Minimum and Guidance Levels for Fort Cooper Lake in Citrus County, Florida

December 29, 2006

Ecologic Evaluation Section
Resource Conservation and Development Department

Southwest Florida
Water Management District

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Brooksville, Florida 34604-6899

On the cover: Ground-level photograph of Fort Cooper Lake in February 2005 (SWFWMD files).

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Minimum and Guidance Levels for Fort Cooper Lake

State law (Section 373.042, Florida Statutes; hereafter F.S.) directs the Department of Environmental Protection or the water management districts to establish minimum flows and levels for lakes, wetlands, rivers and aquifers. As currently defined by statute, the minimum level of an aquifer or surface water body is "the level of groundwater in the aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area". Adoption of a minimum water level does not necessarily protect a water body from significant harm. However, protection, recovery or regulatory compliance can be gauged once a standard has been established.

Minimum flows and levels are to be established based upon the best available information and shall be developed with consideration of "…changes and structural alterations to watersheds, surface waters and aquifers, and the effects such changes or alterations have had, and the constraints such changes or alterations have placed on the hydrology of the affected watershed, surface water, or aquifer…", with the caveat that these considerations shall not allow significant harm caused by withdrawals (Section 373.0421, F.S.). Additional guidance for the establishment of minimum flows and levels is provided in the Florida Water Resources Implementation Rule (Chapter 62-40.473, Florida Administrative Code; hereafter F.A.C.), which requires that "consideration shall be given to the protection of water resources, natural seasonal fluctuations in water flows, and environmental values associated with coastal, estuarine, aquatic and wetland ecology, including: a) recreation in and on the water; b) fish and wildlife habitats and the passage of fish; c) estuarine resources; d) transfer of detrital material; e) maintenance of freshwater storage and supply; f) aesthetic and scenic attributes; g) filtration and absorption of nutrients and other pollutants; h) sediment loads; i) water quality; and j) navigation."

To address this legislative mandate within its jurisdictional boundaries, the Southwest Florida Water Management District (District or SWFWMD) has developed specific methodologies for establishing minimum flows or levels for lakes, wetlands, rivers and aquifers, and adopted them into its Water Level and Rates of Flow Rule (Chapter 40D-8, F.A.C). For lakes, methodologies have been developed for establishing Minimum Levels for systems with fringing cypress-dominated wetlands greater than 0.5 acre in size, and for those without fringing cypress wetlands. Lakes with fringing cypress wetlands where water levels currently rise to an elevation expected to fully maintain the integrity of the wetlands are classified as Category 1 Lakes. Lakes with fringing cypress wetlands that have been structurally altered such that lake water levels do not rise to former levels are classified as Category 2 Lakes. Lakes without fringing cypress wetlands are classified as Category 3 Lakes. Chapter 40D-8, F.A.C. also provides for the establishment of Guidance Levels, which serve as advisory information for the District, lakeshore residents and local governments, or to aid in the management or control of adjustable water level structures.

Typically, two Minimum Levels and three Guidance Levels are established for lakes, and upon adoption by the District Governing Board, are incorporated into Chapter 40D-8, F.A.C. The levels, which are expressed as elevations in feet above the National Geodetic Vertical Datum of 1929 (NGVD), are described below.

- The Ten Year Flood Guidance Level is provided as an advisory guideline for lakeshore development. It is the level of flooding expected on a frequency of not less than the ten-year recurring interval, or on a frequency of not greater than a ten percent probability of occurrence in any given year.

- The High Guidance Level is provided as an advisory guideline for construction of lakeshore development, water dependent structures, and operation of water management structures. The High Guidance Level is the elevation that a lake's water levels are expected to equal or exceed ten percent of the time on a long-term basis.

- The High Minimum Lake Level is the elevation that a lake's water levels are required to equal or exceed ten percent of the time on a long-term basis.

- The Minimum Lake Level is the elevation that a lake's water levels are required to equal or exceed fifty percent of the time on a long-term basis.

- The Low Guidance Level is provided as an advisory guideline for water dependent structures, information for lakeshore residents and operation of water management structures. The Low Guidance Level is the elevation that a lake's water levels are expected to equal or exceed ninety percent of the time on a long-term basis.

In accordance with Chapter 40D-8, F.A.C., Minimum and Guidance Levels were developed for Fort Cooper Lake, a Category 3 Lake located in Citrus County, Florida and adopted by the District Governing Board on October 24, 2006. The levels were established using best available information, including data that were obtained specifically for the purpose of minimum levels development. The data and analyses used for development of the levels are described in the remainder of this report.

Table 2. Minimum and guidance levels for Fort Cooper Lake in Citrus County, Florida.

Level	Elevation (feet above NGVD)
Ten Year Flood Guidance Level	35.4
High Guidance Level	30.9
High Minimum Lake Level	30.1
Minimum Lake Level	28.7
Low Guidance Level	26.7

Data and Analyses Supporting Development of Minimum and Guidance Levels for Fort Cooper Lake

Lake Setting and Description

Fort Cooper Lake (a.k.a. Lake Holathlikaha) is located in eastern Citrus County, Florida (Sections 26 and 27, Township 19 South, Range 20 East)) in the Withlacoochee River Basin of the Southwest Florida Water Management District (Figure 1). White (1970) classified the region of central or mid-peninsular Florida containing Fort Cooper as the Tsala Apopka Plain of the Western Valley. The plain, which lies between the Brooksville Ridge to the west and the Sumter and Lake Uplands to the east, is approximately 50 miles long and up to 14 miles wide. Ground surface elevations range from about 50 to 75 feet above NGVD. Brooks (1981) categorized the area surrounding the lake as the Tsala Apopka Basin of the Ocala Uplift Physiographic District, and described the basin as an erosional valley consisting of a "maze of islands, swamps, marshes and lakes". As part of the Florida Department of Environmental Protection's Lake Bioassessment/ Regionalization Initiative, the area has been identified as Tsala Apopka (Griffith *et al.* 1997). Water bodies in the region are characterized as alkaline, eutrophic, hard-water systems.

