/3	Sandy loam
104-132	C	10YR 5/4	Clay loam
132-163	2C	2.5Y 4/2	Loamy sand
163+	3C	na	Cobble

Table A18. Description of core M6 on the middle transect.
Core: M6
Distance: 68 m

Depth	Horizon	Color	Description
0-23	A	10YR 2/2	Silt loam, many fine roots
23-48	AE	10YR 3/3	Silt loam
48-80	B2	10YR 3/2.5	Silt loam
80-93	2C	10YR 6/8	Loam, gravel inclusions avg. 2 cm max. 5 cm
93+	3C	na	Cobble

Table A19. Core Description of core M7 on the middle transect.
Core: M7
Distance: 57 m

Depth	Horizon	Color	Description
0-20	A	10YR 2/2	Silt loam, many fine roots
20-30	AB	10YR 3/3	Silt loam, few fine roots
30-86	C	10YR 4/6	Silt loam, few fine roots
86-127	2C	2.5Y 5/4	Sandy loam, redox features common 7.5YR 6/8
127+	3C	na	Cobble

Table A20. Description of core M8 on the middle transect.

Core: M8

Distance: 45 m Water Table: 36 cm

Depth	Horizon	Color	Description
0-50	A	10YR 2/2	Silt loam, many fine roots
50-68	AC	10YR 2.5/2	Silt loam
68-113	2C	10YR 3/3	Silt loam, few fine roots
113+	3C	na	Cobble

Table A21. Description of core M9 on the middle transect.

Core: M9

Distance: 37 m

Depth	Horizon	Color	Description
0-10	A	10YR 2/2	Silt loam, many fine roots
10-40	AB	10YR 3/3	Silt loam
40-73	C	10YR 3/4	Sandy loam
73-117	2C	10YR 3/4	Loamy sand
117+	3C	na	Cobble

Table A22. Description of core M10 on the middle transect.
Core: M10
Distance: 18 m

Depth	Horizon	Color	Description
0-62	A	10YR 2/2	Silt loam, many fine roots medium roots common
62-92	AC	10YR 3/3	Sandy loam
92-119	2C	10YR 3/4	Sandy loam
119-160	2C2	10YR 2/1	Loamy sand
160+	3C	na	Cobble

Table A23. Description of core S1 on the southern transect.
Core: S1
Distance: 187 m Probe Depth: 115 cm

Depth	Color	Description
0-4	10YR 2/2	Clayey muck, mostly decomposed, many roots
4-10	10YR 3/2	Mucky clay, many roots, few pieces of vey fine gravel
10-54	Gley 5/10Y	Clay, redox features 2.5Y 7/8, mica prevalent
54-86	10YR 3/2	Sandy clay, woody pieces throughout, mica prevalent
86-100	10YR 3/2	Sandy clay, few woody pieces, few small (<1 cm) gravel
100-115	5Y 3/2	Gravelly sandy clay, large gravel (3 - 5 cm)
115+	na	Cobble

Table A24. Description of core S2 on the southern transect.

Core: S2

Distance: 177 m   Probe Depth: 200 cm

Depth	Color	Description
0-35	2.5YR 4/2	Highly decomposed clayey muck, many fine roots
35-60	10YR 5/1	Extremely decomposed clayey muck, many fine roots
60-87	2.5YR 3/2	Mucky clay, mica throughout
87-123	7.5 YR 3/2	Woody peat, mica
123-149	10YR 3/3	Woody peat, mica
149-180	Gley 4/10Y	Mucky sand, mica
180-200	na	Clastic, based on tile probe
200+	na	Gravel and Cobble, based on tile probe

Table A25. Description of core S3 on the southern transect.

Core: S3

Distance: 172 m Probe Depth: 120 cm

Depth	Color	Description
0-20	7.5YR 2.5/2	Highly humified muck, many fine roots
20-45	10YR 2/2	Extremely humified muck, few fine roots
45-61	2.5YR 2.5/1	Mucky clay, few light brown mottles
61-90	7.5YR 2.5/2	Peat
90-98	7.5YR 2.5/2	Woody peat
98-110	10YR 4/1	Mucky clay, mica prevalent
110-120	na	Clastic, based on tile probe
120+	na	Gravel and Cobble, based on tile probe

Table A26. Description of core S4 on the southern transect.

Core: S4

Distance: 162 m   Probe Depth: 170 cm

Depth	Color	Description
0-41	7.5YR 2.5/2	Highly humified muck, many fine roots
41-66	10YR 2/2	Extremely humified muck, few fine roots
66-80	10YR 2/2	Mucky clay, few gravel, few woody fragments
80-110	7.5YR 2.5/2	Peat
110-170	na	Clastic, based on tile probe
170+	na	Gravel and Cobble, based on tile probe

Table A27. Description of core S5 on the southern transect.

Core: S5

Distance: 152 cm Probe Depth: 250 cm

Depth	Color	Description
0-45	10YR 2/2	Mucky peat, many fine roots
45-92	2.5Y 4/2	Mucky clay, mica
92-180	10YR 3/3	Peat
180-200	10YR 3/3	Woody Peat
200-210	2.5Y 3/2	Sandy clay, lots of mica
210-250	na	Clastic, based on tile probe
250+	na	Gravel and Cobbles, based on tile probe

Table A28. Description of core S6 on the southern transect.

Core: S6

Distance: 137 m   Probe Depth: 160 cm

Depth	Color	Description
0-38	10YR 2/2	Mucky peat, many fine roots
38-82	2.5Y 4/2	Mucky clay, mica
82-94	10YR 3/3	Peat
94-110	2.5Y 4/2	Mucky clay, mica common
110-160	na	Clastic, based on tile probe
160+	na	Gravel and Cobble, based on tile probe

Table A29. Description of core S7 on the southern transect.

Core: S7

Distance: 129 m   Probe Depth: 120 cm

Depth	Color	Description
0-30	10YR 2/1	Mucky peat, many fine roots, woody pieces common
30-49	10YR 3/1	Clayey muck, mica common
49-115	2.5Y 3/2	Mucky clay, mica common, few pieces of wood
115-126	2.5Y 3/3	Sand
126+	na	Cobble

Table A30. Description of core S8 on the southern transect.
Core: S8
Distance: 120 m

Depth	Horizon	Color	Description
0-8	O	10YR 2/1	Slighly humified organic, many fine roots
8-46	A	10YR 2/1	Silt loam, few fine roots
46-75	C	5Y 4/1	Silt loam, redox features rare
75-99	C2	5Y 4/1	Loamy silt
99-127	2C	5Y 3/2	Sandy loam, redox fewatures common 2.5Y 4/6
127+	3C	na	Cobble

Table A31. Description of core S9 on the southern transect.

Core: S9

Distance: 105 m

Depth	Horizon	Color	Description
0-9	O	10YR 2/2	Slightly decomposed organic, many fine roots
9-19	A	10YR 3/2	Silt loam, many fine roots, medium roots rare
19-53	Bw	10YR 2/2	Silt loam, fine roots common
53-70	Bh	10YR 2/1	Loam, some increase in sand
70-82	C1	2.5Y 4/2	Sandy loam, black spots 10YR 2/1
82-160	C2	2.5Y 4/2	Sandy loam, redox features common 7.5YR 6/8
160+	2C	na	Cobble

Table A32. Description of core S10 on the southern transect.
Core: S10
Distance: 85 m

Depth	Horizon	Color	Description
0-10	A	10YR 2/1	Silt loam, many fine roots
10-28	B1	10YR 3/2	Silt loam
28-70	B2	10YR 2/2	Silt loam
70-77	BC	10YR 4/2	Loam
77-116	C	2.5Y 4/2	Loam, redox features common 5YR 5/8
116+	2C	na	Cobble

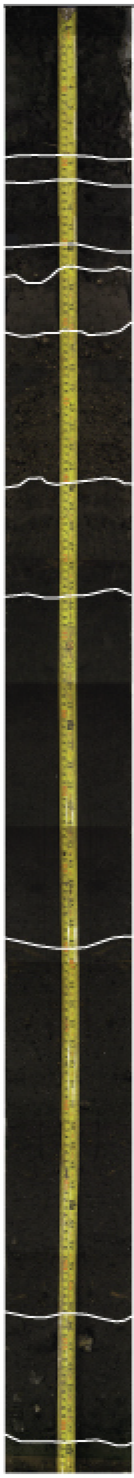
Table A33. Description of core S11 on the southern transect.
Core: S11
Distance: 67 m

Depth	Horizon	Color	Description
0-5	O	10YR 2/2	Slightly humified organic, leaves and roots
5-13	A	10YR 2/1	Silt loam, few fine roots, few small roots
13-19	Bw	7.5YR 2.5/3	Silt loam, few fine roots
19-27	C	10YR 3/6	Silt loam
27-38	2C	10YR 3/4	Sandy loam
38-96	2C2	10YR 5/6	Sandy loam
96+	3C	na	Cobble

Table A34. Description of core S12 on the southern transect.
Core: S12
Distance: 52 m

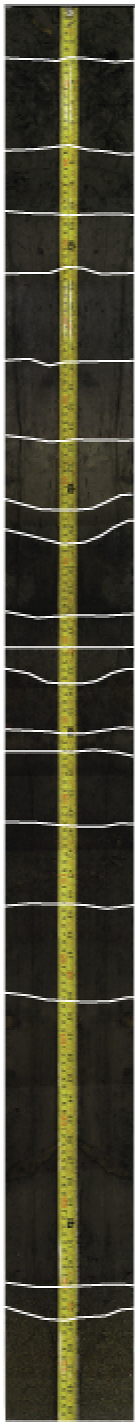
Depth	Horizon	Color	Description
0-8	O	10YR 2/1	Slightly humified organic, leaves and roots, many fine roots
8-19	A	10YR 2/1	Silt loam, many fine roots
19-26	AB	7.5YR 3/3	Silt loam, many fine roots
26-55	C	10YR 4/6	Sandy loam
55-113	2C	10YR 5/6	Loamy sandy
113+	3C	na	Cobble

WOB 1B - (North Core)



Depth (cm)	Description
0 - 19	10YR 2/1 (Black); highly decomposed muck; roots -- fine-many, medium-rare; smooth, abrupt.
19 - 22	10YR 3/2 (Very Dark Grayish Brown); mucky sand; smooth, abrupt.
22 - 30	10YR 2/1 (Black); sandy muck; smooth, clear.
30 - 33	10YR 2/1 (Black); silty muck; fine angular gravel-rare; smooth, clear.
33 - 41	10YR 3/2 (Very Dark Grayish Brown); silty loam; smooth, abrupt.
41 - 60	10YR 3/3 (Dark Brown); gravelly sandy loam; angular gravel -- fine-many, medium-common; smooth, abrupt.
60 - 75	10YR 2/2 (Very Dark Brown); woody peat; smooth, abrupt.
75 - 120	10YR 2/1 (Black); mossy peat; mica-rare; smooth, gradual.
120 - 168	10YR 2/1 (Black); woody peat; mica - common; gravel -- fine-common, medium-rare; smooth, abrupt.
168 - 182	10YR 2/1 (Black); woody peat; gravel -- coarse-rare; smooth, abrupt.
182 - 187	10YR 3/1 (Very Dark Gray); silty clay

Figure A1. Photograph and description of northern core.



