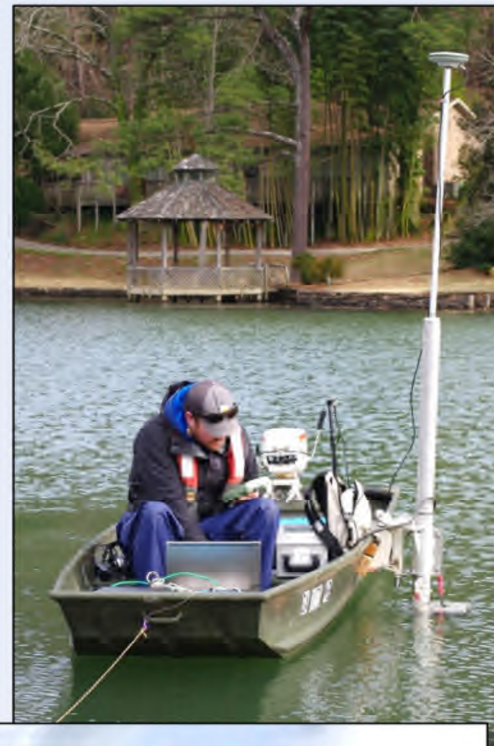
Highland Lake Bathymetric Survey

Final Report, May 2014



Prepared For:
The Town of Highland Lake
612 Lakeshore Drive
Oneonta, AL 35121

THE TOWN OF Highland Lake

Prepared By:
Tetra Tech
2110 Powers Ferry Road SE
Suite 202
Atlanta, GA 30339

TETRA TECH

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Executive Summary

Highland Lake, in Blount County, Alabama, was constructed in 1954 by impounding the Blackburn Fork of the Little Warrior River behind an 80 foot high earthen, stone, and concrete dam and is presently managed by the town of Highland Lake. The lake has continuously been undergoing sedimentation. In 2000, bathymetric surveys of Brasher Creek Bay and Sand Creek Bay were conducted to help plan the subsequent dredging. Dredging took place in or about 2000 with dredged materials being placed on town property adjacent to the two bays.

In March 2014 Tetra Tech collected bathymetry data and sediment thicknesses in the Brasher Creek and Sand Creek Bays. The 2000 and 2014 bathymetry data were compared to determine how sedimentation has occurred over the 14 years since the last dredging. Sediment thickness measurements indicate the total amount of sedimentation that has occurred over the life of the lake.

Both Brasher Creek and Sand Creek Bays have large areas along the shorelines that are one to four feet deeper than in the 2000 survey. These areas are assumed to have been dredged in 2000 and presently appear to have undergone little sedimentation. Both Brasher Creek and Sand Creek Bays have central areas that show 1 to 2 feet of sedimentation since 2000. The net sedimentation for Brasher Creek Bay is negative 8500 cubic yards and for Sand Creek Bay is negative 8300 cubic yards. This difference between the 2000 survey and 2014 surveys indicates that the amount of material dredged in 2000 is significantly greater than the amount of sedimentation that has taken place since. From the 2014 survey, dredgable sediment volumes were calculated in one foot depth increments for both Brasher and Sand Creek Bays.

A bathymetric survey of the entire lake was also conducted in 2014, during the same field effort as the survey of the bays. The resulting bathymetry from this survey can serve as a baseline for the state of the lake in 2014 from which future surveys can be compared to assess sedimentation issues, and also be used for other lake management needs.

1 Introduction

Highland Lake, managed by the town of Highland Lake, Alabama, has been undergoing sedimentation in several locations throughout the lake. This sedimentation has impacted recreation by limiting access to shallow areas, in particular near the marina at Brasher Creek Bay and in Sand Creek Bay. These two areas were previously surveyed and dredged in or about 2000. In 2014, Tetra Tech was contracted to conduct two tasks; first, to conduct a new hydrographic survey of the two bays and to evaluate the sediment impacts, and second, to conduct a lake-wide hydrographic survey to create a baseline bathymetry and to locate other areas potentially impacted by sedimentation.

2 Bathymetric Survey

2.1 2000 Survey

The pre-dredging bathymetric maps from 2000 (Appendix C) were brought into GIS (Geographic Information Systems) and aligned with the 2014 data using aerial photos for guidance. Digital Terrain Models (DTMs) representing the 2000 bathymetry of Brasher Creek Bay and Sand Creek Bay were then created. The DTMs were then used to generate depth contour maps representing the state of the bays before dredging in 2000 (Figures 1 and 3).

2.2 2014 Survey

The bathymetric survey was conducted from March 17-19, 2014 using a single-beam sonar. Approximately 180,000 depth soundings were collected throughout the lake with the two bays of Brasher and Sand Creeks surveyed at a higher density than the main lake body. The location of each sounding was recorded using RTK GPS which is accurate to within several inches horizontally and vertically. The accuracy of the depth soundings varies depending on the firmness of the lake bed and on boat motion due to the roughness of the water surface, but is expected to be accurate within several inches. Calm water was experienced on all three survey days. The depth soundings were then processed into a DTM of the lake bed. The DTM was then used to generate a depth contour map of each bay and of the entire lake (Figures 2, 4, and 5). A technical memorandum providing a complete explanation of the bathymetric survey methods and data processing is included as Appendix A.