The lake is classified as an Outstanding Florida Water, and is completely contained within Fort Cooper State Park (Figure 2). Aquatic and semi-aquatic plants occur along most of the shoreline and throughout the basin. Dominant species include sand cordgrass (*Spartina bakeri*), pickerelweed (*Pontedaria cordata*), saw grass (*Cladium jamaicense*), willow (*Salix* sp.), wax myrtle (*Myrica cerifera*), and cattail (*Typha* sp.). A portion of the northern lakeshore has been cleared and is used as a public swimming area. Motorized boats are not permitted on the lake, but canoes and paddleboats rentals are available from a State Park concessionaire. Uplands in the immediate lake basin are covered in natural vegetation and are used primarily for recreation and natural system conservation. Dominant upland species include live oak (*Quercus virginiana*), hickory (*Carya* sp.), longleaf pine (*Pinus palustris*), turkey oak (*Quercus laevis*), and saw palmetto (*Serenoa repens*). Elevations of saw palmetto at various points throughout the basin provide an indication of high lake-water levels. Water levels are currently monitored at a District gauge site along the northern lakeshore.

Fort Cooper Lake lies within the Tsala Apopka Outlet drainage basin in the Withlacoochee River watershed (U.S. Geolgocial Survey Hydrologic Unit Classification System). Surface water inputs include direct precipitation on the lake, runoff from immediately adjacent upland areas, and drainage from a stormwater system located east of the lake (Figure 3). No surface water drainage occurs from the basin currently, and based on historical photography (Figures 4-13) from the 1940s through the 1990s (USDA1944a-b, 1951a-b, 1953, 1960a-c, 1969, 1974, SWFWMD 1982, USGS 1984, 1994, 1999, 2004, 2005, Woolpert Inc. 2003), this has been the case for the past 61 years. There are no surface withdrawals from the lake permitted by the District. There

are, however, several permitted groundwater withdrawals in the lake vicinity.

The "Gazetteer of Florida Lakes" (Florida Board of Conservation 1969, Shafer *et al.* 1986) lists an area of 150 acres and water surface elevation of 33 feet for Fort Cooper Lake. The 1895 United States Geological Survey 1:62,500 Florida, Tsala Apopka Sheet includes water surface elevation of 32 feet above mean sea level for Fort Cooper Lake. The 1954 (and photorevised 1988) U.S. Geological Survey 1:24:000 Inverness, Fla. map show the lake at 33 feet above NGVD (Figure 14). A topographic map of the Fort Cooper basin that was generated to support of minimum levels development (Figure 15) indicates that the lake extend over 186 acres when the water surface is at 33 feet above NGVD.

Figure 1. Location of Fort Cooper Lake in Citrus County, Florida.