WOB 2B - (South Core)	Depth (cm)	Description
	0 - 7	10YR 2/1 (Black); highly decomposed muck; roots -- fine-many; smooth, abrupt.
	7 - 18	10YR 2/1 (Black); highly decomposed muck; roots -- fine-many, medium-common ; smooth, clear.
	18 - 27	10YR 2/1 (Black); highly decomposed muck; roots -- fine-common; smooth, abrupt.
	27 - 33	10YR 3/1 (Very Dark Gray); silt loam; clear to gradual boundary.
	33 - 45	10YR 2/1 (Black); silt loam; smooth, abrupt.
	45 - 55	10YR 3/1 (Very Dark Gray); silt loam; roots -- fine-common; smooth, clear.
	55 - 64	10YR 4/1 (Dark Gray); silt loam; smooth, abrupt.
	64 - 68	10YR 3/1 (Very Dark Gray); silt loam, smooth, abrupt.
	68 - 77	10YR 2/2 (Very Dark Brown); mossy peat; smooth, abrupt.
	77 - 81	10YR 2/1 (Black); mossy peat; smooth, abrupt.
	81 - 86	10YR 2/1 (Black); silty muck; smooth, abrupt.
	86 - 92	10YR 2/1 (Black); woody peat; smooth, abrupt.
	92 - 94	10YR 3/1 (Very Dark Gray); silty muck; mica-common; smooth, abrupt.
	94 - 103	10YR 2/1 (Black); mossy peat; smooth, abrupt.
	103 - 113	10YR 2/1 (Black); woody peat; smooth, abrupt.
	113 - 125	10YR 2/1 (Black); mossy peat; smooth, abrupt.
	125 - 160	10YR 2/1 (Black); woody peat; smooth, abrupt.
	160 - 164	10YR 2/1 (Black); mucky sand; smooth, abrupt.
	164 - 178	5Y 3/2 (Dark Olive Gray); sand.

Figure A2. Photograph and description of the southern core.

Appendix B

Topographic Survey Data

Table B1. The location (lat/long: UTM, NAD1983), elevation (m a.s.l.), and depth of histosol development (m).

PT	LAT	LONG	Z	D2B
2	3884801.646	269274.944	1033.141	0.8
4	3884793.897	269276.229	1033.376	1.31
5	3884790.271	269269.653	1033.303	0.3
6	3884783.138	269273.022	1033.468	0.8
7	3884784.413	269277.866	1033.47	1.33
8	3884775.324	269277.547	1033.563	1.44
9	3884772.548	269273.547	1033.51	1.02
10	3884777.966	269271.301	1033.469	0.8
11	3884773.532	269263.076	1033.732	1
12	3884773.999	269261.217	1033.405	1
13	3884766.686	269262.536	1033.721	1.58
14	3884764.877	269268.146	1033.627	1.78
15	3884763.881	269275.954	1033.699	0.65
16	3884768.858	269278.149	1033.625	2.05
17	3884770.867	269277.247	1033.606	1.8
18	3884768.776	269279.638	1033.654	2.05
19	3884764.998	269279.631	1033.651	2.05
20	3884759.328	269278.56	1033.749	1.38
21	3884759.513	269281.868	1033.729	1.09
22	3884756.358	269280.788	1033.833	1.15
23	3884764.141	269273.022	1033.68	2.05
24	3884758.982	269271.374	1033.735	1.68
25	3884753.599	269277.641	1033.846	1.3
26	3884756.389	269273.414	1033.694	1.47
27	3884753.643	269283.355	1033.946	1.11
28	3884762.138	269286.47	1033.975	1.17
29	3884769.545	269288.88	1033.817	0.98
30	3884774.21	269290.547	1033.855	0.6
31	3884779.526	269286.67	1033.707	0.71
32	3884774.605	269283.652	1033.674	1.33
33	3884766.974	269283.388	1033.721	1.38
34	3884760.801	269267.149	1033.829	1.43
35	3884765.107	269263.313	1033.546	1.4
36	3884768.358	269257.74	1033.694	1.52
37	3884772.139	269254.287	1033.437	1.16
38	3884776.376	269249.341	1033.639	1.23
39	3884776.547	269248.282	1033.456	1.02
40	3884767.107	269244.813	1033.479	0.9

41	3884764.35	269251.332	1033.597	1.33
42	3884761.528	269258.279	1033.617	1.48
43	3884758.46	269264.895	1033.691	0.96
44	3884757.206	269270.128	1033.694	1.69
45	3884752.388	269274.972	1033.835	1.57
46	3884752.766	269269.179	1033.808	1.47
47	3884754.269	269263.076	1033.768	0.74
48	3884759.595	269260.183	1033.66	1.02
49	3884782.886	269271.682	1033.415	0.87
50	3884788.093	269269.705	1033.346	0.54
51	3884795.142	269267.86	1033.299	0.38
52	3884793.223	269263.556	1033.22	0.6
53	3884789.522	269262.708	1033.243	0.69
54	3884783.725	269264.422	1033.33	0.63
55	3884785.287	269257.983	1033.328	0.6
56	3884790.125	269254.649	1033.32	0.6
57	3884785.597	269252.751	1033.336	0.58
58	3884783.755	269247.788	1033.316	0.75
59	3884784.483	269243.584	1033.399	0.8
60	3884780.295	269244.479	1033.416	0.8
61	3884781.256	269240.082	1033.399	0.65
62	3884775.503	269239.778	1033.45	0.7
63	3884777.25	269243.298	1033.478	0.7
64	3884770.97	269239.308	1033.49	0.55
65	3884733.361	269266.806	1034.187	0
66	3884751.377	269281.73	1033.863	1.43
67	3884748.697	269286.426	1033.992	1.6
68	3884743.704	269289.212	1034.104	1.32
69	3884738.599	269287.432	1034.117	1.69
70	3884732.374	269285.608	1034.116	1.35
71	3884727.977	269286.691	1034.386	1.1
72	3884715.362	269280.153	1034.385	0.9
73	3884714.319	269275.512	1034.262	0.85
74	3884714.342	269269.522	1034.43	0.9
75	3884716.078	269264.165	1034.261	0.94
76	3884715.869	269258.153	1034.3	1.5
77	3884722.375	269253.035	1034.228	1.29
78	3884725.293	269251.132	1034.063	0.92
79	3884724.679	269248.109	1034.141	0.82
80	3884730.936	269248.858	1034.128	0.93
81	3884738.007	269253.177	1034.03	1.34

82	3884740.816	269248.559	1033.824	0.77
83	3884741.78	269255.434	1033.761	1.11
84	3884738.623	269256.815	1033.959	0.8
85	3884744.625	269256.908	1034.069	1.2
86	3884745.178	269257.47	1033.714	0.5
87	3884749.815	269254.507	1033.666	0.8
88	3884753.022	269255.885	1033.667	1
89	3884752.674	269260.555	1033.703	0.55
90	3884749.322	269262.38	1033.844	0.7
91	3884749.507	269258.219	1033.875	0.8
92	3884747.739	269257.049	1033.798	0.62
93	3884751.356	269271.315	1033.767	1.65
94	3884749.905	269276.79	1033.878	1.58
95	3884746.502	269278.85	1033.921	0.95
96	3884742.941	269281.731	1033.961	0.86
97	3884738.946	269281.58	1034.083	0.7
98	3884733.111	269282.899	1034.139	0.8
99	3884730.251	269278.073	1034.122	0.5
100	3884727.844	269274.665	1034.14	0.6
101	3884719.719	269277.234	1034.256	1.1
102	3884716.565	269272.986	1034.274	1.01
103	3884719.132	269267.335	1034.158	0.8
104	3884720.047	269262.868	1034.167	1.4
105	3884723.37	269259.578	1034.202	1.7
106	3884726.536	269255.724	1034.028	1
107	3884731.72	269255.592	1034.019	1
108	3884736.524	269255.705	1033.956	1.34
109	3884739.328	269259.153	1034.135	1.43
110	3884742.267	269262.049	1033.755	0.67
111	3884743.427	269266.615	1033.781	0.9
112	3884743.76	269264.515	1033.943	1.05
113	3884741.985	269272.887	1033.881	1.23
114	3884737.443	269275.73	1033.986	0.4
115	3884731.469	269273.426	1034.053	0.56
116	3884727.764	269269.628	1034.137	0.6
117	3884724.942	269264.438	1034.166	1.34
118	3884726.473	269262.642	1034.149	1.6
119	3884730.773	269261.956	1034.028	1.2
120	3884735.575	269260.781	1034.108	1.51
121	3884737.239	269268.321	1034.072	1.42
122	3884731.569	269270.372	1034.069	0.51

123	3884730.346	269266.845	1034.047	1.2
124	3884732.703	269264.665	1034.086	1.71
125	3884734.549	269268.593	1034.004	1.13
126	3884867.224	269236.195	1032.567	0
127	3884751.723	269289.482	1034.07	1.02
128	3884755.653	269288.388	1034.047	0.96
129	3884754.357	269282.662	1033.937	1.35
130	3884762.858	269286.736	1033.955	1.51
131	3884767.014	269294.042	1034.065	0.89
132	3884767.256	269288.008	1033.987	1.61
133	3884770.674	269282.926	1033.687	1.35
134	3884774.603	269287.71	1033.789	1.27
135	3884778.794	269288.43	1033.772	0.7
136	3884782.78	269287.017	1033.521	0.88
137	3884779.249	269281.936	1033.65	1.73
138	3884779.624	269277.487	1033.506	1.58
139	3884784.66	269277.143	1033.287	1.28
140	3884787.628	269279.941	1033.507	1.51
141	3884788.488	269282.909	1033.311	1.25
184	3884555.361	269283.913	1036.446	1.41
185	3884561.972	269283.900	1036.534	2.05
186	3884560.472	269279.448	1036.325	1.22
187	3884566.732	269280.697	1036.402	1.75
188	3884572.892	269281.169	1036.436	2.05
189	3884569.621	269276.103	1036.229	1.3
190	3884578.069	269279.190	1036.462	2.05
191	3884576.209	269272.430	1036.360	2.05
192	3884571.807	269269.375	1036.027	1.2
193	3884583.113	269271.806	1036.183	1.75
194	3884581.212	269276.864	1036.209	2.05
195	3884586.066	269278.262	1036.298	2.05
196	3884588.490	269274.673	1036.194	1.7
197	3884590.995	269281.773	1036.393	1.77
198	3884592.488	269287.139	1036.596	0.18
199	3884594.980	269293.345	1036.841	0.12
200	3884597.358	269299.599	1036.988	0.52
201	3884598.856	269287.236	1036.524	0.19
202	3884595.550	269280.030	1036.129	1.7
203	3884591.230	269275.739	1036.276	1.9
204	3884593.249	269273.433	1036.217	1.87
205	3884599.174	269273.618	1036.114	1.85