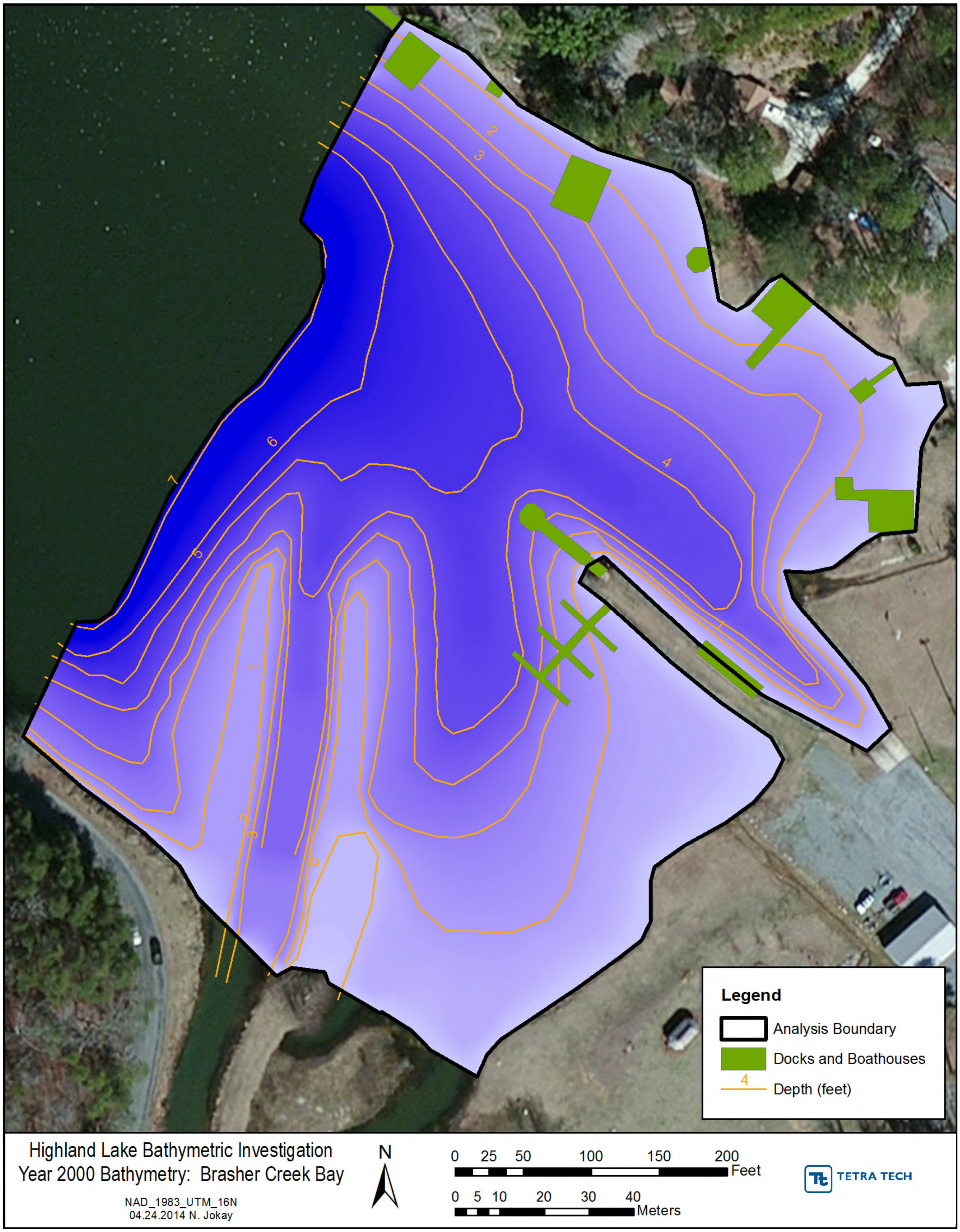

Figure 1. Brasher Creek Bay bathymetry surveyed in 2000 before dredging.

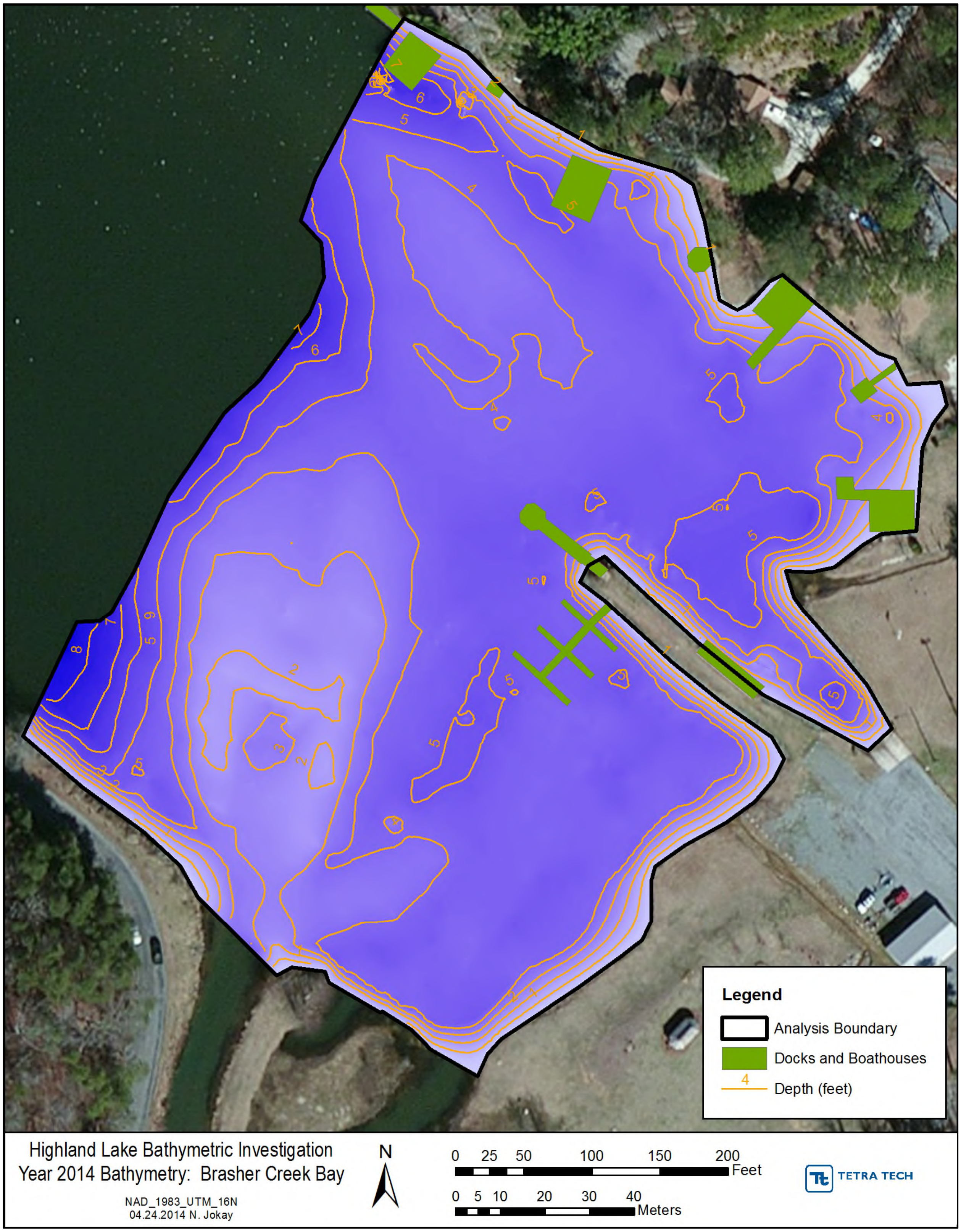

Figure 2. Brasher Creek Bay bathymetry surveyed in March 2014.