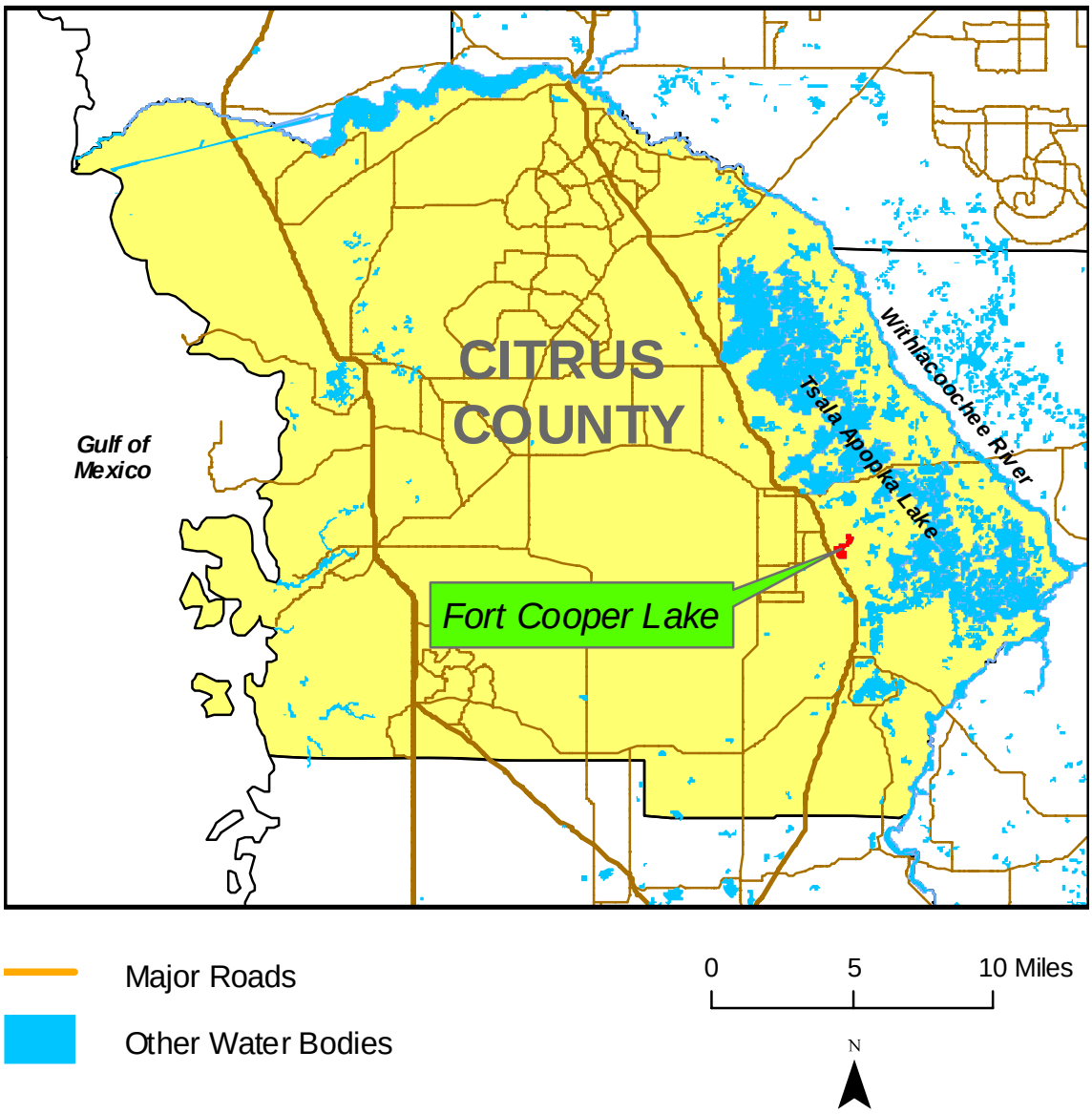


Figure 2. Location of the District lake water-level gauge, inlets, and sites where hydrologic indicators were measured at Fort Cooper Lake. The boundary of Fort Cooper State Park is also shown, along with names for selected roads.

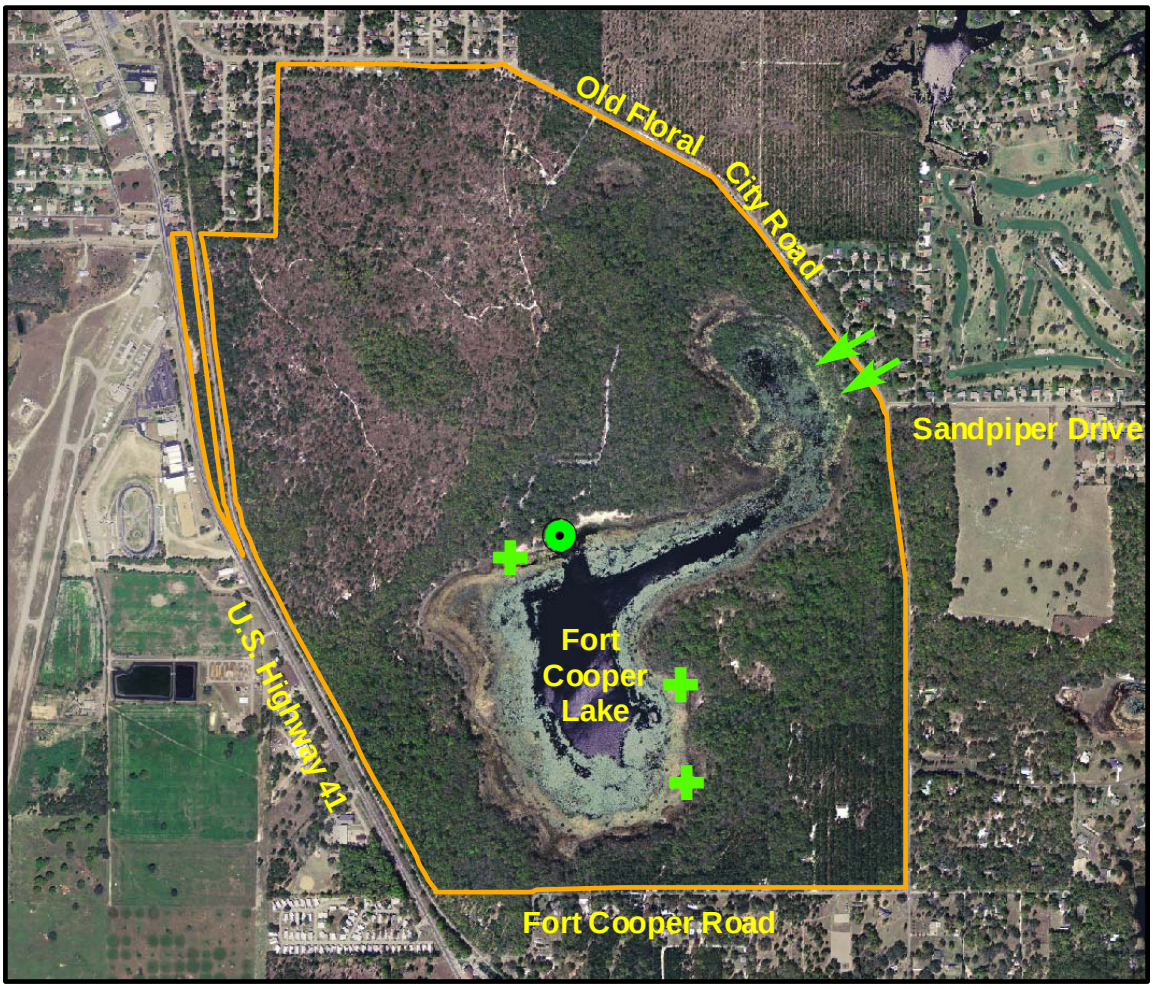


Figure 3. Inlets along the northeastern shore of Fort Cooper Lake.

Map prepared on October 14, 2005 using USGS (2004) digital orthophotogray, and elevation data collected on March 28, 2005 by the SWFWMD Survey Section (SWFWMD 2005) and on October 14, 2005 by the SWFWMD Ecologic Evaluation Section.