206	3884606.134	269274.615	1035.984	1.97
207	3884610.313	269275.056	1035.892	1.98
208	3884615.369	269275.812	1035.816	2.05
209	3884619.364	269276.292	1035.916	2.05
210	3884611.416	269270.586	1035.891	1.6
211	3884603.733	269270.807	1036.045	1.6
212	3884595.210	269272.480	1036.119	1.8
213	3884590.514	269271.097	1036.024	1.65
214	3884594.353	269268.700	1036.075	1.55
215	3884599.740	269266.851	1035.938	1.3
216	3884605.938	269264.845	1035.856	1.16
217	3884612.121	269263.421	1035.608	1.16
218	3884617.932	269261.946	1035.569	1.35
219	3884618.666	269264.686	1035.424	1.3
220	3884624.505	269263.051	1035.497	1.28
221	3884630.348	269261.553	1035.408	1.4
222	3884630.964	269256.893	1035.351	1.82
223	3884623.975	269259.139	1035.420	1.15
224	3884619.964	269260.120	1035.438	1.13
225	3884603.094	269264.033	1035.977	1.1
226	3884611.295	269249.363	1035.518	1.35
227	3884613.738	269249.937	1035.391	1.58
228	3884616.327	269248.653	1035.365	1.52
229	3884607.859	269247.374	1035.433	1.28
230	3884604.606	269252.358	1035.652	1.9
231	3884600.580	269257.220	1035.714	0.98
232	3884596.976	269262.693	1035.814	1.15
233	3884592.469	269266.971	1035.949	1.41
234	3884589.835	269270.409	1036.123	1.7
235	3884590.596	269264.475	1035.770	1.03
236	3884592.007	269259.080	1035.780	1
237	3884594.580	269253.608	1035.615	0.8
238	3884598.803	269253.012	1035.615	1.35
239	3884596.071	269250.744	1035.529	0.88
240	3884589.502	269255.734	1035.834	1.15
241	3884589.382	269264.007	1035.840	1.11
242	3884587.796	269268.537	1036.007	1.23
243	3884585.800	269268.256	1036.046	1.09
244	3884585.563	269264.482	1035.921	1.18
245	3884586.743	269260.599	1035.803	1
246	3884585.512	269257.063	1035.738	0.98

247	3884579.789	269255.291	1035.701	1.2
249	3884589.779	269242.837	1035.449	0
250	3884577.572	269260.826	1035.803	1.91
251	3884580.390	269264.382	1035.904	1.83
252	3884584.241	269269.035	1035.900	1.2
253	3884586.597	269271.854	1036.178	1.73
254	3884582.395	269271.611	1036.220	1.86
255	3884579.256	269266.910	1036.066	1.87
256	3884576.723	269263.575	1035.818	1.96
257	3884574.881	269259.450	1035.856	1.7
258	3884570.077	269256.887	1035.575	1.53
259	3884568.911	269263.045	1035.795	1.18
260	3884573.445	269265.768	1035.873	1.4
261	3884577.550	269268.498	1035.902	1.9
262	3884581.617	269271.470	1036.116	1.83
263	3884585.893	269273.085	1036.307	1.85
264	3884557.025	269281.288	1036.344	1.2
265	3884559.061	269276.463	1036.262	1.76
266	3884561.745	269272.820	1036.109	1.2
267	3884560.573	269269.497	1035.997	1.4
268	3884562.335	269265.971	1035.902	1.2
269	3884563.875	269261.773	1035.753	1.48
270	3884564.669	269257.589	1035.769	1.15
271	3884565.835	269254.637	1035.668	1.4
272	3884564.195	269250.409	1035.526	1.48
273	3884565.290	269245.530	1035.527	1.08
274	3884564.364	269240.639	1035.279	1.1
275	3884565.395	269235.177	1035.334	1.3
276	3884555.409	269277.481	1036.280	1.58
277	3884556.054	269271.402	1036.081	1.41
278	3884558.816	269264.717	1035.824	1.7
279	3884559.019	269259.418	1035.725	1.3
280	3884592.191	269250.949	1035.553	0.98
281	3884596.579	269250.088	1035.707	1.5
282	3884594.078	269247.006	1035.382	1.22
283	3884591.666	269243.535	1035.563	2.05
284	3884595.668	269244.766	1035.471	2.05
285	3884599.099	269246.687	1035.538	1.3
286	3884602.226	269247.572	1035.445	1.18
287	3884606.283	269246.880	1035.428	1.3
288	3884611.362	269246.453	1035.468	1.1

289	3884612.505	269243.206	1035.411	2
290	3884609.692	269242.686	1035.242	1.71
291	3884605.087	269243.406	1035.319	1.95
292	3884599.298	269243.272	1035.447	2.05
293	3884595.864	269242.473	1035.402	1.93
294	3884593.281	269242.558	1035.492	2.05
295	3884596.296	269239.653	1035.459	1.7
296	3884600.936	269238.434	1035.223	1.1
297	3884608.513	269237.516	1035.228	1.55
298	3884613.791	269239.242	1035.265	1.5
299	3884614.392	269234.123	1035.234	1.42
300	3884618.954	269231.454	1035.015	1
301	3884623.445	269230.172	1035.169	1.25
302	3884627.877	269228.944	1035.075	1.2
303	3884626.888	269225.769	1035.173	1.1
304	3884621.868	269227.440	1035.098	1.02
305	3884621.155	269223.398	1035.263	1.3
306	3884615.852	269226.639	1035.126	1.38
307	3884613.677	269228.459	1035.464	1.6
308	3884609.745	269229.798	1035.169	1.45
309	3884611.845	269225.404	1035.087	1.28
310	3884616.014	269222.857	1035.171	1
311	3884608.412	269229.114	1035.240	1.2
312	3884605.194	269232.931	1035.182	1.44
313	3884602.140	269235.146	1035.400	1.43
314	3884599.841	269230.397	1035.288	1.4
315	3884603.088	269227.696	1035.227	1.4
316	3884604.121	269225.208	1035.207	1.35
317	3884596.835	269231.738	1035.199	0.95
318	3884595.598	269228.434	1035.275	1.1
319	3884596.881	269224.592	1035.227	0.6
320	3884592.847	269225.798	1035.268	1.18
321	3884591.142	269230.447	1035.338	1.2
322	3884592.373	269233.835	1035.309	1.22
323	3884590.335	269237.822	1035.245	1.5
324	3884597.695	269233.881	1035.312	1.1
325	3884594.359	269235.008	1035.473	1.42
326	3884598.951	269237.119	1035.394	1.37
327	3884593.704	269239.227	1035.398	1.58
328	3884590.291	269241.228	1035.483	1.83
329	3884587.261	269239.817	1035.211	1.27

330	3884586.294	269236.079	1035.263	1.13
331	3884585.753	269232.108	1035.404	0.96
332	3884588.994	269229.646	1035.279	0.4
333	3884587.859	269226.993	1035.233	0.5
334	3884583.214	269231.098	1035.577	1.1
335	3884581.329	269228.603	1035.307	0.58
336	3884580.596	269234.291	1035.367	1.1
337	3884577.347	269233.457	1035.422	1.2
338	3884575.136	269230.781	1035.282	1.3
339	3884574.887	269234.689	1035.564	1.7
340	3884579.920	269236.153	1035.448	1.33
341	3884583.917	269236.397	1035.273	1.26
342	3884584.714	269239.398	1035.460	1.7
343	3884588.497	269241.728	1035.411	1.93
344	3884586.333	269243.228	1035.438	1.9
345	3884582.327	269243.007	1035.553	1.82
346	3884578.221	269244.574	1035.402	1.54
347	3884575.174	269241.563	1035.440	0.9
348	3884570.569	269240.196	1035.323	0.95
349	3884574.660	269245.886	1035.380	0.7
350	3884571.002	269244.748	1035.379	0.81
351	3884570.492	269247.881	1035.468	0.9
352	3884566.551	269244.898	1035.412	1.33
353	3884564.472	269241.940	1035.466	1.38
354	3884559.450	269241.884	1035.382	0.32
355	3884574.601	269247.723	1035.451	0.81
356	3884579.773	269247.733	1035.504	0.93
357	3884583.643	269246.225	1035.630	1.78
358	3884587.624	269244.878	1035.388	1.7
359	3884582.893	269248.310	1035.454	1.12
360	3884578.628	269250.243	1035.703	0.9
361	3884573.895	269250.031	1035.534	0.95
362	3884568.767	269251.483	1035.536	1.38
363	3884563.768	269249.847	1035.497	1.12
364	3884556.456	269249.872	1035.498	0.84
365	3884549.996	269250.732	1035.579	1.36
366	3884545.365	269255.655	1035.620	0.82
367	3884540.656	269259.957	1035.674	0.54
368	3884535.989	269261.321	1035.736	0.55
369	3884551.162	269259.973	1035.666	1.27
370	3884557.860	269258.135	1035.607	1.24

371	3884564.853	269255.253	1035.632	1.35
372	3884570.231	269254.282	1035.670	1.49
373	3884578.244	269254.806	1035.807	1.36
374	3884584.880	269250.568	1035.535	1.02
375	3884587.564	269248.563	1035.529	1.5
376	3884589.311	269246.137	1035.478	1.7
377	3884593.601	269249.213	1035.509	1.17
378	3884590.559	269244.920	1035.429	1.94
379	3884582.041	269240.589	1035.665	2.05
380	3884555.598	269281.031	1036.310	1.36
381	3884555.578	269275.862	1036.215	1.36
382	3884555.941	269271.492	1036.003	1.25
383	3884555.812	269266.620	1035.865	1.6
384	3884555.809	269262.406	1035.715	1.44
385	3884561.112	269262.404	1035.765	1.24
386	3884550.588	269262.324	1035.888	1.54
387	3884548.556	269263.988	1035.848	1.08
388	3884542.467	269266.256	1035.827	0.62
389	3884539.183	269267.657	1035.849	0.4
390	3884542.374	269269.011	1035.834	0.77
391	3884547.020	269268.689	1035.944	1
392	3884549.450	269273.111	1036.020	0.93
393	3884550.370	269277.192	1036.088	1.15
394	3884548.186	269281.118	1036.367	1.32
395	3884551.702	269281.436	1036.340	1.6
396	3884610.292	269258.826	1035.572	1.08
397	3884615.27	269252.631	1035.353	1.22
398	3884623.351	269249.174	1035.34	1.77
399	3884628.087	269246.958	1035.067	1.33
400	3884629.327	269239.905	1035.161	1.55
401	3884634.07	269232.751	1035.059	1.36
402	3884643.346	269230.716	1034.898	1.2
403	3884647.732	269227.867	1034.854	1.8
404	3884649.29	269224.301	1034.88	1.5
405	3884652.735	269223.308	1035.006	1.38
406	3884655.038	269220.334	1034.856	1.33
407	3884658.472	269218.035	1034.905	1.19
408	3884658.368	269215.515	1035.198	1.24
409	3884667.951	269242.007	1034.756	1.01
410	3884665.774	269246.472	1034.814	0.8
411	3884660.019	269247.931	1034.869	0.97