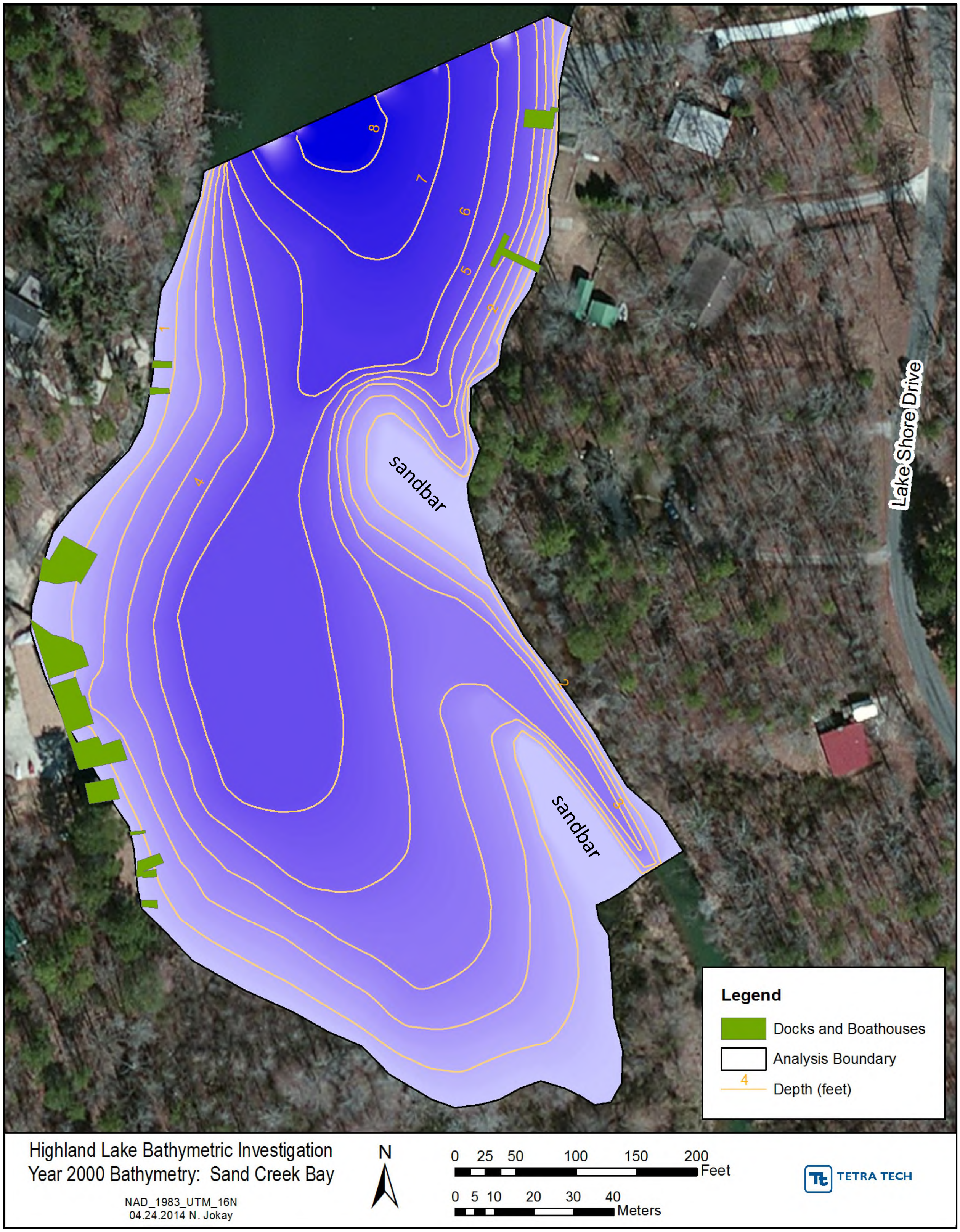

Figure 3. Sand Creek Bay bathymetry surveyed in 2000 before dredging.

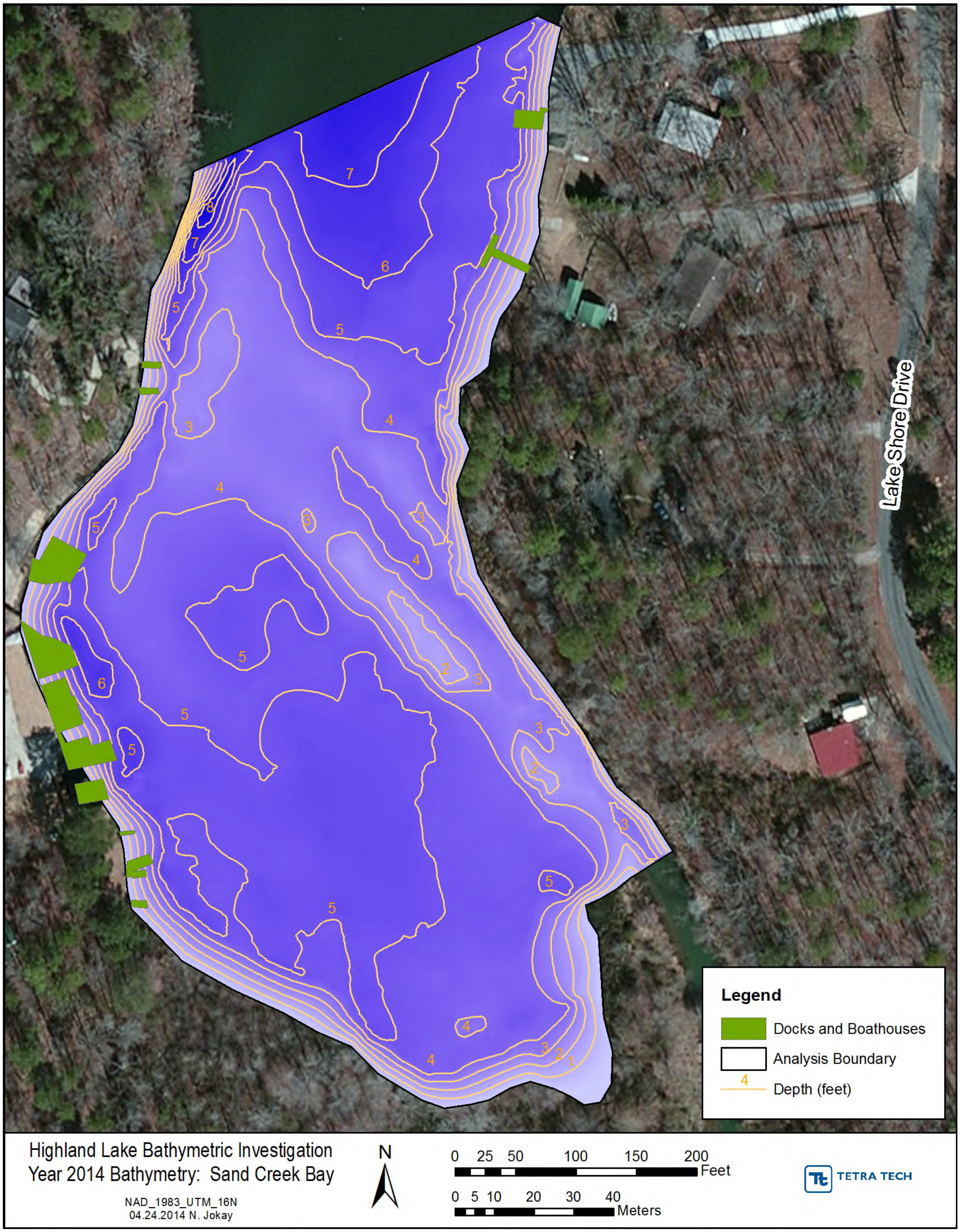

Figure 4. Sand Creek Bay bathymetry surveyed in March 2014.