0 250 500 Feet

N

Figure 4. Aerial photography of Fort Cooper Lake in 1944. Image is from a United States Department of Agriculture aerial photograph (USDA 1944).

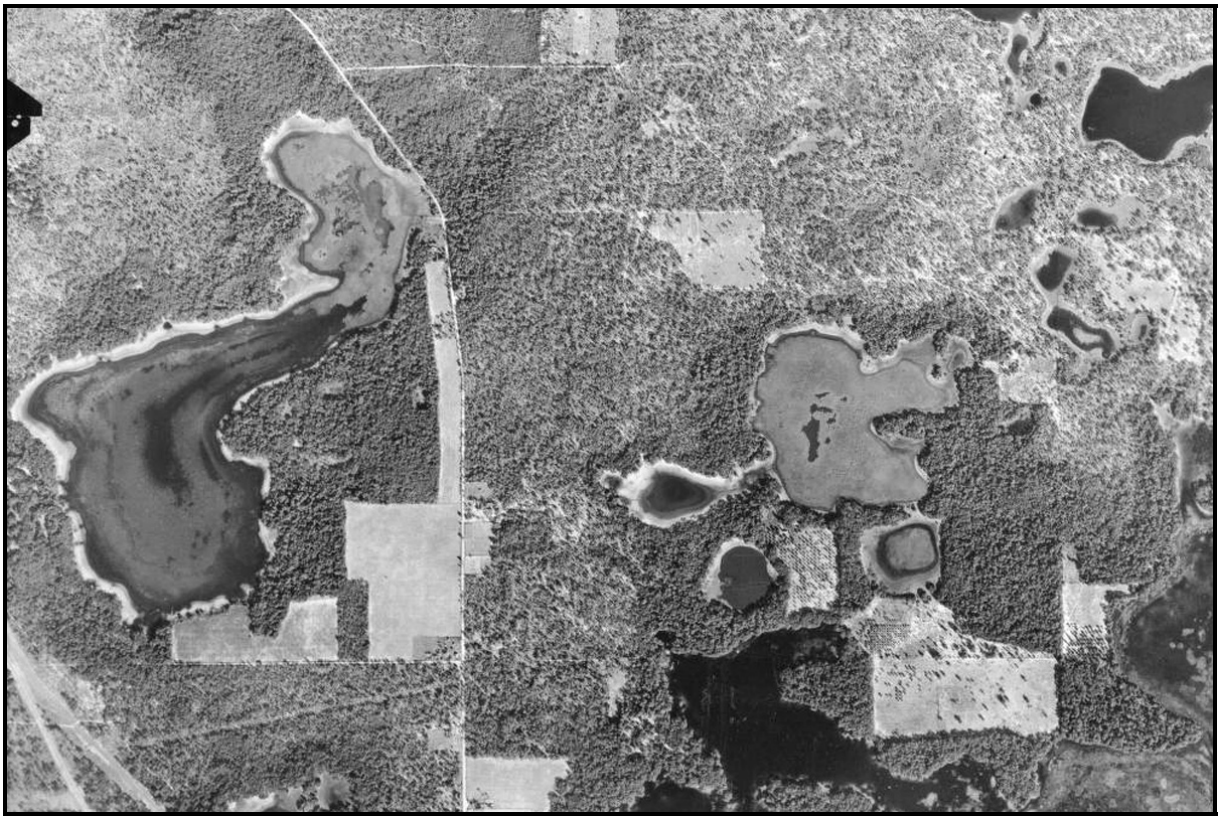


Figure 5. Aerial photography of Fort Cooper Lake in 1951. Image is from a United States Department of Agriculture aerial photograph (USDA 1951).

Figure 6. Aerial photography of Fort Cooper Lake in 1960. Image is from a United States Department of Agriculture aerial photograph (USDA 1960).

Figure 7. Aerial photography of Fort Cooper Lake in 1969. Image is from a United States Department of Agriculture aerial photograph (USDA 1969).

Figure 8. Aerial photography of Fort Cooper Lake in 1973. Image is from a 1970s Historical Aerial Photo Database (Woolpert 2003).

