Assessment of Lake Forest Lake Sediment Trapping Efficiency and Capacity

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Impacts of the Lake at Lake Forest on the connectivity of the D'Olive Creek watershed with D'Olive Bay and Mobile Bay have led to concerns about the viability of proposed restoration and remediation projects upstream from the lake. These concerns are based on a lack of quantitative sediment transport and other water-quality data and poor understanding of the function of the lake as a sediment retention structure. The Geological Survey of Alabama Groundwater Assessment Program (GSA GAP) has been involved in assessing water quality and sediment transport processes in the D'Olive Creek watershed since 2005. Therefore, the GSA GAP has taken on the task of assessing the efficiency of the lake in trapping sediment, estimation of sediment being passed through the lake to D'Olive Bay and estimation of the volumetric and temporal capacity of the lake to serve as a sediment retention structure.

The efficiency of impoundments to trap sediment was investigated by Brune (1953). Brune developed a sediment trapping efficiency regression based on field evaluations of 44 reservoirs throughout the United States. Maidment (1993) reported that the Brune regression continues to be a commonly used relation for determining sediment trapping efficiency. The Brune regression relates watershed area, impoundment sediment storage capacity, and impoundment water inflow with the percentage of suspended sediment trapped.

Sediment transport to the lake occurs in six streams, which include D'Olive Creek, Tiawasee Creek, and four unnamed streams (GSA GAP monitoring sites 1, 2, 3, 4, 5, and 7) (fig. 1). Sediment is also transported by Joes Branch, which flows into D'Olive Creek downstream from the Lake Forest Lake, which was monitored at GSA GAP site 10 (fig. 1). Discharge was measured and bed and suspended sediment loads were estimated by the GSA GAP in two previous investigations. Sediment transport, discharge, and watershed geographic data collected by the GSA GAP from 2005 through 2008 in the D'Olive Creek watershed were used with the Brune regression to determine the quantity