412	3884651.135	269250.07	1034.936	1.16
413	3884644.905	269253.311	1035.108	1.73
414	3884639.386	269255.107	1035.235	1.54
415	3884634.761	269255.514	1035.02	1.23
416	3884627.924	269258.833	1035.348	1.61
417	3884620.118	269263.669	1035.501	1.3
418	3884614.142	269267.012	1035.29	1.195
419	3884618.383	269260.979	1035.49	1.1
420	3884627.264	269256.213	1035.305	2.01
421	3884638.708	269252.007	1035.018	1.08
422	3884648.043	269247.507	1035.116	1.06
423	3884631.554	269223.208	1035.109	1.38
424	3884624.407	269215.764	1035.106	1.27
425	3884558.413	269248.577	1035.497	1.3
426	3884593.597	269284.078	1036.405	0.75
427	3884593.94	269288.938	1036.577	0.15
428	3884587.59	269288.134	1036.656	0.4
429	3884587.461	269291.508	1036.72	0.25
430	3884577.917	269291.466	1037.045	0.18
431	3884570.959	269288.811	1036.851	1.76
432	3884572.014	269294.605	1037.057	0.82
433	3884573.1	269296.596	1037.326	0.2
434	3884569.038	269284.349	1036.601	0.64
435	3884567.368	269281.146	1036.434	0.7
436	3884563.642	269276.887	1036.269	0.75
437	3884556.265	269283.561	1036.456	1.55
438	3884560.365	269283.402	1036.527	0.87
439	3884554.145	269278.145	1036.222	1.58
440	3884557.342	269271.856	1036.107	1.4
441	3884558.16	269276.411	1036.268	1.22
442	3884553.186	269276.573	1036.228	0.62
443	3884549.925	269276.995	1036.14	1.35
444	3884549.435	269282.996	1036.522	0.43
445	3884549.967	269286.453	1036.692	0.05
446	3884559.056	269287.105	1036.591	2.05
447	3884555.307	269283.451	1036.45	0
448	3884721.346	269266.25	1034.252	0.8
449	3884715.257	269264.197	1034.365	1.22
450	3884709.006	269262.093	1034.375	1.02
451	3884702.892	269260.436	1034.491	1.18
452	3884696.572	269261.398	1034.507	1.2

453	3884691.048	269259.707	1034.626	0.98
454	3884686.118	269258.143	1034.555	1
455	3884681.8	269256.509	1034.637	1.02
456	3884677.3	269252.462	1034.67	1.06
457	3884672.721	269248.829	1034.732	0.97
458	3884665.774	269246.472	1034.814	0.82
459	3884667.307	269241.6	1034.764	0.81
460	3884674.626	269240.505	1034.673	0.78
461	3884678.608	269239.944	1034.842	0.81
462	3884684.743	269238.393	1034.634	0.78
463	3884688.472	269246.691	1034.547	0.84
464	3884692.772	269250.849	1034.713	1.03
465	3884694.429	269252.045	1034.697	1.18
466	3884697.413	269254.139	1034.475	0.96
467	3884701.77	269255.065	1034.305	1
468	3884704.491	269257.414	1034.403	1.18
469	3884706.747	269259.121	1034.347	1.07
470	3884709.604	269261.238	1034.399	1.21
471	3884712.204	269263.052	1034.54	1.17
472	3884716.396	269263.341	1034.295	1.22
473	3884720.44	269262.583	1034.223	1.32
474	3884720.998	269260.516	1034.199	1.54
475	3884719.062	269259.139	1034.516	1.52
476	3884716.749	269257.654	1034.157	1.84
477	3884714.705	269255.681	1034.342	1.62
478	3884712.912	269254.251	1034.389	1.55
479	3884711.508	269253.161	1034.233	1.21
480	3884709.248	269250.783	1034.27	1.03
481	3884706.285	269248.879	1034.202	0.91
482	3884704.643	269247.786	1034.365	0.78
483	3884703.158	269247.075	1034.314	0.68
484	3884701.217	269245.008	1034.495	0.78
485	3884699.065	269244.958	1034.367	0.96
486	3884696.012	269244.488	1034.451	1.02
487	3884693.509	269242.859	1034.559	0.98
488	3884685.7	269235.166	1034.524	1.18
489	3884680.554	269232.56	1034.565	1.78
490	3884676.9	269231.71	1034.658	1.66
491	3884674.031	269230.146	1034.711	1.79
492	3884669.211	269226.934	1034.73	1.63
493	3884664.134	269225.379	1034.776	1.41

494	3884665.585	269222.652	1034.732	1.44
495	3884670.354	269221.406	1034.656	1.28
496	3884671.442	269224.766	1034.602	1.63
497	3884673.841	269229.917	1034.678	1.57
498	3884677.905	269229.472	1034.614	1.91
499	3884680.889	269229.697	1034.64	1.99
500	3884684.113	269229.247	1034.725	1.61
501	3884688.365	269230.356	1034.568	1.77
502	3884690.594	269231.022	1034.588	1.59
503	3884692.684	269232.727	1034.464	1.76
504	3884695.47	269234.223	1034.587	1.5
505	3884699.175	269239.098	1034.324	0.52
506	3884701.396	269240.975	1034.229	0.61
507	3884703.652	269242.217	1034.381	0.81
508	3884705.658	269243.065	1034.397	1.08
509	3884710.121	269248.039	1034.559	1.74
510	3884714.007	269250.36	1034.185	1.42
511	3884715.614	269251.422	1034.252	1.69
512	3884718.393	269252.714	1034.162	1.74
513	3884720.173	269254.648	1034.353	1.73
514	3884722.47	269256.889	1034.125	1.51
515	3884749.907	269279.749	1033.967	0
516	3884729.53	269261.311	1035.033	1.1
517	3884724.998	269254.436	1034.277	1.03
518	3884718.94	269247.168	1034.162	0.78
519	3884720.75	269241.222	1034.235	0.74
520	3884716.792	269239.381	1034.143	0.83
521	3884712.536	269236.871	1034.065	1.57
522	3884710.881	269232.764	1034.079	1.2
523	3884706.917	269228.78	1034.443	1.44
524	3884750.281	269279.985	1033.87	0
525	3884724.195	269252.071	1034.239	0.9
526	3884719.189	269248.867	1034.121	0.9
527	3884717.264	269242.288	1034.045	0.7
528	3884715.561	269236.282	1034.132	1.17
529	3884710.702	269227.147	1034.133	1.36
530	3884708.086	269222.771	1034.216	0.82
531	3884701.286	269224.622	1034.28	1.43
532	3884695.613	269227.307	1034.344	1.5
533	3884692.073	269220.162	1034.425	1.05
534	3884686.876	269220.339	1034.5	1.03

535	3884682.685	269220.444	1034.529	1.19
536	3884680.37	269218.771	1034.664	1.26
537	3884681.511	269228.289	1034.679	1.63
538	3884690.676	269228.907	1034.31	1.58
539	3884694.948	269228.58	1034.178	0.63
540	3884711.481	269218.482	1034.178	1.23
541	3884716.782	269228.1	1034.041	1.2
542	3884717.28	269234.636	1034.058	1.45
543	3884720.768	269235.64	1034.05	0.95
544	3884725.954	269237.068	1034.051	0.6
545	3884727.929	269240.353	1034.126	0.63
546	3884729.815	269244.438	1033.975	0.47
547	3884732.181	269247.308	1033.245	0.9
548	3884734.897	269251.235	1033.926	0.7
549	3884737.074	269254.786	1033.915	1.21
550	3884749.485	269279.576	1033.918	0
551	3884740.86	269261.063	1033.911	1.23
552	3884737.726	269255.173	1034.009	1.17
553	3884734.942	269250.649	1034.057	1.19
554	3884732.671	269246.893	1034.134	0.96
555	3884731.22	269242.617	1033.959	0.6
556	3884729.732	269239.547	1034.083	0.77
557	3884729.125	269236.725	1033.828	0.76
558	3884727.218	269232.326	1034.077	1.45
559	3884726.543	269228.601	1034.041	1.27
560	3884727.082	269224.694	1033.975	1.15
561	3884734.179	269223.766	1033.991	1.15
562	3884734.232	269229.591	1033.783	1.37
563	3884734.866	269236.75	1033.86	1.01
564	3884736.157	269239.418	1034.014	0.92
565	3884737.256	269243.18	1033.844	0.76
566	3884740.688	269248.104	1033.791	0.79
567	3884740.826	269252.035	1033.773	0.91
568	3884742.028	269256.887	1033.892	1.14
569	3884743.286	269261.106	1033.663	0.59
572	3884749.474	269276.407	1033.906	0.58
573	3884748.869	269273.181	1033.893	1.63
574	3884749.731	269268.493	1033.954	1.4
575	3884747.88	269263.893	1033.736	1.08
576	3884749.493	269259.392	1033.81	0.63
577	3884748.559	269256.431	1033.811	0.58

578	3884746.706	269254.894	1033.614	0.67
579	3884747.321	269250.458	1033.93	0.6
580	3884748.815	269247.084	1033.687	1
581	3884746.96	269244.296	1033.675	1.06
582	3884745.733	269239.338	1033.74	0.96
583	3884745.794	269235.052	1033.734	0.95
584	3884742.904	269231.119	1033.768	1.2
585	3884739.833	269228.75	1034.109	1.5
586	3884742.57	269225.635	1034.561	0.58
587	3884743.323	269221.549	1033.642	0.9
588	3884736.39	269220.301	1033.783	0.87
589	3884737.146	269215.905	1033.847	0.58
590	3884751.248	269223.064	1033.608	1.08
591	3884750.686	269229.252	1033.473	1.19
592	3884753.209	269234.136	1033.625	0.78
593	3884753.923	269238.285	1033.619	0.5
594	3884755.901	269240.596	1033.617	0.62
595	3884757.36	269246.976	1033.531	0.73
596	3884757.902	269249.618	1033.617	0.83
597	3884757.822	269254.687	1033.667	1.23
598	3884758.205	269258.434	1033.718	0.99
599	3884757.775	269262.282	1033.657	0.8
601	3884765.346	269252.603	1033.628	0.98
602	3884768.435	269249.049	1033.511	0.8
603	3884767.85	269244.841	1033.523	0.78
604	3884770.623	269241.093	1033.625	0.75
605	3884772.282	269237.76	1033.465	0.78
606	3884773.81	269234.465	1033.384	0.6
607	3884773.907	269230.8	1033.487	0.78
608	3884774.482	269226.517	1033.436	1
609	3884775.939	269223.086	1033.448	0.95
610	3884777.698	269220.067	1033.401	0.82
611	3884771.779	269224.669	1033.315	1.1
612	3884767.638	269225.832	1033.414	0.97
613	3884763.237	269225.103	1033.49	1.09
614	3884758.748	269227.912	1033.542	1.05
615	3884759.83	269231.745	1033.445	0.78
616	3884762.333	269236.571	1033.423	0.8
617	3884730.425	269273.614	1034.181	0.6
618	3884727.331	269273.547	1034.157	0.55
619	3884723.269	269273.101	1034.306	0.63