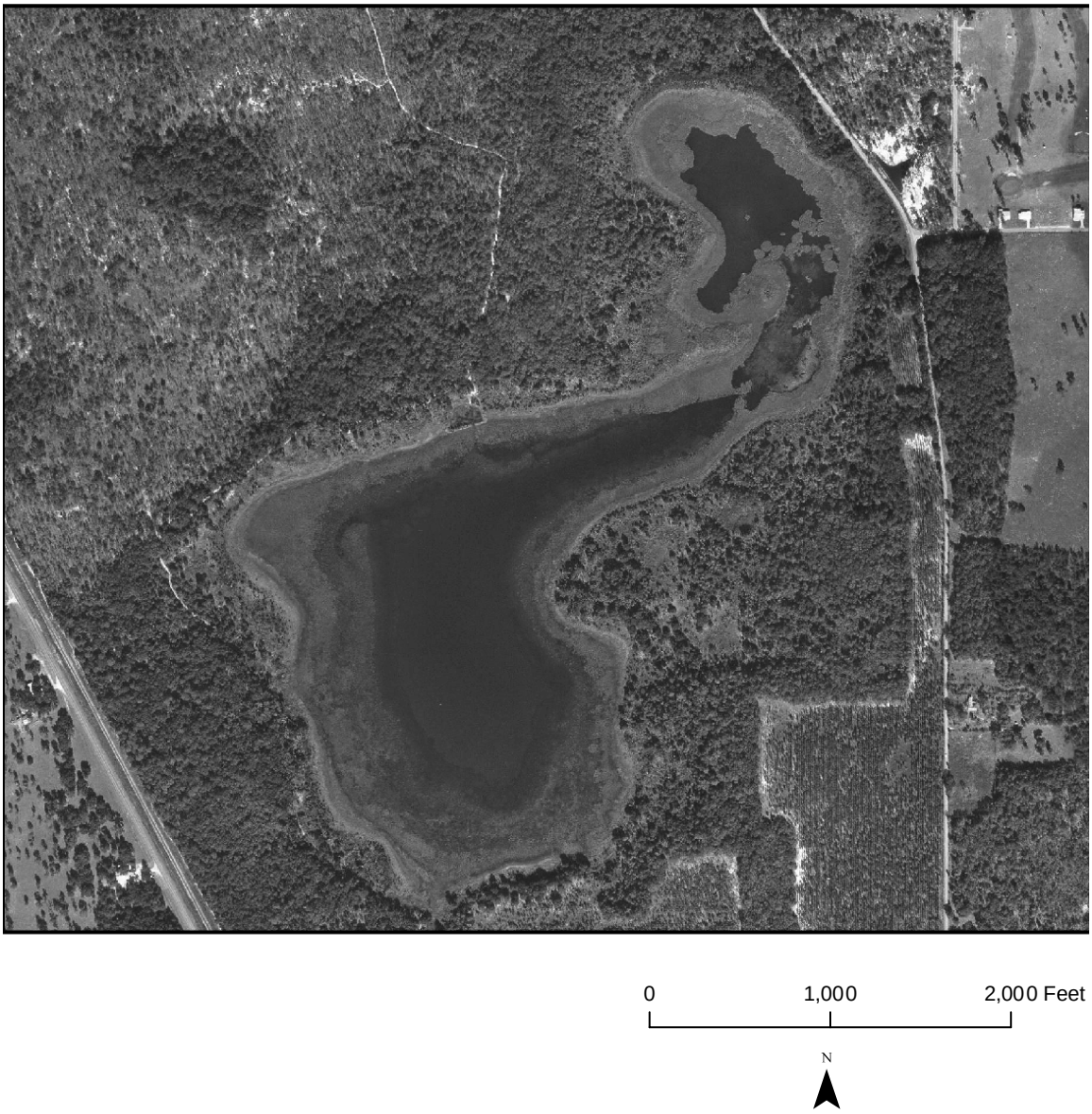


Figure 9. Aerial photography of Fort Cooper Lake in 1974. Image is from a United States Department of Agriculture aerial photograph (USDA 1974).

Figure 10. Aerial photograph of Fort Cooper Lake in 1984 (USGS 1984).

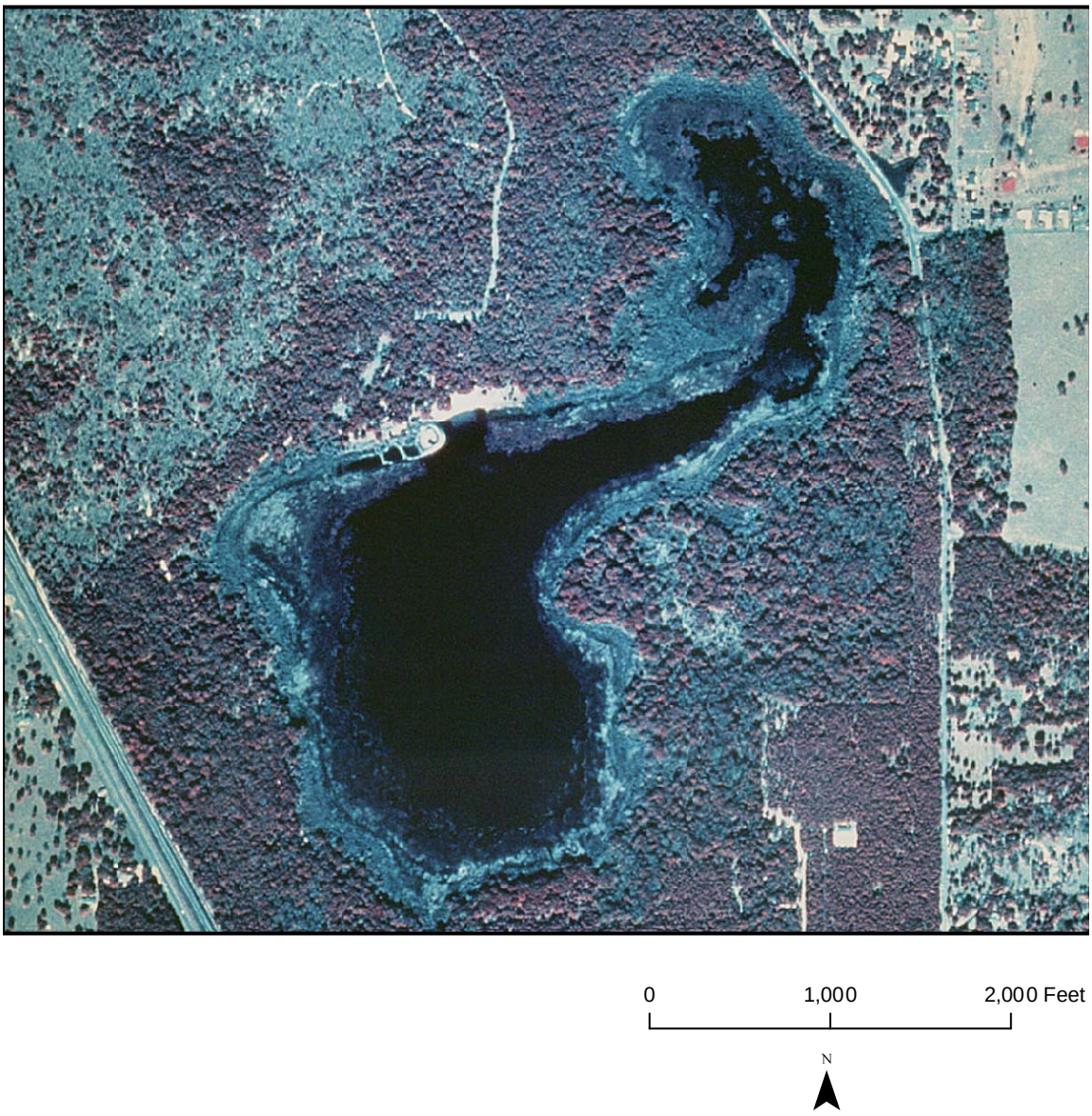


Figure 11. Aerial photography of Fort Cooper Lake in 1994. Image is from United States Geological Survey digital orthophotography (USGS 1994).