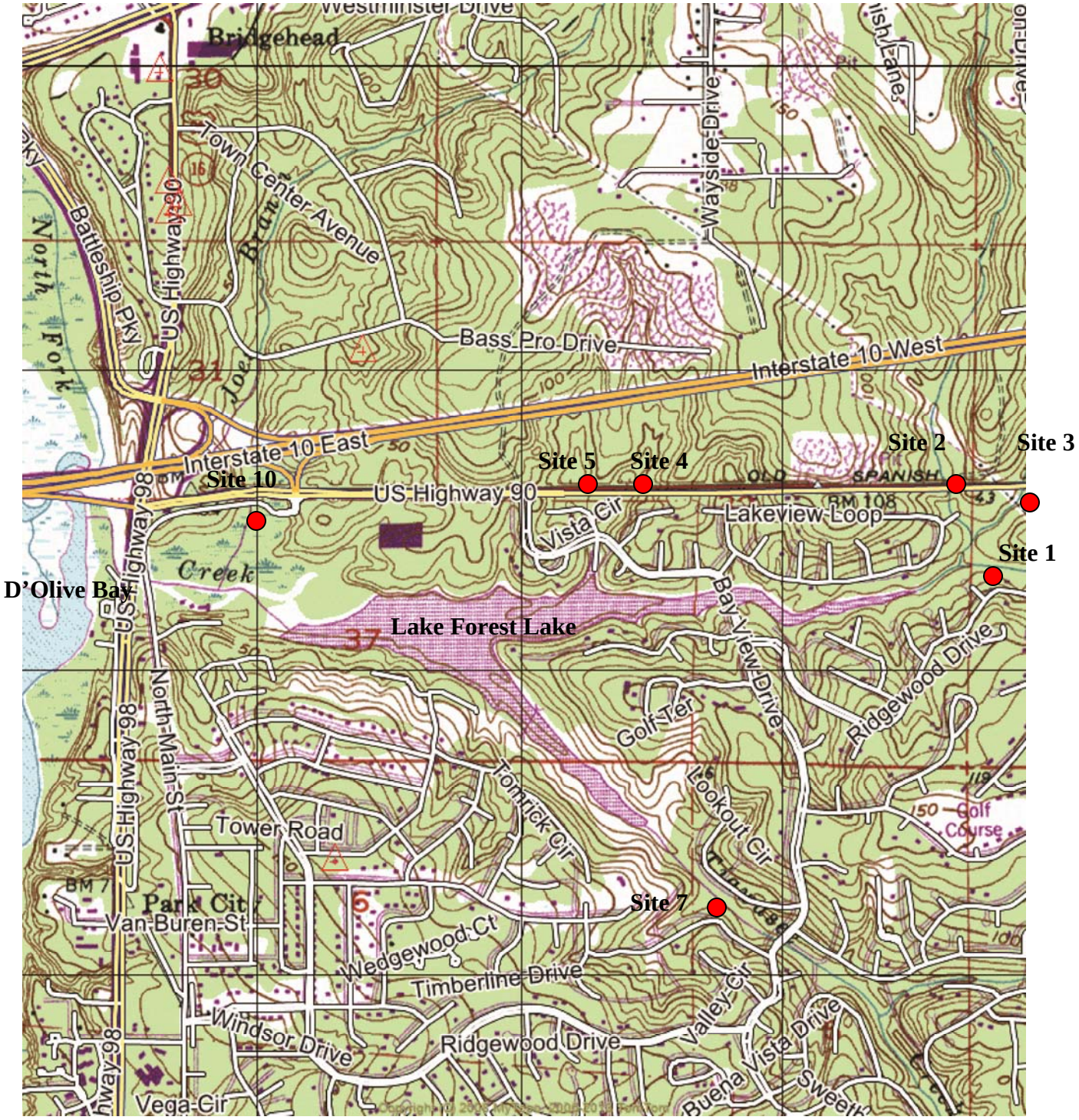

Figure 1.—Topography, infrastructure, streams, and GSA GAP monitoring sites in the D'Olive Creek watershed.

of sediment being passed through Lake Forest Lake. Since only suspended sediment is passed through the lake, bed sediment loads were not used in this assessment. Suspended sediment loads entering the lake were estimated at six sites. The site 1 (unnamed tributary to D'Olive Creek) load was 563 tons per year (t/yr), site 2 (unnamed tributary to the lake) was 4.6 t/yr, site 3 (D'Olive Creek at highway 90) was 619 t/yr, site 4 (unnamed tributary to the lake) was 30 t/yr, site 5 (unnamed tributary to the lake) was 81 t/yr, and site 7 (Tiawasee Creek immediately upstream for the lake) was 835 t/yr (Cook, 2007, Cook, Moss, and O'Neil, 2008). Total suspended sediment loads for the six sites was 2,133 t/yr or 0.82 acre feet. Application of these data to the Brune regression indicates that 68 percent of the suspended sediment load is trapped in the lake. Thirty-two percent is passed through the lake, which equates to 683 t/yr. However, this pass through load estimation is probably underestimated due to resuspension of sediment on the lake bed by wave action and high velocity discharge entering the lake during storm events. When combined with the sediment load from Joes Branch site 10 (303 t/yr), the total sediment load transported to D'Olive Bay is 986 tons per year.

The volume of Lake Forest Lake has been reduced about 60 percent by excessive upstream erosion and sediment deposition (fig. 2). Sedimentation in the lake is sourced from D'Olive Creek, Tiawasee Creek, and an unnamed tributary on the north side of the lake (fig. 3). The remaining volume of the lake is currently about 200 acre feet. The GSA GAP estimated total sediment load entering the lake is about 8,150 t/yr or about 3.1 acre feet per year. Therefore, at current sedimentation rates, it will take about 80 years for the lake to completely fill. However, the fill time will be significantly less if no restoration or remediation occurs in the D'Olive Creek watershed upstream from the lake, due to increasing sediment loads that will be transported as the watershed builds out.

Figure 2.—Photographs taken during low water level of sediment fill in Lake Forest Lake. (Upper photograph looking westward towards the lake dam. Lower photograph looking eastward towards the upper end of the lake.)