620	3884720.498	269276.25	1034.309	1.02
621	3884716.432	269274.287	1034.322	0.8
622	3884713.211	269273.308	1034.345	0.77
623	3884709.654	269271.444	1034.385	0.75
624	3884705.401	269269.973	1034.449	0.62
625	3884701.818	269268.096	1034.407	1.11
627	3884696.841	269267.432	1034.507	0.86
628	3884692.586	269266.384	1034.493	0.83
629	3884686.824	269255.5	1034.569	0.97
630	3884684.276	269252.032	1034.484	0.92
631	3884689.943	269244.022	1034.47	0.85
632	3884694.832	269245.4	1034.395	0.81
633	3884697.466	269247.206	1034.363	0.92
634	3884699.419	269249.573	1034.449	0.98
635	3884702.113	269250.433	1034.369	1
636	3884704.257	269251.572	1034.341	1.05
637	3884706.766	269252.955	1034.299	0.58
638	3884708.756	269255.253	1034.308	1
639	3884710.914	269257.905	1034.438	1.21
640	3884715.381	269260.021	1034.279	0.84
641	3884721.293	269261.166	1034.201	1.2
642	3884754.264	269278.91	1033.765	1.02
643	3884757.773	269276.456	1033.707	1.5
644	3884761.31	269273.202	1033.738	2.05
645	3884765.754	269269.354	1033.604	1.85
646	3884770.414	269267.166	1033.532	0.76
647	3884773.381	269264.044	1033.562	1
648	3884775.411	269262.184	1033.417	0.78
649	3884777.212	269260.439	1033.502	1.19
650	3884779.528	269258.945	1033.544	1
651	3884783.762	269254.573	1033.442	0.78
652	3884786.104	269251.73	1033.316	0.57
653	3884800.442	269273.654	1033.174	0.77
654	3884800.723	269269.403	1033.15	0.4
655	3884801.971	269265.105	1033.137	0.42
656	3884802.886	269261.524	1033.052	0.2
657	3884799.843	269261.387	1033.068	0.78
658	3884800.247	269258.177	1033.175	0.78
659	3884798.804	269256.7	1033.197	0.43
660	3884796.806	269256.238	1033.189	0.58
661	3884805.23	269259.433	1032.488	0.2

662	3884805.133	269265.095	1032.585	0.1
663	3884805.995	269267.974	1032.987	0.4
664	3884806.205	269270.728	1032.846	0.8
665	3884806.92	269273.511	1033.058	0.75
666	3884806.024	269277.954	1033.137	0.74
667	3884806.164	269281.466	1033.094	1.18
668	3884805.611	269283.852	1033.127	0.43
669	3884802.417	269282.1	1033.16	1.21
670	3884799.798	269281.765	1033.174	1.21
671	3884797.809	269283.377	1033.248	0.9
672	3884794.366	269282.898	1033.287	1.3
673	3884806.249	269279.13	1033.088	1.14
674	3884808.275	269280.141	1033.123	1.17
675	3884811.017	269279.281	1033.087	1.16
676	3884814.945	269279.312	1032.941	1.2
677	3884821.385	269280.412	1032.987	1.6
678	3884824.509	269275.789	1032.819	1.3
679	3884820.778	269274.559	1032.747	0.92
680	3884817.062	269273.82	1032.776	0.65
681	3884813.331	269273.173	1032.943	0.8
682	3884808.966	269273.26	1033.026	0.75
683	3884811.879	269269.266	1032.947	1
684	3884815.804	269267.941	1032.747	0.2
685	3884819.03	269266.795	1032.69	0.9
686	3884823.126	269266.279	1032.724	0.61
687	3884825.83	269265.76	1032.57	1.1
688	3884828.139	269265.736	1032.498	1.15
689	3884830.647	269263.566	1032.645	1.17
690	3884833.318	269262.829	1032.655	0.75
691	3884831.661	269258.743	1032.602	0.6
692	3884833.656	269255.485	1032.665	0.35
693	3884830.845	269254.876	1032.631	0.92
694	3884829.235	269252.571	1032.611	1.17
695	3884830.455	269250.127	1032.649	1.02
696	3884828.452	269249.619	1032.665	1.35
697	3884827.063	269249.092	1032.65	1.05
698	3884825.515	269252.639	1032.734	0.64
699	3884823.432	269251.369	1032.725	0.8
700	3884822.044	269251.023	1032.846	0.76
701	3884821.195	269253.807	1032.745	1.04
702	3884823.11	269254.611	1032.745	1

703	3884823.092	269257.808	1032.732	0.96
704	3884819.886	269258.573	1032.7	0.83
705	3884817.007	269254.714	1032.823	1
706	3884815.696	269257.095	1032.925	1.02
707	3884816.083	269261.034	1032.874	0.5
708	3884816.625	269263.882	1032.843	0.72
709	3884810.982	269266.4	1032.94	1.07
710	3884809.336	269263.42	1032.935	0.8
711	3884809.671	269258.962	1032.997	0.8
712	3884789.866	269281.679	1033.316	0.43
713	3884787.196	269282.99	1033.454	1.5
714	3884786.499	269287.722	1033.59	0.8
715	3884789.992	269289.405	1033.549	0.8
716	3884784.083	269288.795	1033.718	0.45
717	3884781.265	269291.407	1033.754	0.4
718	3884780.316	269294.092	1033.806	0.6
719	3884777.189	269291.953	1033.862	0.8
720	3884774.992	269290.237	1033.745	0.97
721	3884771.95	269288.033	1033.714	1.22
722	3884769.827	269286.241	1033.695	1.4
723	3884766.85	269284.25	1033.679	1.6
724	3884763.607	269285.64	1033.7	1.2
725	3884765.51	269288.734	1033.923	1
726	3884767.437	269291.161	1033.965	0.6
727	3884769.398	269293.878	1033.919	0.6
728	3884771.88	269296.274	1033.992	0.77
729	3884774.541	269298.141	1034.058	0.6
730	3884776.918	269301.975	1034.034	0.76
731	3884770.235	269304.1	1034.161	0.4
732	3884767.094	269299.93	1034.216	0.4
733	3884765.468	269297.65	1034.093	0.38
734	3884763.297	269294.873	1033.966	0.85
735	3884760.777	269292.912	1033.873	0.58
736	3884758.02	269289.986	1034.139	1.54
737	3884756.47	269287.971	1033.931	0.4
738	3884754.449	269285.244	1033.912	1.06
739	3884756.629	269291.361	1034.058	1.2
740	3884758.126	269294.071	1034.06	1.18
741	3884759.349	269296.087	1034.036	1
742	3884761.127	269299.11	1034.146	0.6
743	3884763.141	269301.773	1034.181	0.6

744	3884765.421	269304.683	1034.228	0.8
745	3884761.587	269306.061	1034.321	0.2
746	3884758.017	269301.423	1034.284	0.2
747	3884754.571	269298.516	1034.272	0.4
748	3884754.098	269295.124	1034.104	1.05
749	3884752.793	269292.778	1034.113	1
750	3884752.175	269289.862	1034.092	1.3
751	3884752.056	269286.438	1033.929	1.2
752	3884593.684	269271.914	1036.133	1.8
753	3884598.125	269272.093	1035.974	1
754	3884602.447	269271.941	1035.985	1.8
755	3884605.801	269272.928	1036.071	1.42
756	3884608.512	269272.748	1035.809	1.6
757	3884611.656	269273.774	1035.873	1.36
758	3884613.724	269274.584	1035.835	0.82
759	3884616.549	269271.377	1035.593	1.3
760	3884620.22	269271.472	1035.659	0.62
761	3884620.291	269266.393	1035.623	1.6
762	3884622.689	269266.387	1035.785	1.8
763	3884626.263	269266.137	1035.431	1.6
764	3884629.532	269265.79	1035.417	2
765	3884629.644	269267.072	1035.395	2.03
766	3884629.685	269268.2	1035.437	1.17
767	3884635.751	269263.767	1035.335	1.8
768	3884638.557	269263.189	1035.175	1.42
769	3884641.984	269262.532	1035.196	2.05
770	3884644.338	269263.416	1035.254	1.35
771	3884647.273	269263.62	1035.132	1.85
772	3884650.317	269263.562	1035.099	1.8
773	3884652.879	269262.931	1035.011	1.95
774	3884655.189	269262.978	1034.952	1.25
775	3884660.153	269262.883	1034.856	1.24
776	3884666.564	269258.782	1034.812	1.17
777	3884666.385	269256.188	1034.791	0.14
778	3884664.091	269254.088	1034.755	0.88
779	3884661.147	269254.316	1034.834	1
780	3884658.615	269254.092	1034.873	0.94
781	3884656.489	269253.545	1034.896	1.12
782	3884654.874	269252.323	1034.893	1
783	3884651.069	269251.013	1034.938	1.3
784	3884652.146	269245.481	1034.759	0.83

785	3884645.56	269251.001	1034.989	1.1
786	3884638.081	269254.398	1035.001	0.87
787	3884634.826	269254.799	1035.285	1.38
788	3884631.067	269254.712	1035.289	1.4
789	3884626.586	269253.298	1035.335	1.8
790	3884624.524	269253.85	1035.464	2.05
791	3884622.447	269255.745	1035.3	1.8
792	3884619.425	269257.906	1035.402	1.63
793	3884617.67	269258.735	1035.456	2.05
794	3884615.936	269260.533	1035.645	1.2
795	3884614.225	269261.624	1035.833	1.25
796	3884611.446	269261.862	1035.711	1.17
802	3884750.347	269285.348	1033.916	1.53
803	3884748.533	269288.932	1034.062	1.38
804	3884747.825	269294.353	1034.151	1.1
805	3884746.827	269298.296	1034.309	1.15
806	3884746.364	269301.146	1034.474	0
807	3884726.266	269305.106	1034.668	1.85
808	3884730.211	269302.577	1034.611	1.85
809	3884733.57	269299.251	1034.472	1.85
810	3884737.08	269297.169	1034.41	1.45
811	3884739.205	269295.422	1034.349	1.37
812	3884741.171	269293.457	1034.321	1.37
813	3884742.43	269291.499	1034.102	1.08
814	3884744.663	269289.366	1034.153	1.37
815	3884746.346	269286.713	1034.069	1.7
816	3884747.202	269284.869	1034.012	1.6
817	3884747.633	269287.75	1034.154	1.47
818	3884745.968	269290.401	1034.16	1.38
819	3884743.848	269293.186	1034.265	1.18
820	3884740.178	269295.837	1034.385	1.37
821	3884737.181	269298.441	1034.429	1.37
822	3884733.575	269299.616	1034.489	1.85
823	3884730.864	269301.123	1034.574	1.85
824	3884726.201	269302.901	1034.648	1.85
825	3884722.889	269304.967	1034.636	1.85
826	3884725.541	269311.801	1034.813	1.85
827	3884730.16	269311.802	1034.802	1.37
828	3884732.873	269309.794	1034.572	1.37
829	3884736.336	269309.973	1034.54	1.85
830	3884738.657	269312.566	1035.005	1.2