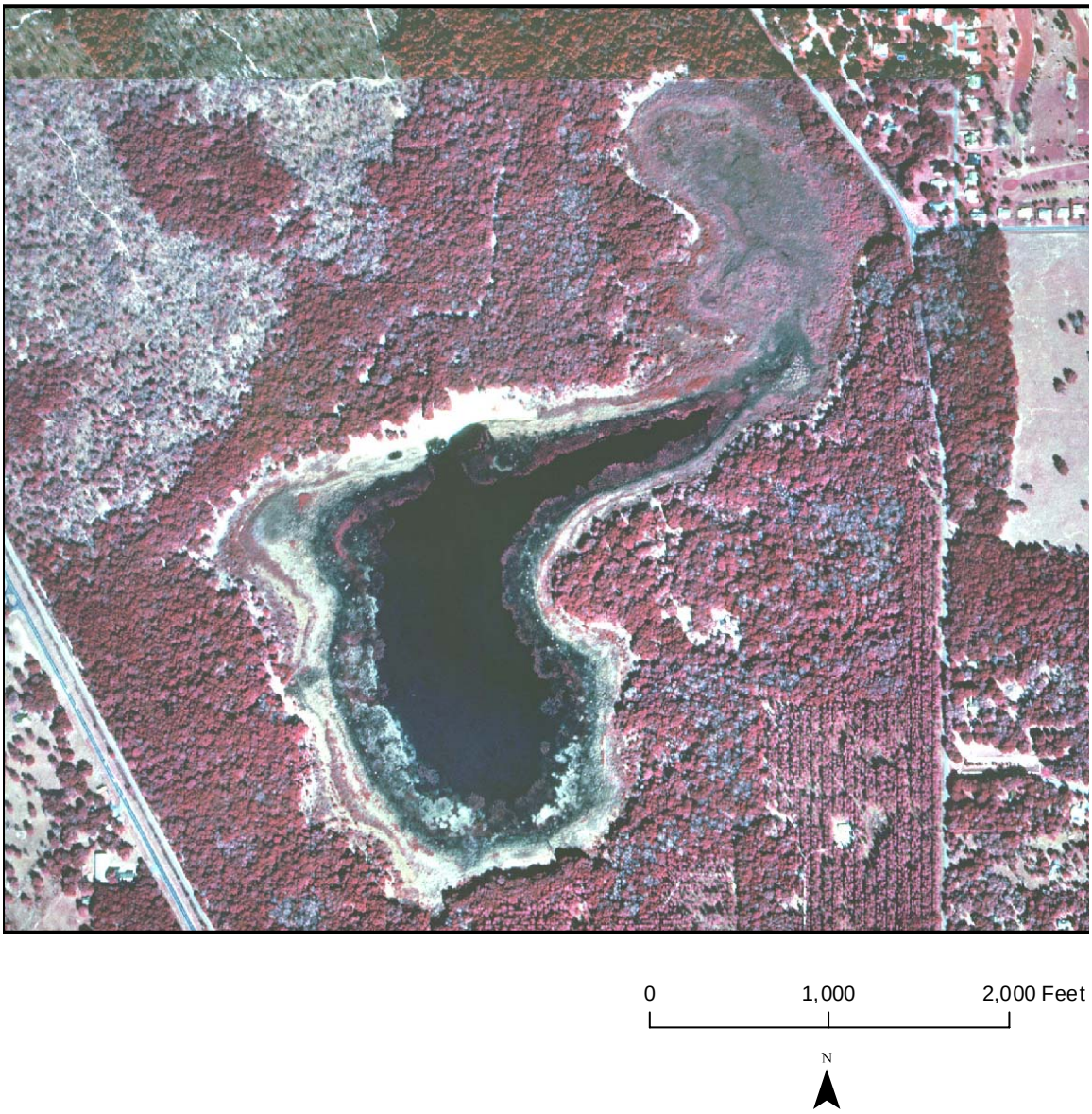


Figure 12. Aerial photography of Fort Cooper Lake in 1999. Image is from United States Geological Survey digital orthophotography (USGS 1999).