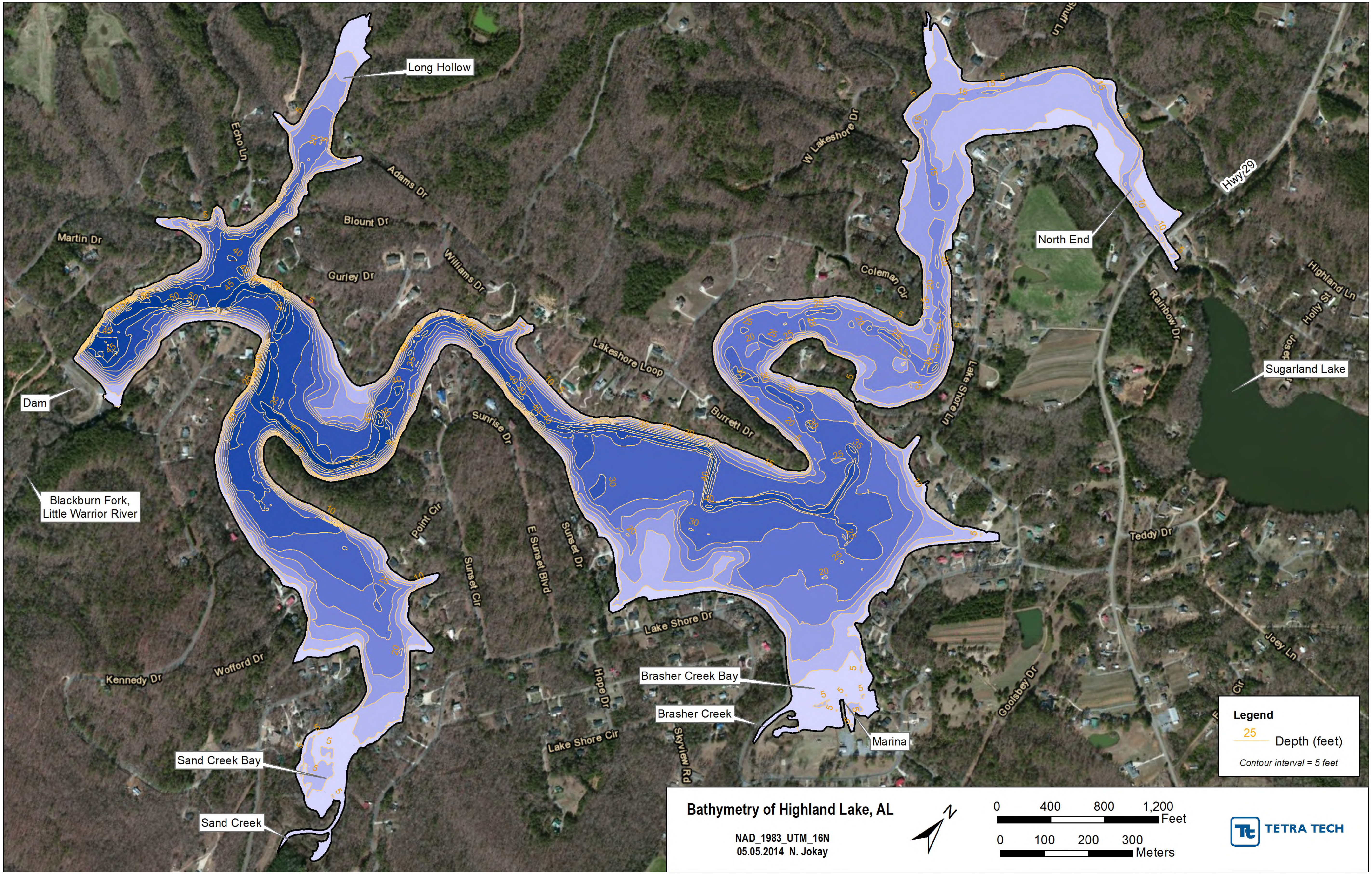

Figure 5. Highland Lake bathymetry, 2014.

3 Bathymetric Analysis

The DTMs from 2000 and 2014 were compared to help understand changes due to sedimentation over the 14 years between surveys. The lake-wide bathymetry was reviewed for areas of interest, especially in other major tributary bays.

3.1 Brasher Creek Bay

The 2000 and 2014 DTMs were compared for changes in depth and volume. The 2014 DTM was subtracted from the 2000 DTM to create a "depth change since 2000" map (Figure 6). This comparison shows that the central part of the bay has undergone about 1 to 3 foot increase in bed elevation (sedimentation) since 2000, whereas the near shore areas have undergone a 1 to 3 foot reduction in bed elevation.

The areas with the greatest increase in bed elevation (orange in Figure 6) have either undergone the highest sedimentation rates since the 2000 dredging, or these areas were never dredged and simply have had ongoing sedimentation above the 2000 bed elevation.

The reduced areas (green in Figure 6) are assumed to have been dredged in 2000 and have not since been strongly impacted by sedimentation.

Because the total volume of sediment dredged in 2000 is not known, it is not possible to accurately estimate how much sedimentation has taken place between 2000 and 2014. However, a cut/fill analysis indicates there is presently 8500 cubic yards less sediment in the bay than in 2000. So it is assumed that this 8500 cubic yards represents the dredged material minus any sedimentation since 2000.

3.2 Sand Creek Bay

The 2000 and 2014 DTMs were compared for changes in depth and volume. The 2014 DTM was subtracted from the 2000 DTM to create a "depth change since 2000" map (Figure 7). This comparison shows that the central part of the bay has undergone about 0 to 1 foot increase in bed elevation (sedimentation), and the north central area has undergone 1 to 3 foot increase in bed elevation (sedimentation) since 2000. The nearshore areas, especially the western and southern shorelines, have undergone a 1 to 4 foot reduction in bed elevation.

The areas with the greatest increase in bed elevation (orange in Figure 7) have either undergone the highest sedimentation rates since the 2000 dredging, or these areas were never dredged and simply have had ongoing sedimentation above the 2000 bed elevation.

The reduced areas (green in Figure 7) are assumed to have been dredged in 2000 and have not since been strongly impacted by sedimentation. It is noteworthy that the two sand bars in Figure 3, one to the immediate left of the mouth of Sand Creek, and the other at the apex of the bend in the eastern shoreline, appear in Figure 7 as 3 to 4 foot deep pools 14 years after the dredging. This indicates that either the pools were dredged much deeper, or little sedimentation has occurred I the pools.

Because the total volume of sediment dredged in 2000 is not known, it is not possible to accurately estimate how much sedimentation has taken place between 2000 and 2014. However, a cut/fill analysis indicates there is presently 8300 cubic yards less sediment in the bay than in 2000. So it is assumed that this 8300 cubic yards represents the dredged material minus any sedimentation since 2000.