831	3884740.671	269312.408	1035.162	1.85
832	3884739.327	269306.113	1034.807	1.85
833	3884745.08	269280.925	1034.057	0.97
834	3884740.916	269280.905	1034.086	0.83
835	3884736.739	269281.245	1034.201	1.05
836	3884733.135	269281.637	1034.218	1.05
837	3884725.986	269282.072	1034.325	1
838	3884722.107	269283.063	1034.317	1.17
839	3884717.656	269283.607	1034.219	1.35
840	3884714.506	269283.992	1034.485	1.37
841	3884710.418	269285.152	1034.553	1.73
842	3884707.327	269286.833	1034.563	1.2
843	3884703.448	269286.241	1034.593	1.67
844	3884700.289	269286.418	1034.766	1.76
845	3884704.285	269288.207	1034.595	1.06
846	3884704.736	269292.848	1034.663	1.35
847	3884701.51	269293.59	1034.683	1.85
848	3884708.941	269296.627	1034.635	1.4
849	3884709.735	269300.826	1034.674	1.61
850	3884707.097	269302.451	1034.784	1.43
851	3884704.908	269304.502	1034.793	1.54
852	3884714.502	269299.962	1034.664	1.85
853	3884716.462	269299.742	1034.685	1.67
854	3884723.343	269299.057	1034.579	1.37
859	3884716.714	269319.504	1035.292	2.14
860	3884717.108	269318.428	1035.302	2.73
861	3884717.281	269317.57	1035.183	2.33
862	3884717.64	269316.961	1034.95	2.33
863	3884717.862	269315.872	1034.92	2.46
864	3884718.279	269314.786	1035.051	2.58
865	3884718.275	269313.724	1034.864	2.58
866	3884718.556	269312.708	1034.896	2.51
867	3884718.61	269311.712	1034.849	2.65
868	3884718.813	269310.83	1034.882	2.6
869	3884718.895	269309.608	1034.783	2.61
870	3884719.099	269308.9	1034.724	2.61
871	3884719.237	269307.873	1034.774	2.05
872	3884719.488	269306.789	1034.766	1.85
873	3884719.469	269305.874	1034.643	1.9
874	3884719.749	269304.957	1034.639	1.6
875	3884720.096	269304.059	1034.667	1.57

876	3884720.295	269303.13	1034.595	1.7
877	3884720.579	269302.085	1034.6	1.7
878	3884720.94	269301.244	1034.654	1.67
879	3884721.11	269300.181	1034.523	1.55
880	3884721.38	269299.318	1034.486	1.6
881	3884721.954	269298.318	1034.514	1.6
882	3884722.178	269297.534	1034.395	1.59
883	3884722.808	269296.552	1034.462	1.8
884	3884722.937	269295.615	1034.559	1.97
885	3884723.219	269294.575	1034.448	1.9
886	3884723.177	269293.524	1034.497	1.6
887	3884723.854	269292.643	1034.378	1.59
888	3884724.186	269291.911	1034.222	1.58
889	3884724.941	269291.055	1034.305	1.7
890	3884725.45	269290.157	1034.339	1.97
891	3884725.88	269289.384	1034.339	1.97
892	3884726.4	269288.482	1034.363	1.8
893	3884726.823	269287.52	1034.32	1.79
894	3884727.111	269286.661	1034.227	1.79
895	3884727.509	269285.825	1034.25	1.6
896	3884727.976	269284.468	1034.203	1.6
897	3884728.322	269283.825	1034.137	1.55
898	3884728.814	269282.915	1034.215	1.18
899	3884729.09	269282.042	1033.934	1.38
900	3884729.494	269281.183	1034.283	1.38
901	3884729.862	269280.112	1034.145	1.39
902	3884730.377	269279.386	1034.147	1.22
903	3884730.626	269278.315	1034.062	1.3
904	3884730.926	269277.468	1033.997	1
905	3884731.284	269276.346	1034.148	1.38
906	3884731.44	269275.554	1034.069	0.7
907	3884731.758	269274.398	1034.094	0.6
908	3884732.027	269273.53	1034.029	0.8
909	3884732.137	269272.486	1034.015	0.7
910	3884732.345	269271.55	1033.962	0.7
911	3884732.465	269270.517	1034.024	0.62
912	3884732.671	269269.543	1033.964	1.02
913	3884732.94	269268.617	1033.93	1.02
914	3884732.947	269267.577	1033.958	1.18
915	3884733.21	269266.566	1033.917	1.5
916	3884733.461	269265.611	1033.945	1.5

917	3884733.546	269264.685	1033.949	1.59
918	3884733.584	269263.595	1033.946	1.6
919	3884733.766	269262.699	1033.982	1.8
920	3884734.092	269261.731	1033.938	1.6
921	3884734.247	269260.627	1033.806	1.6
922	3884734.434	269259.743	1033.899	1.5
923	3884734.547	269258.753	1033.844	1.6
924	3884734.6	269257.651	1033.971	1.4
925	3884734.659	269256.686	1033.901	1.4
926	3884734.489	269255.824	1033.89	1.4
927	3884734.61	269254.784	1033.895	1.4
928	3884734.837	269253.923	1033.943	1.4
929	3884734.803	269252.795	1033.92	1.4
930	3884734.993	269251.64	1033.738	1.2
931	3884735.104	269250.892	1033.965	1.23
932	3884735.122	269249.704	1033.908	1.38
933	3884735.322	269248.851	1033.947	1.4
934	3884735.543	269247.768	1033.826	1.34
935	3884735.536	269246.893	1033.812	0.9
936	3884735.924	269245.868	1033.907	0.8
937	3884736.242	269245.042	1033.816	0.8
938	3884736.909	269243.975	1033.859	0.79
939	3884737.016	269243	1033.83	0.79
940	3884736.981	269242.129	1033.8	0.7
941	3884737.245	269241.014	1033.771	0.81
942	3884737.395	269240.149	1033.77	1.3
943	3884737.438	269239.166	1033.526	1.02
944	3884737.07	269237.968	1033.748	0.99
945	3884737.327	269237.182	1033.656	1.59
946	3884737.446	269235.964	1033.54	1.5
947	3884737.556	269235.151	1033.718	1.6
948	3884737.66	269234.037	1033.416	1.6
949	3884737.688	269233.107	1033.547	1.6
950	3884737.702	269232.082	1033.643	1.63
951	3884649.319	269233.378	1035.034	1.1
952	3884652.413	269234.404	1035.022	1.4
953	3884655.604	269235.909	1034.887	1.15
954	3884658.633	269236.959	1034.839	1
955	3884661.999	269239.126	1034.793	1
956	3884666.352	269240.174	1034.729	0.74
957	3884670.057	269241.715	1034.735	0.8

958	3884675.383	269243.699	1034.536	0.87
959	3884677.291	269246.53	1034.668	1.14
960	3884679.012	269248.151	1034.638	1.07
961	3884681.453	269250.33	1034.69	1.03
962	3884680.647	269253.785	1034.607	1.24
963	3884676.052	269251.714	1034.642	1.23
964	3884672.117	269248.064	1034.768	0.8
965	3884669.877	269245.713	1034.709	0.77
966	3884666.713	269246.27	1034.814	0.93
967	3884663.763	269243.974	1034.859	1.23
968	3884662.555	269241.414	1034.944	1.18
969	3884656.804	269239.736	1034.889	0.8
970	3884654.033	269237.694	1034.883	1.14
971	3884651.361	269237.15	1034.951	1.17
972	3884649.476	269235.067	1035.071	1.2
973	3884654.315	269239.179	1035.045	1.15
974	3884657.663	269241.287	1034.889	0.98
975	3884660.355	269242.527	1034.934	1.17
976	3884663.79	269244.336	1034.844	1.21
977	3884668.392	269248.849	1034.771	1.02
978	3884671.15	269252.746	1034.742	0.82
979	3884674.929	269254.256	1034.66	0.94
980	3884677.801	269257.348	1034.672	1.01
981	3884681.031	269260.086	1034.602	1.4
982	3884682.651	269261.679	1034.603	1.5
983	3884675.855	269261.08	1034.688	1.05
984	3884673.983	269263.584	1034.737	1.37
985	3884676.742	269266.162	1034.864	1.64
986	3884678.918	269268.226	1034.7	1.32
987	3884681.099	269270.588	1034.664	1.6
988	3884670.774	269255.817	1034.758	1
989	3884666.663	269253.713	1034.777	1.3
990	3884664.673	269250.707	1034.842	1.2
991	3884662.014	269247.805	1034.824	1
992	3884659.247	269246.018	1034.88	0.97
993	3884654.691	269244.075	1034.956	1.01
994	3884656.438	269247.049	1034.917	1.03
995	3884656.387	269251.764	1034.919	1.4
996	3884658.758	269253.477	1034.878	1
997	3884658.949	269255.844	1034.902	1.4
998	3884657.76	269258.827	1034.927	1.6

999	3884658.534	269264.281	1034.934	1.75
1000	3884657.584	269268.668	1035.011	2.05
1001	3884657.15	269270.12	1035.08	2.05
1002	3884653.543	269266.914	1035.076	1.92
1003	3884651.717	269262.321	1035.065	1.93
1004	3884651.205	269260.017	1035.013	1.98
1005	3884651.265	269256.843	1035.009	1.8
1006	3884649.263	269253.733	1035.092	1.9
1007	3884647.03	269252.982	1034.963	2.05
1008	3884647.439	269256.268	1035.11	1.5
1009	3884649.277	269260.112	1035.08	2.05
1010	3884649.311	269261.897	1035.098	2
1011	3884649.283	269264.203	1035.17	1.58
1012	3884649.775	269266.764	1035.136	1.48
1013	3884649.556	269271.258	1035.429	0
1014	3884644.315	269266.17	1035.283	1.38
1015	3884644.61	269263.063	1035.208	1.7
1016	3884643.563	269259.304	1035.114	2.05
1017	3884643.68	269255.717	1035.032	1.55
1018	3884642.983	269251.832	1035.095	1.7
1019	3884642.912	269248.677	1035.009	1.7
1020	3884643.313	269244.702	1034.968	1.18
1021	3884643.216	269242.037	1034.981	0.83
1022	3884642.059	269239.073	1034.999	1
1023	3884642.133	269237.016	1034.869	0.77
1024	3884641.749	269234.862	1034.945	1.45
1025	3884642.076	269232.233	1035.053	1.4
1026	3884641.734	269229.244	1034.894	1.3
1027	3884641.217	269226.549	1035.258	1.4
1028	3884641.102	269222.406	1035.017	1.76
1029	3884639.569	269219.726	1034.973	1.7
1030	3884637.528	269208.838	1034.889	1.67
1031	3884636.38	269204.009	1034.861	1.6
1032	3884633.756	269200.704	1034.881	1.42
1033	3884632.341	269197.884	1034.988	1.8
1034	3884618.074	269211.262	1035.017	1.3
1035	3884622.263	269212.666	1035.045	1
1036	3884625.048	269216.005	1035.017	1.2
1037	3884630.049	269221.551	1034.907	1.2
1038	3884632.461	269226.372	1034.968	1
1039	3884635.367	269222.635	1034.962	1.36

1040	3884633.759	269229.165	1035.121	1.3
1041	3884633.276	269231.826	1035.033	1.58
1042	3884633.391	269233.89	1034.996	1.4
1043	3884633.345	269236.714	1034.872	1.82
1044	3884634.532	269242.405	1035.14	1.4
1045	3884638.279	269241.606	1034.974	1.16
1046	3884637.538	269246.143	1035.091	1.5
1047	3884636.662	269248.904	1035.136	0.78
1048	3884641.815	269247.738	1034.922	1.5
1049	3884646.617	269242.485	1034.989	1.1
1050	3884648.42	269239.987	1034.906	1.02
1051	3884646.82	269237.759	1034.901	1.02
1053	3884772.03	269219.859	1033.5	1
1054	3884771.873	269220.724	1033.503	1
1055	3884771.723	269221.694	1033.516	1.15
1056	3884771.138	269222.658	1033.538	1.18
1057	3884771.071	269223.671	1033.538	1.17
1058	3884771.064	269224.599	1033.51	1.1
1059	3884771.1	269225.62	1033.494	1.2
1060	3884771.185	269226.673	1033.495	1.1
1061	3884771.457	269227.689	1033.534	1.05
1062	3884771.739	269228.525	1033.475	1.05
1063	3884771.617	269229.594	1033.533	0.8
1064	3884771.098	269230.47	1033.488	0.4
1065	3884771.052	269231.563	1033.489	0.9
1066	3884770.831	269232.421	1033.52	0.5
1067	3884770.873	269233.458	1033.066	0.4
1068	3884770.658	269234.479	1033.468	0.62
1069	3884770.01	269235.2	1033.494	0.84
1070	3884769.432	269235.954	1033.415	0.6
1071	3884769.113	269236.889	1033.487	0.8
1072	3884768.508	269237.728	1033.362	0.8
1073	3884767.912	269238.482	1033.529	0.95
1074	3884767.33	269239.339	1033.574	1
1075	3884767.061	269240.228	1033.526	1
1076	3884767.112	269241.265	1033.708	0.97
1077	3884766.684	269242.087	1033.327	0.97
1078	3884766.884	269243.192	1033.459	1
1079	3884766.767	269244.14	1033.454	1.03
1080	3884766.573	269245.139	1033.48	1
1081	3884766.305	269246.21	1033.481	1