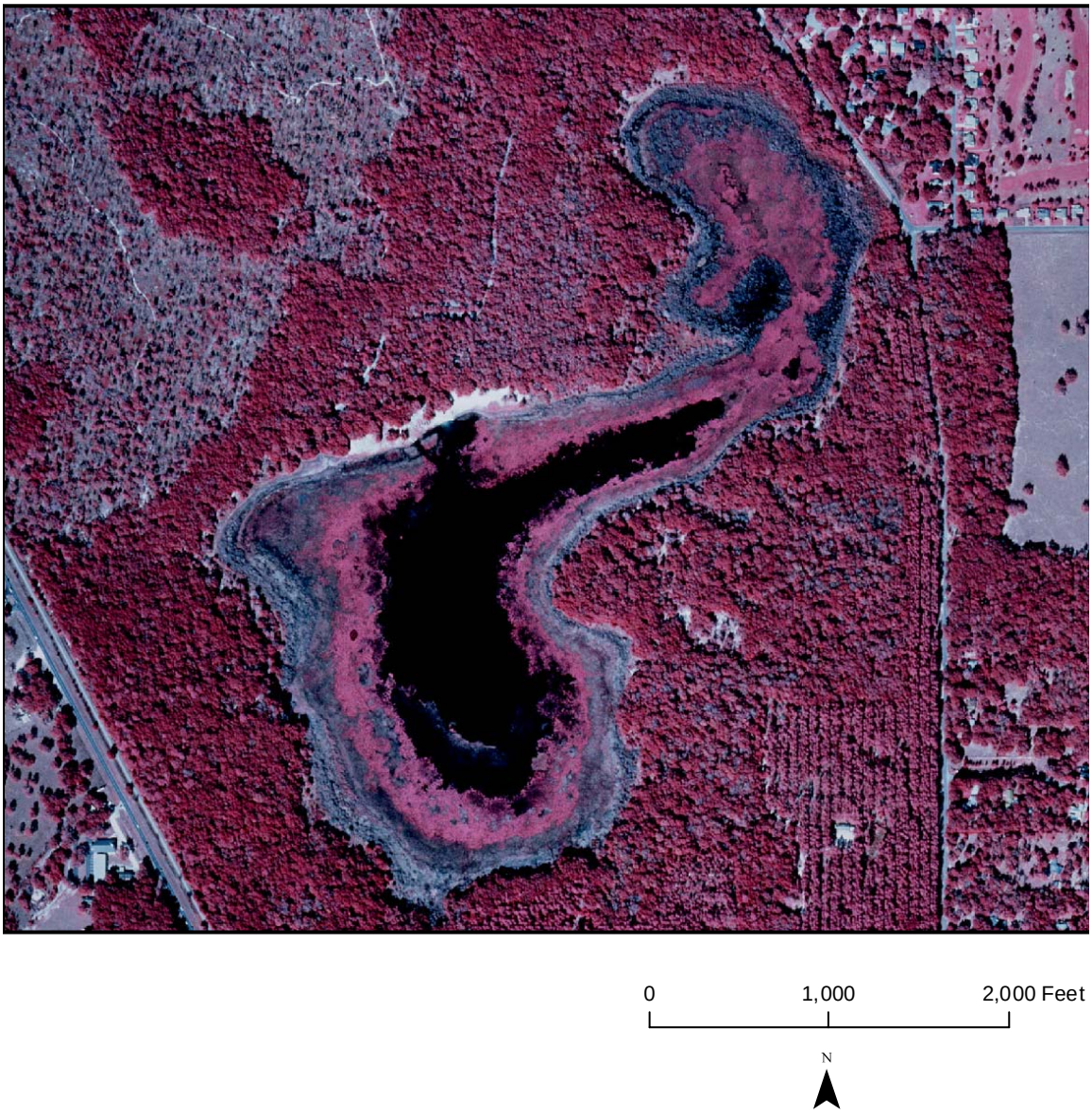


Figure 13. Aerial photograph of Fort Cooper Lake in 2005. Image is from United States Geological Survey digital orthophotography (USGS 2005).