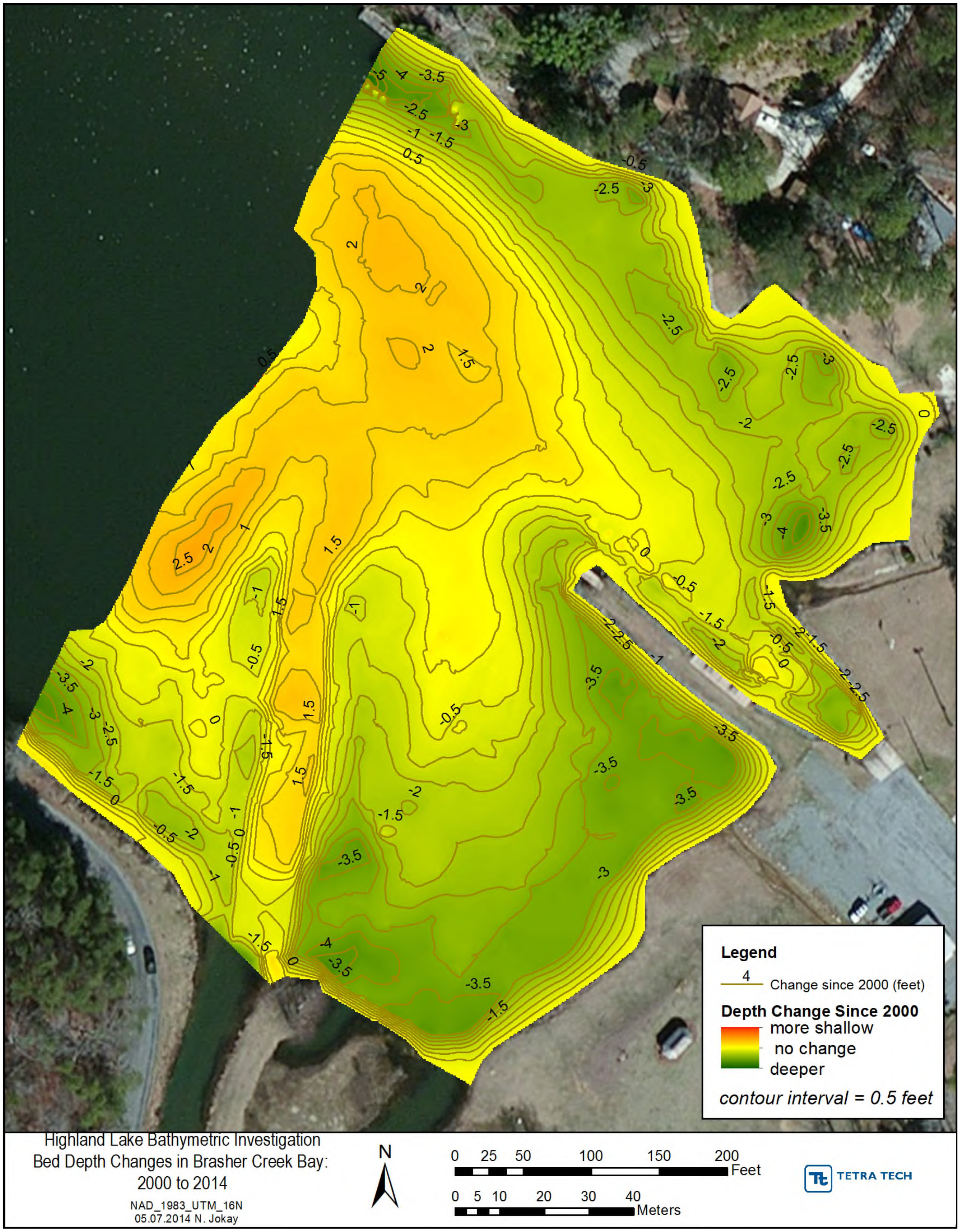

Figure 6. Changes in depth between 2000 and 2014, Brasher Creek Bay.

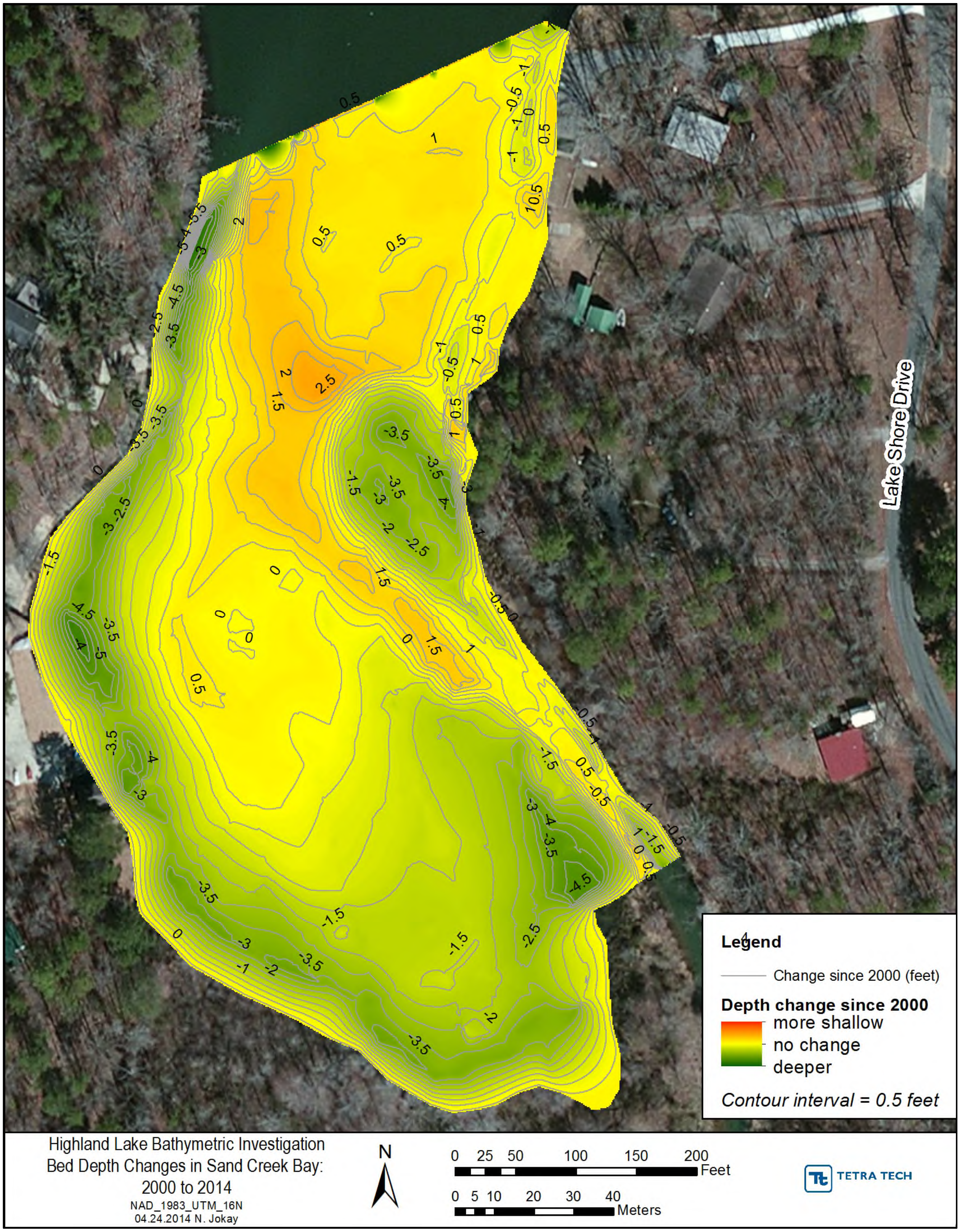

Figure 7. Changes in depth between 2000 and 2014, Sand Creek Bay.

4 Sediment Volume

4.1 Poling Study

Sediment thicknesses were measured using a sediment spud (steel rod with grooves ground into it) into the lake bed at 14 locations in Brasher Creek Bay, and 10 locations in Sand Creek Bay. Locations were selected as a uniform grid in the portion of the bays with less than 10 feet of water depth. Water depths at each location were first measured, then the spud was pushed into the lake bed as far as it could be driven by hand. It was assumed that this depth was the boundary between the sediment and the underlying 1954 pre-lake land surface. The measurement locations and thickness data were then mapped in GIS (Figures 8 and 9).

4.2 Brasher Creek Bay Sediment Volume

The 2014 DTM was used to calculate the volume of sediment above a given depth surface across the bay. This calculation was made in 1 foot depth increments from 2 to 6 feet. The difference between the 2014 DTM and the DTM defined by the poling survey is considered the volume for the entire analysis area down to the 1954 lake bed (Table 1). The spatial distributions of these sediments are shown in Appendix B, Figures B-1 through B-5.

Table 1. Sediment deposit volumes in Brasher Creek Bay.