1082	3884765.948	269247.191	1033.506	1.1
1083	3884766.274	269248.114	1033.443	1
1084	3884766.169	269249.216	1033.464	1.17
1085	3884766.158	269250.288	1033.217	1
1086	3884766.371	269251.177	1033.615	1.4
1087	3884766.107	269252.087	1033.66	1.42
1088	3884765.893	269253.056	1033.588	1.4
1089	3884765.549	269254.074	1033.564	1.44
1090	3884765.371	269255.045	1033.555	1.4
1091	3884765.313	269256.113	1033.64	1.37
1092	3884765.114	269257.019	1033.668	1.38
1093	3884764.811	269258.011	1033.689	1.43
1094	3884764.802	269259.073	1033.625	1.47
1095	3884764.691	269260.079	1033.646	1.5
1096	3884764.6	269260.938	1033.642	1.5
1097	3884764.538	269261.976	1033.702	1.6
1098	3884764.525	269263.41	1033.564	1.6
1099	3884764.39	269264.058	1033.639	1.65
1100	3884764.294	269265.291	1033.602	1.65
1101	3884764.131	269266.012	1033.555	1.65
1102	3884764.092	269267.009	1033.766	1.9
1103	3884764.049	269267.962	1033.761	1.9
1104	3884763.93	269268.934	1033.661	1.88
1105	3884763.637	269270.49	1033.091	1.3
1106	3884763.368	269271.32	1033.66	1.83
1107	3884763.219	269272.068	1033.66	1.78
1108	3884762.921	269272.92	1033.723	2.73
1109	3884762.721	269273.918	1033.739	2.17
1110	3884762.54	269274.829	1033.709	2.32
1111	3884762.495	269275.911	1033.677	2.42
1112	3884762.242	269276.863	1033.726	2.3
1113	3884762.135	269277.891	1033.7	2.09
1114	3884762.124	269278.778	1033.685	2.1
1115	3884762.002	269279.837	1033.73	2
1116	3884761.753	269281.099	1033.596	1.7
1117	3884761.552	269282.169	1033.605	1.7
1118	3884761.173	269282.823	1033.312	1.6
1119	3884760.959	269283.569	1033.368	1.6
1120	3884760.715	269284.898	1033.653	1.6
1121	3884760.446	269285.632	1033.723	1.17
1122	3884760.411	269286.621	1033.85	1.07

1123	3884760.309	269287.57	1033.971	1.3
1124	3884760.562	269288.355	1033.86	1.21
1125	3884760.582	269289.285	1033.849	1.2
1126	3884760.552	269290.416	1033.982	1.4
1127	3884760.524	269291.364	1033.959	1.4
1128	3884760.406	269292.463	1034.009	1.22
1129	3884760.569	269293.378	1033.938	1
1130	3884760.459	269294.39	1034.019	1.2
1131	3884760.743	269295.518	1034.022	1.1
1132	3884760.794	269296.423	1034.073	1.17
1133	3884760.803	269297.365	1034.09	1.4
1134	3884761.056	269298.37	1034.073	0.76
1135	3884761.172	269299.335	1034.125	0.3
1136	3884761.576	269300.344	1034.238	1.6
1137	3884761.782	269301.213	1034.225	1.6
1138	3884762.041	269302.195	1034.277	0.8
1139	3884762.227	269303.129	1034.155	1.8
1140	3884762.433	269304.107	1034.5	0.8
1141	3884762.662	269305.249	1034.351	1.7
1142	3884762.758	269306.153	1034.33	1.7
1143	3884762.684	269307.183	1034.346	0.6
1144	3884762.867	269308.184	1034.408	0.6
1145	3884762.955	269309.105	1034.427	0.4
1146	3884763.132	269310.161	1034.387	0.54
1147	3884763.149	269311.153	1034.439	0.6
1148	3884763.363	269312.138	1034.472	1.4
1149	3884763.281	269313.132	1034.576	1.9
1150	3884763.258	269314.078	1034.521	1.6
1151	3884763.115	269315.076	1034.638	1.9
1152	3884763.366	269316.071	1034.667	2.2
1153	3884763.36	269317.584	1034.683	1.2
1154	3884763.385	269318.439	1034.742	1.15
1155	3884764.013	269320.2	1034.896	1.5
1156	3884763.539	269321.919	1034.904	1.2
1157	3884764.117	269322.651	1034.951	1
1160	3884593.194	269225.881	1035.258	1.35
1161	3884592.693	269224.874	1035.528	0
1162	3884593.402	269226.946	1035.311	1.15
1163	3884593.352	269228.045	1035.158	1.4
1164	3884593.806	269229.043	1035.236	1.64
1165	3884593.919	269229.873	1035.214	1.45

1166	3884594.006	269230.946	1035.22	1.4
1167	3884594.193	269231.842	1035.23	1.4
1168	3884594.217	269232.886	1035.253	1.5
1169	3884594.305	269233.923	1035.304	1.44
1170	3884594.459	269234.827	1035.318	1.62
1171	3884594.516	269235.897	1035.384	1.77
1172	3884594.631	269236.844	1035.338	1.64
1173	3884594.834	269237.819	1035.306	1.62
1174	3884594.975	269238.854	1035.321	1.75
1175	3884595.114	269239.843	1035.319	1.65
1176	3884595.322	269240.801	1035.357	1.84
1177	3884595.577	269241.717	1035.164	2.05
1178	3884595.56	269242.833	1035.424	2.05
1179	3884595.607	269243.844	1035.257	2.05
1180	3884595.694	269244.883	1035.359	2.05
1181	3884595.855	269245.78	1035.325	2.05
1182	3884596.029	269246.783	1035.264	1.77
1183	3884596.358	269247.723	1035.502	1.22
1184	3884596.639	269248.625	1035.483	1.22
1185	3884596.895	269249.578	1035.429	1.23
1186	3884597.128	269250.518	1035.705	1.75
1187	3884597.362	269251.559	1035.487	1.45
1188	3884597.606	269252.535	1035.499	1.64
1189	3884597.734	269253.501	1035.634	1.59
1190	3884597.802	269254.523	1035.616	1.17
1191	3884597.889	269255.518	1035.594	1.12
1192	3884598.049	269256.59	1035.6	1.05
1193	3884597.978	269257.517	1035.679	1.05
1194	3884598.237	269258.447	1035.702	1.22
1195	3884598.317	269259.395	1035.707	1.29
1196	3884598.437	269260.589	1035.732	1.18
1197	3884598.321	269261.516	1035.817	1.31
1198	3884598.559	269262.49	1035.811	1.25
1199	3884598.648	269263.533	1035.774	1.57
1200	3884598.847	269264.495	1035.737	1
1201	3884598.944	269265.472	1035.784	1.32
1202	3884599.02	269266.556	1035.76	1.35
1203	3884599.473	269267.417	1035.884	1.5
1204	3884599.771	269268.349	1035.971	1.65
1205	3884599.907	269269.449	1035.94	1.75
1206	3884600.027	269270.418	1036.072	1.8

1207	3884600.122	269271.346	1035.933	1.75
1208	3884600.325	269272.379	1036.01	2
1209	3884600.41	269273.321	1036.024	2.05
1210	3884600.639	269274.404	1035.99	2.05
1211	3884600.781	269275.426	1036.035	2.05
1212	3884600.962	269276.327	1036.012	2.05
1214	3884601.073	269277.331	1036.129	2.05
1215	3884601.416	269278.233	1036.119	2.05
1216	3884601.495	269279.183	1036.116	1.95
1217	3884601.737	269280.217	1036.109	1.98
1218	3884602.2	269281.774	1036.168	1.22
1219	3884602.427	269282.981	1036.169	1.05
1220	3884602.133	269284.274	1036.232	0.56
1221	3884602.89	269285.2	1036.392	0.3
1222	3884603.688	269286.147	1036.813	0.3
1224	3884669.001	269272.755	1035.151	2.05
1225	3884668.942	269274.378	1035.163	2
1226	3884668.387	269275.968	1035.053	2.05
1227	3884668.12	269277.361	1035.247	2
1228	3884671.146	269271.866	1035.217	2
1229	3884670.874	269271.288	1035.023	1.78
1230	3884670.261	269270.372	1034.96	1.8
1231	3884670.687	269269.196	1034.908	1.6
1232	3884670.801	269268.438	1034.906	1.7
1233	3884670.682	269267.4	1034.765	1.4
1234	3884670.624	269266.288	1034.91	1.4
1235	3884670.708	269265.277	1034.842	1.4
1236	3884670.849	269264.332	1034.741	1.2
1237	3884670.946	269263.468	1034.759	1.18
1238	3884671.039	269262.45	1034.805	1.15
1239	3884671.129	269261.363	1034.787	1.16
1240	3884671.14	269260.388	1034.734	1.18
1241	3884671.171	269259.526	1034.778	1.2
1242	3884671.101	269258.386	1034.776	1.27
1243	3884671.217	269257.435	1034.835	1
1244	3884671.443	269256.523	1034.793	1.1
1245	3884671.354	269255.402	1034.738	0.83
1246	3884671.442	269254.433	1034.952	1
1247	3884671.616	269253.486	1034.737	0.82
1248	3884671.774	269252.47	1034.962	0.82
1249	3884671.964	269251.524	1034.738	0.8

1250	3884672.224	269250.546	1034.767	0.82
1251	3884672.4	269249.483	1034.7	0.82
1252	3884672.43	269248.627	1034.732	0.85
1253	3884672.5	269247.536	1034.743	0.9
1254	3884672.414	269246.538	1034.746	0.83
1255	3884672.524	269245.584	1034.739	0.8
1256	3884672.456	269244.502	1034.745	0.82
1257	3884672.37	269243.502	1034.705	0.9
1258	3884672.497	269242.613	1034.744	0.9
1259	3884672.68	269241.644	1034.775	0.86
1260	3884672.793	269240.57	1034.796	1
1261	3884672.517	269239.48	1034.721	0.85
1262	3884672.342	269238.531	1034.742	0.97
1263	3884672.147	269237.577	1034.716	0.8
1264	3884672.031	269236.464	1034.691	1
1265	3884672.145	269235.494	1034.723	1.25
1266	3884672.129	269234.533	1034.726	1.4
1267	3884672.027	269233.497	1034.695	1.4
1268	3884672.487	269232.527	1034.722	1.4
1269	3884672.661	269231.487	1034.714	1.57
1270	3884672.786	269230.378	1034.69	1.57
1271	3884672.847	269229.583	1034.75	1.55
1272	3884672.847	269228.505	1034.756	1.7
1273	3884672.81	269227.59	1034.72	1.7
1274	3884672.767	269226.452	1034.558	1.78
1275	3884672.893	269225.292	1034.125	1.28
1276	3884672.739	269224.577	1034.648	1.78
1277	3884672.621	269223.468	1034.655	1.7
1278	3884672.704	269222.616	1034.692	2.05
1279	3884672.631	269221.429	1034.643	2.03
1280	3884672.542	269220.643	1034.624	2.05

Appendix C

Laboratory Results

Table C1. Shape analysis of the Hillslope North gravels sized 4 to 6 mm (percent of n).