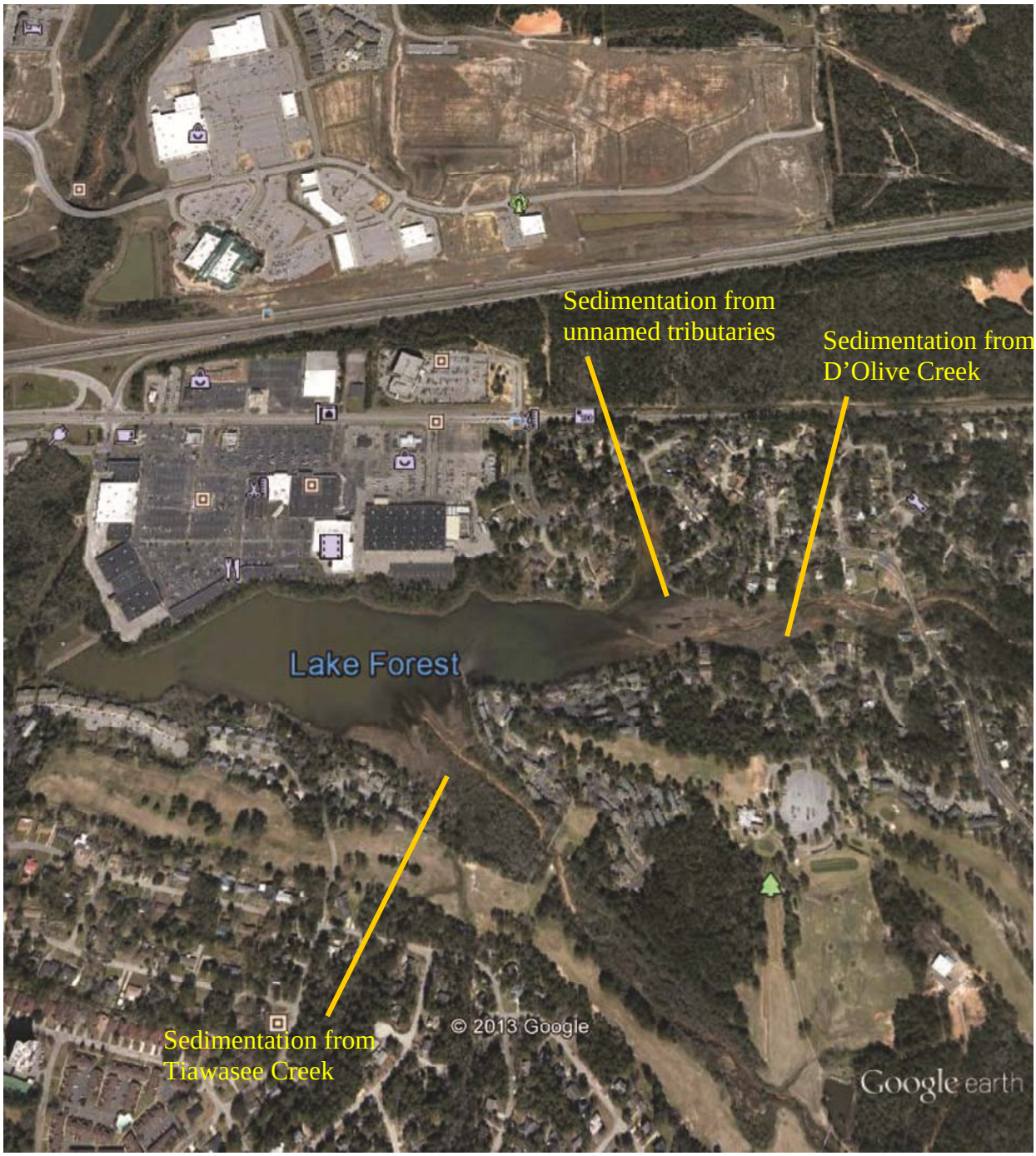

Figure 3.—Google earth March 13, 2013 image of Lake Forest Lake showing sediment fill.

References

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