Depth Surface (ft)	Area (acres)	Sediment Volume Above Depth Surface (cu-yd)
2	0.1	20
3	0.6	530
4	1.4	2,000
5	4.0	6,400
6	4.5	13,000
1954 Lake Bed	6.6	47,000

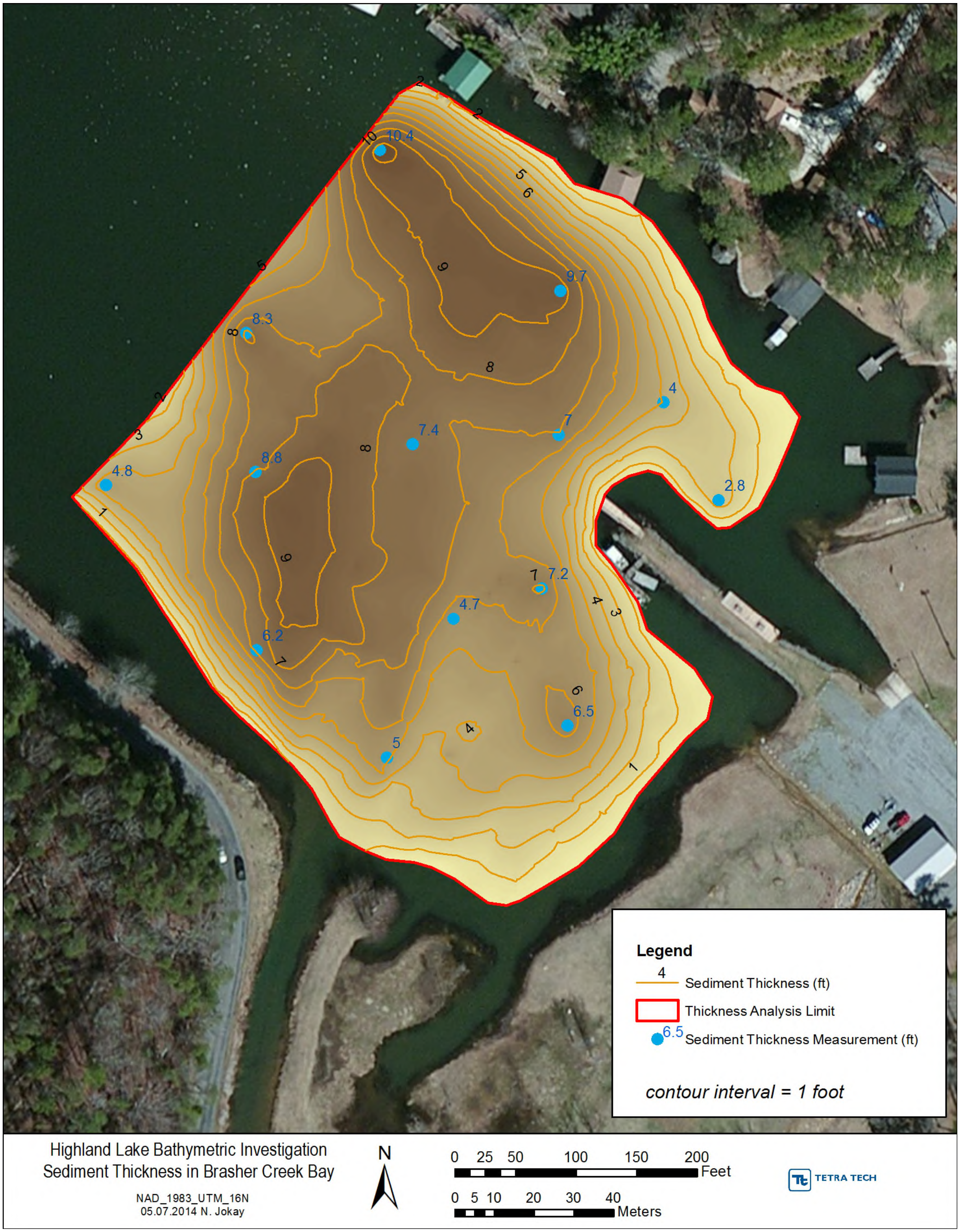

Figure 8. Sediment thickness in Brasher Creek Bay.

4.3 Sand Creek Bay Sediment Volume

The 2014 DTM was used to calculate the volume of sediment above a given depth surface across the bay. This calculation was made in 1 foot depth increments from 2 to 6 feet. The difference between the 2014 DTM and the DTM defined by the poling survey is considered the volume for the entire analysis area down to the 1954 lake bed (Table 2). The spatial distributions of these sediments are shown in Appendix B, Figures B-5 through B10.

Table 2. Sediment deposit volumes in Sand Creek Bay.

Depth Surface	Area (acres)	Sediment Volume Above Depth Surface (cu-yd)
2 feet	0.05	20
3 feet	0.3	230
4 feet	1.2	1,400
5 feet	2.8	4,400
6 feet	4.4	11,000
1954 Lake bed	4.8	36,000

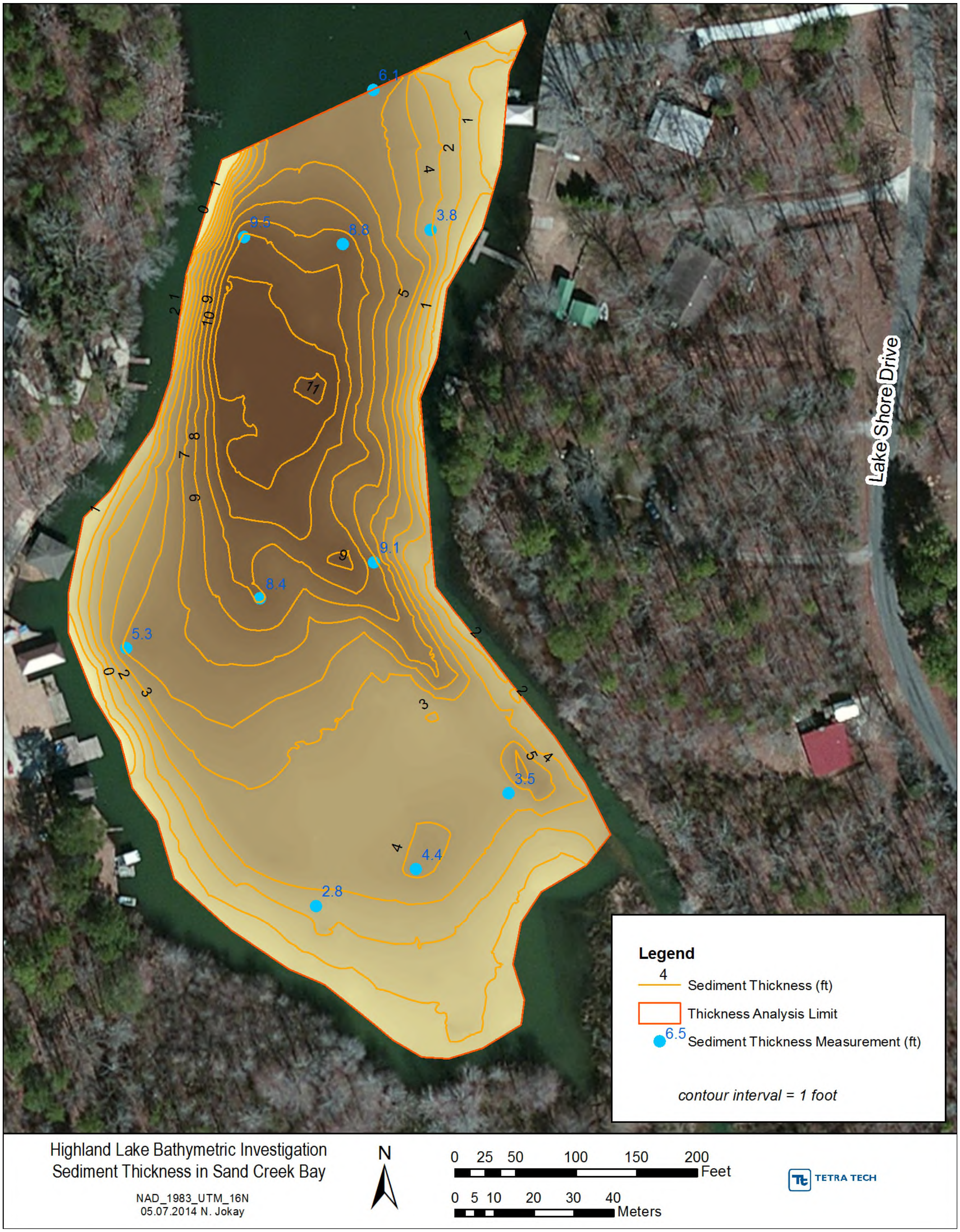

Figure 9. Sediment thickness in Sand Creek Bay.