Site: Hillslope North			Size: 4 to 6 mm			n = 87
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	20.7	20.7	2.3	0	0	0
Low Sphericity	12.6	34.5	9.2	0	0	0

Table C2. Shape analysis of the Hillslope North gravels sized 6 to 8 mm (percent of n).

Site: Hillslope North			Size: 6 to 8 mm			n = 71
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	8.5	12.7	7.0	0	0	0
Low Sphericity	12.7	42.3	15.5	1.4	0	0

Table C3. Shape analysis of the Hillslope North gravels sized 8 to 16 mm (percent of n).

Site: Hillslope North			Size: 8 to 16 mm			n = 38
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	2.6	13.2	0	0	0	0
Low Sphericity	18.4	60.5	5.3	0	0	0

Table C4. Shape analysis of the Hillslope North gravels sized 4 to 6 mm (percent of n).

Site: Hillslope South			Size: 4 to 6 mm			n = 100
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	14.0	20.0	7.0	3.0	0	0
Low Sphericity	30.0	19.0	4.0	3.0	0	0

Table C5. Shape analysis of the Hillslope North gravels sized 6 to 8 mm (percent of n).

Site: Hillslope South			Size: 6 to 8 mm			n = 104
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	9.6	11.5	2.9	0	0	0
Low Sphericity	24.0	24.0	22.1	5.8	0	0

Table C6. Shape analysis of the Hillslope North gravels sized 8 to 16 mm (percent of n).

Site: Hillslope South			Size: 8 to 16 mm			n = 40
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	17.5	12.5	0	2.5	0	0
Low Sphericity	10.0	52.5	5.0	0	0	0

Table C7. Shape analysis of the Hillslope North gravels sized 4 to 6 mm (percent of n).

Site: North Core 41 to 60 cm			Size: 4 to 6 mm			n = 101
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	17.8	24.8	9.9	1.0	0	0
Low Sphericity	9.9	20.8	9.9	5.0	1.0	0

Table C8. Shape analysis of the Hillslope North gravels sized 6 to 8 mm (percent of n).

Site: North Core 41 to 60 cm			Size: 6 to 8 mm			n = 65
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	26.2	10.8	1.5	0	0	0
Low Sphericity	30.8	26.2	4.6	0	0	0

Table C9. Shape analysis of the Hillslope North gravels sized 8 to 16 mm (percent of n).

Site: North Core 41 to 60 cm			Size: 8 to 16t mm			n = 28
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	3.6	17.9	0	0	0	0
Low Sphericity	14.3	46.4	17.9	0	0	0

Table C10. Shape analysis of the Hillslope North gravels sized 4 to 6 mm (percent of n).

Site: North Core 155 to 180 cm			Size 4 to 6 mm			n = 51
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	3.9	17.6	23.5	9.8	0	0
Low Sphericity	2.0	19.6	15.7	5.9	2.0	0

Table C11. Shape analysis of the Hillslope North gravels sized 6 to 8 mm (percent of n).

Site: North Core 155 to 180 cm			Size: 6 to 8 mm			n = 24
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	4.2	12.5	20.8	8.3	0	0
Low Sphericity	0	4.2	25.0	12.5	12.5	0

Table C12. Shape analysis of the Hillslope North gravels sized 8 to 16 mm (percent of n).

Site: North Core 155 to 180 cm			Size: 8 to 16 mm			n = 20
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	0	20.0	25.0	5.0	0	0
Low Sphericity	0	20.0	15.0	10.0	5.0	0

Table C13. Shape analysis of the Hillslope North gravels sized 4 to 6 mm (percent of n).

Site: River South			Size 4 to 6 mm			n = 98
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	5.1	28.6	14.3	8.2	0	0
Low Sphericity	0	11.2	21.4	8.2	2.0	1.0

Table C14. Shape analysis of the Hillslope North gravels sized 6 to 8 mm (percent of n).

Site: River South			Size: 6 to 8 mm			n = 86
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	5.8	19.8	14.0	8.1	4.7	1.2
Low Sphericity	0	3.5	26.7	10.5	3.5	2.3

Table C15. Shape analysis of the Hillslope North gravels sized 8 to 16 mm (percent of n).

Site: River South			Size: 8 to 16 mm			n = 88
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	0	9.1	13.6	8.0	1.1	0
Low Sphericity	1.1	15.9	19.3	20.5	11.4	0

Table C16. Shape analysis of the Hillslope North gravels sized 4 to 6 mm (percent of n).

Site: River Midtran			Size 4 to 6 mm			n= 131
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	2.3	17.6	15.3	5.3	1.5	0
Low Sphericity	1.5	18.3	19.8	13.7	4.6	0

Table C17. Shape analysis of the Hillslope North gravels sized 6 to 8 mm (percent of n).

Site: River Midtran			Size: 6 to 8 mm			n = 120
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	0	9.2	10.0	7.5	2.5	0.8
Low Sphericity	0	12.5	19.2	20.8	15.0	2.5

Table C18. Shape analysis of the Hillslope North gravels sized 8 to 16 mm (percent of n).

Site: River Midtran			Size: 8 to 16 mm			n = 69
	Very Angular	Angular	Sub-Angular	Sub-Rounded	Rounded	Well-Rounded
High Sphericity	0	2.9	17.4	10.1	1.4	0
Low Sphericity	0	5.8	21.7	26.1	14.5	0

Table C17. Particle size and loss on ignition analyses of the Northern core.

Sample	%Sand	%Silt	%Clay	%LOI	>2mm
0-5	41.01	44.37	14.62	36.03	0.00
5-10	47.72	38.93	13.35	28.69	0.00
10-15	56.37	35.08	8.55	28.55	0.00
15-19	68.80	22.60	8.60	15.82	2.53
19-22	70.30	22.27	7.43	13.58	2.09
22-25	67.38	23.78	8.85	25.45	0.70
25-30	66.33	24.30	9.38	16.93	4.05
30-33	68.15	21.88	9.97	11.01	17.89
33-37	50.31	36.11	13.58	8.73	13.56
37-41	60.96	27.50	11.54	7.70	16.92
41-45	74.09	18.63	7.28	4.34	33.24
45-50	86.35	10.05	3.60	2.37	40.19
50-55	87.25	9.35	3.40	2.15	40.04
55-60	83.40	11.27	5.33	4.57	19.39
60-65	36.37	52.02	11.61	27.17	12.28
65-70	16.23	72.53	11.25	42.28	0.00
70-75	13.56	74.83	11.62	43.47	0.00
75-80	20.67	66.11	13.23	54.37	0.00
80-85	15.47	70.90	13.63	60.72	0.00
85-90	16.16	69.39	14.45	55.55	0.00
90-95	12.77	75.61	11.63	55.61	0.00
95-100	41.77	51.36	6.87	32.65	0.00
100-105	20.88	63.80	15.32	44.58	0.00
105-110	29.48	60.98	9.54	32.28	0.00
110-115	48.10	47.15	4.74	23.18	0.00
115-120	53.90	42.16	3.94	19.68	1.65
120-125	71.65	25.05	3.30	14.68	2.32
125-130	65.83	29.75	4.42	14.83	0.42
130-135	73.03	23.35	3.62	13.48	0.93
135-140	76.47	20.09	3.44	10.57	9.31
140-145	71.97	24.50	3.54	12.55	3.54
145-150	70.52	25.78	3.70	11.33	12.70
150-155	70.91	25.01	4.08	12.48	6.12
155-160	72.98	23.54	3.47	11.30	8.33
160-165	69.98	26.09	3.92	11.86	4.12
165-170	77.12	19.52	3.36	7.92	26.39
170-175	74.89	21.53	3.59	10.50	8.83
175-180	72.53	23.32	4.15	11.42	4.86
180-182	63.97	27.65	8.38	11.87	6.73
182-186	73.76	21.72	4.52	10.63	17.63

Table C18. Particle size and loss on ignition analyses of the Southern core.

Sample	%Sand	%Silt	%Clay	%LOI	>2mm
0-5	27.57	55.69	16.73	26.40	0.00
5-7	23.55	63.30	13.15	26.49	0.00
7-10	26.15	61.48	12.38	26.12	0.00
10-15	27.96	61.16	10.87	25.10	0.00
15-18	30.81	60.67	8.51	22.23	0.00
18-23	27.54	62.22	10.24	18.35	0.00
23-27	29.32	60.57	10.11	18.26	0.00
27-32	30.66	55.56	13.79	11.56	0.00
32-35	35.61	50.74	13.65	9.55	0.00
35-40	34.78	48.73	16.49	11.89	0.00
40-45	28.14	49.81	22.06	13.41	0.00
45-50	31.35	49.92	18.72	11.96	0.00
50-55	38.57	45.72	15.71	9.92	0.00
55-60	35.09	49.88	15.03	9.56	0.00
60-64	28.01	54.82	17.17	12.51	0.00
64-68	30.01	53.73	16.26	16.03	0.00
68-72	26.03	62.41	11.56	33.92	0.00
72-77	27.39	59.20	13.41	17.73	0.00
77-81	22.61	63.79	13.60	45.96	0.00
81-86	28.68	60.18	11.14	17.22	0.00
86-89	16.25	71.29	12.46	57.54	0.00
89-92	11.49	79.48	9.03	59.94	0.00
92-94	20.14	71.84	8.02	26.52	0.00
94-99	7.98	79.16	12.86	58.71	0.00
99-103	10.15	78.47	11.38	49.30	0.00
103-108	12.75	72.78	14.46	61.47	0.00
108-113	24.91	51.73	23.36	77.94	0.00
113-117	19.65	60.84	19.51	63.32	0.00
117-121	23.33	50.00	26.67	61.91	0.00
121-125	3.34	85.43	11.24	44.78	0.00
125-130	3.37	86.69	9.94	32.37	0.00
130-135	16.40	73.18	10.43	28.18	0.00
135-140	17.03	73.46	9.51	27.31	0.00
140-145	19.17	72.56	8.27	37.34	0.00
145-150	20.07	70.44	9.49	29.29	0.00
150-155	18.62	72.82	8.56	25.81	0.00
155-160	36.32	54.99	8.68	17.99	0.00
160-164	78.73	16.40	4.86	4.94	1.68
164-169	92.48	5.81	1.72	1.57	4.59
169-174	93.92	4.67	1.42	1.41	0.75
174-178	91.28	6.45	2.26	2.10	0.00