4.4 Highland Lake

The Long Hollow and North End of the Highland Lake bathymetry were reviewed for indicators of sedimentation impacts. The lack of the historical submerged stream channel in the Long Hollow bathymetry indicates that it has been buried by sediment (Figure 5). Long Hollow is sufficiently deep so that impacts to navigation and recreation appear limited to the northernmost part of the hollow.

At the North End of the lake, immediately below Highway 29, the main body of the lake does not appear to be heavily impacted by sediment. The historic stream channel is clearly discernible in the bathymetry, thus it is assumed that the sedimentation impacts are minimal. However, the north shore of the lake immediately below Highway 29 is heavily silted in. The source may be from runoff along the Highway 29 ditch draining to the lake at that location (Figure5). The upstream presence of Sugarland, McKay, and Will Engle Lakes likely serve as sediment traps which catch the majority of all sediment sand sized and greater, and a substantial percentage of silt sized particles which enter these lakes. By trapping sediment, these three lakes prevent sedimentation in the North End of Highland Lake from occurring to the degree of that found in Brasher Creek and Sand Creek Bays.

5 Results

5.1 Brasher Creek Bay

Based on the difference between the 2000 and 2014 surveys, the net change in the sediment volume of the bay is approximately negative 8500 cubic-yards (a decrease in sediment volume of 8500 cubic-yards). This decrease is attributed to the amount of material dredged in 2000 being significantly greater than the amount of sediment delivered by Brasher Creek between 2000 and 2014. The short-term sediment loading rate cannot be determined without information on the specific areas dredged and the amount of material removed. A long-term rate can be estimated by dividing the total volume of sediment in the bay, about 47,000 cubic-yards, by the age of the lake, 60 years, which equates to about 800 cubic-yards per year.

Sediment thicknesses in Brasher Creek Bay ranged from 2.8 to 10 feet with an average of 6.6 feet. Thicknesses varied throughout the bay with the thinnest measurements occurring near the shoreline and the thickest measurements occurring near the middle of the bay. These thinly sedimented near-shore areas appear to be the long-term result of the 2000 dredging. It is common for recent sedimentation rates to be much lower than historical rates. Over time, improvements to farming and construction erosion control practices help to reduce soil erosion, which, in turn, reduces the sediment loading to streams and rivers. Thus, it’s possible that most of the 47,000 cubic-yards was delivered to the lake early in its history, and the present rate is lower than the long-term average of 800 cubic-yards per year.

5.2 Sand Creek Bay

Based on the difference between the 2000 and 2014 surveys, the net change in the volume of the bay is approximately negative 8300 cubic-yards (a decrease in volume of 8300 cubic-yards). This decrease is attributed to the amount of material dredged in 2000 being significantly greater than the amount of sediment delivered by Sand Creek between 2000 and 2014. The short-term sediment loading rate cannot be determined without information on the specific areas dredged and the amount of material removed. A long-term rate can be estimated by dividing the total volume of sediment in the bay, about 36,000 cubic-yards, by the age of the lake, 60 years, which equates to about 600 cubic-yards per year.

Sediment thicknesses in Sand Creek Bay ranged from 2.8 to 9.5 feet with an average of 6.2 feet. Thicknesses varied throughout the bay with the thinnest measurements occurring near the shoreline and the thickest measurements occurring near the middle of the bay. These thinly sedimented near-shore areas appear to be the long-term result of the 2000 dredging. Using similar logic as with Brasher Creek Bay, the long-term sediment delivery rate was likely higher in the past and has since dropped below the long-term average. Thus, it’s possible that most of the 36,000 cubic-yards was delivered to the lake early in its history, and the present rate is lower than the long-term average of 600 cubic-yards per year.

5.3 Highland Lake

The lake-wide bathymetry shows that Highland Lake is just over 50 feet deep in the bay near the dam with a maximum measured depth of 53.9 feet. The average depth of the lake is 19.1 feet and the surface area, per the shoreline shown in Figure 5, is 251 acres.

6 Dredging and Sediment Disposal

The town of Highland Lake wishes to maintain boating access in the bays and to all boat docks on the lake, and should consider dredging efforts that will provide a water depth to accommodate this access. The primary focal areas for dredging efforts should be on Brasher Creek and Sand Creek Bays where sediment has continued to accumulate since the previous dredging effort, creating areas that make boat access difficult.

Two primary disposal options include utilizing the previous disposal areas from 2000 or open water disposal with both options having various pros and cons. Secondary options include disposing of the sediment on private land adjacent to the lake, or hauling the sediment to a remote location.

Open water disposal, the pumping of dredged material to deep water areas, is typically used in the Great Lakes and in ocean environments and not commonly used for inland lakes. Thus, a more thorough investigation into the permits and regulations would be needed to determine if open water disposal is viable for Highland Lake.

The viability, costs, and permitting requirements of any of these options would be compiled in a complete dredging feasibility study.

6.1 Brasher Creek Bay

Pat Bellew Park has the advantage of being city property, being close to the dredge area, and having been previously used for dredged material storage. However, it is limited by space. Using a 0.8 acre footprint, the area outlined in Figure 10 can hold about 1300 cubic-yards of dredged material for each foot of depth.

Open water disposal for Brasher Creek Bay would require sediment to be pumped about 1000 feet to a mid-lake area greater than 20 feet deep. Space is essentially not limited. Using a 5 acre footprint, the area outlined in Figure 10 can hold about 8000 cubic-yards of dredged material for each foot of depth.

6.2 Sand Creek Bay

The previous disposal area has the advantage of being city property, being close to the dredge area, and having been previously used for dredged material storage. However, it is limited by space. Using a 0.9 acre footprint, the area outlined in Figure 11 can hold about 1400 cubic-yards of dredged material for each foot of depth.

Open water disposal for Sand Creek Bay would require sediment to be pumped about 1500 feet to a mid-lake area greater than 20 feet deep. Space is essentially not limited. Using a 4.4 acre footprint, the area outlined in Figure 11 can hold about 7000 cubic-yards of dredged material for each foot of depth.

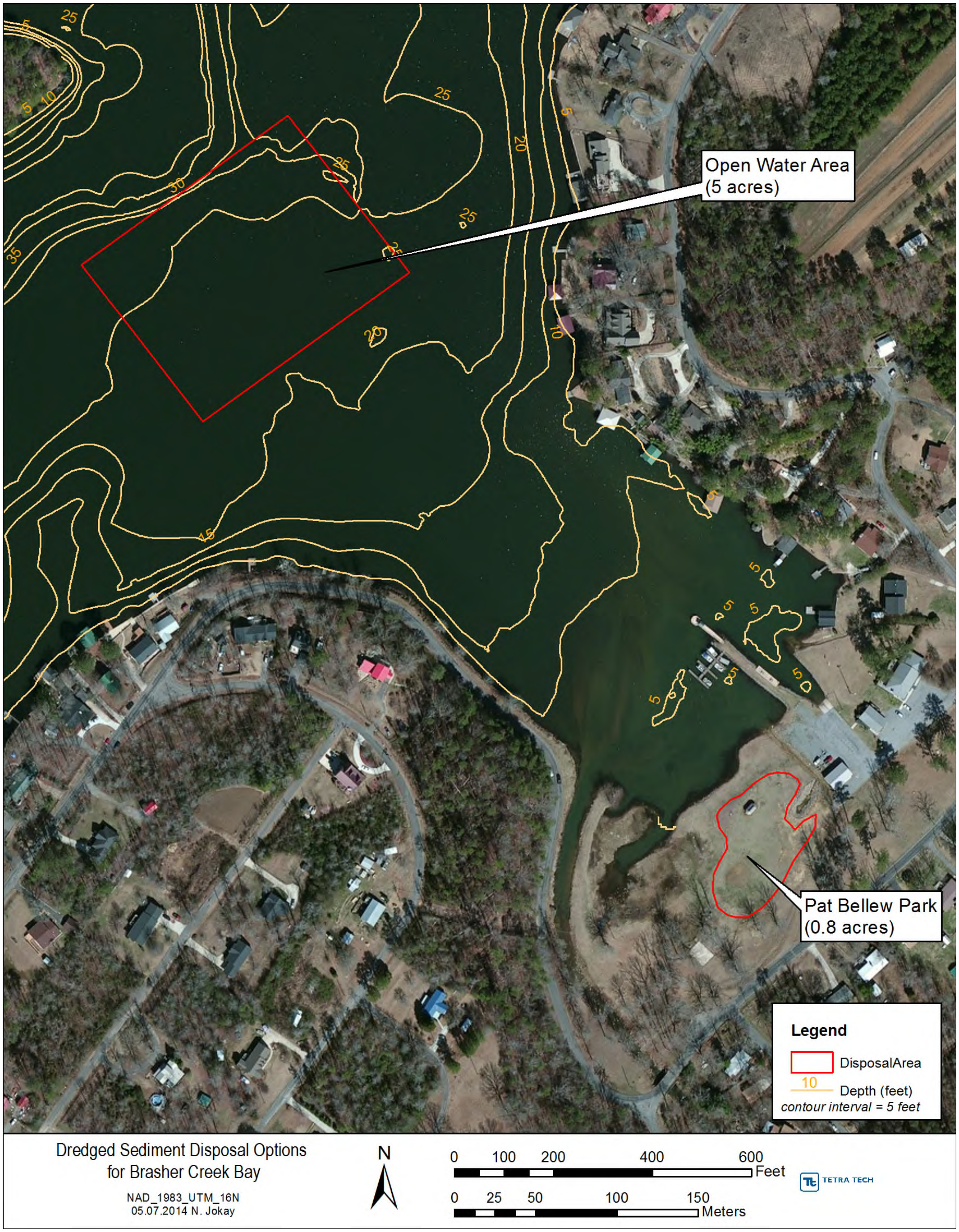

Figure 10. Dredged sediment disposal options for Brasher Creek Bay.

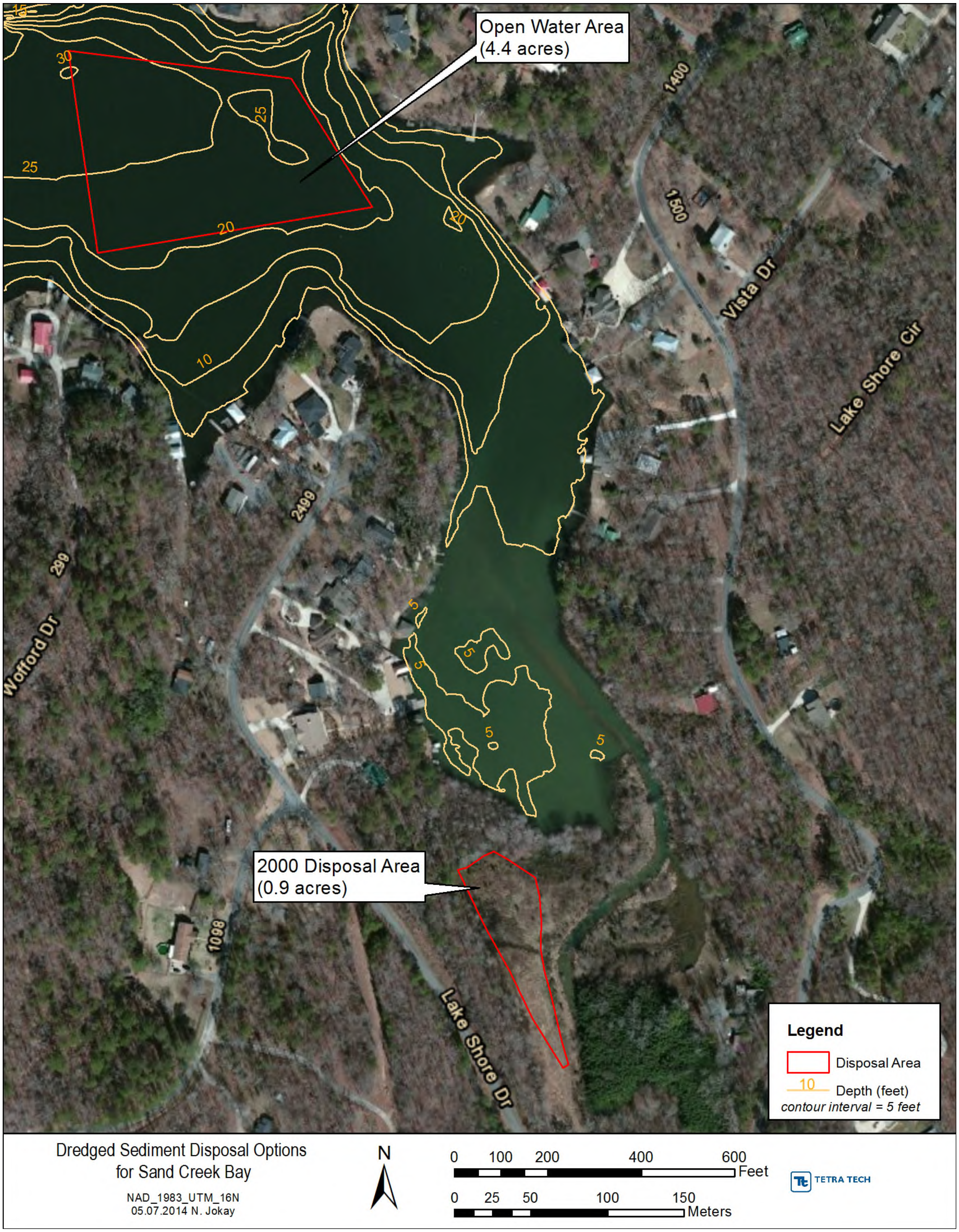

Figure 11. Dredged sediment disposal options for Sand Creek Bay.