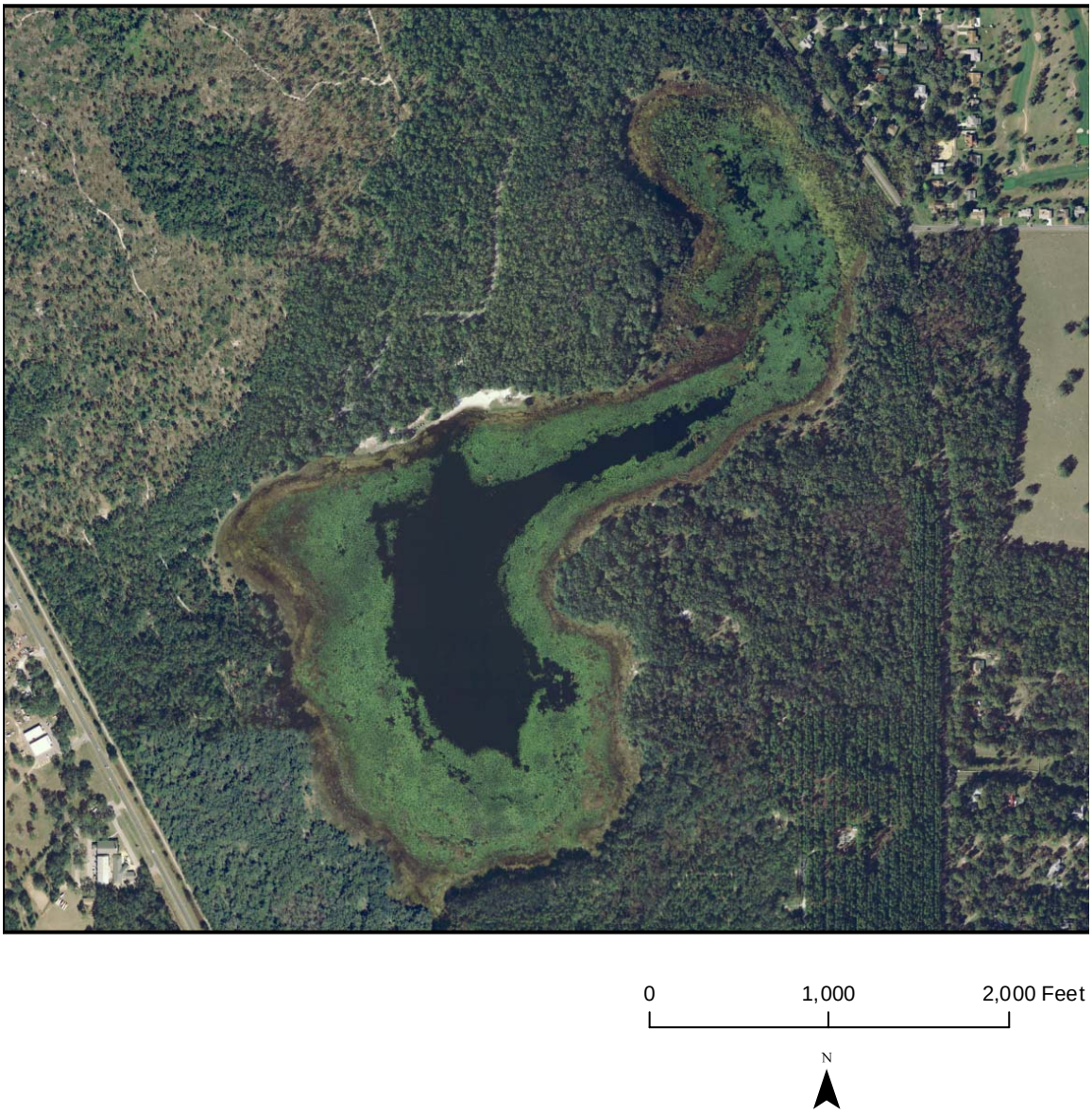


Figure 14. Ten-foot elevation contours in the vicinity of Fort Cooper Lake. Image is from the U.S. Geological Survey 1:24,000 scale topographic map (DRG) layer available from the Southwest Florida Water Management District. Note that the lake water surface elevation is listed as 33 feet above NGVD.

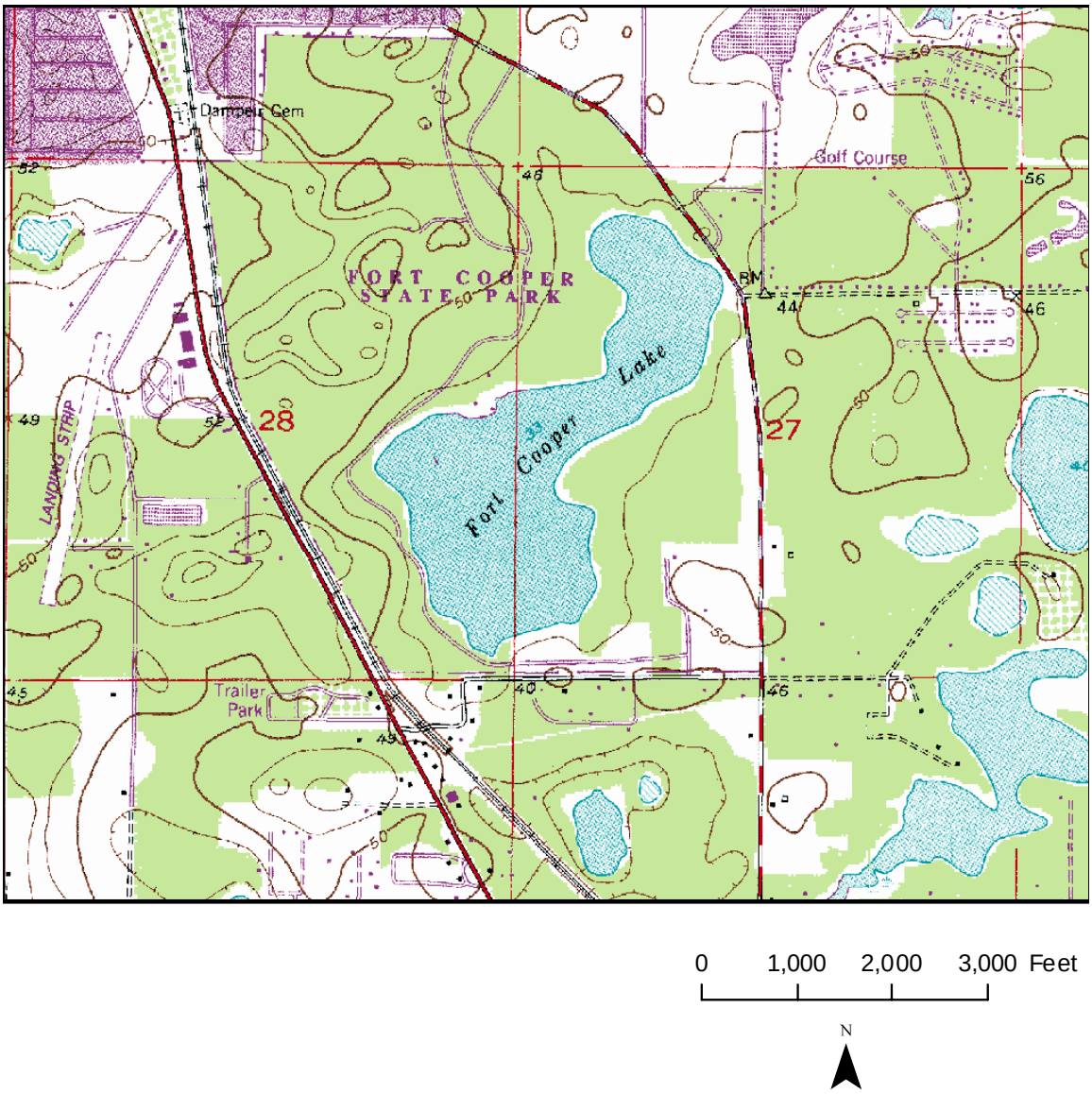
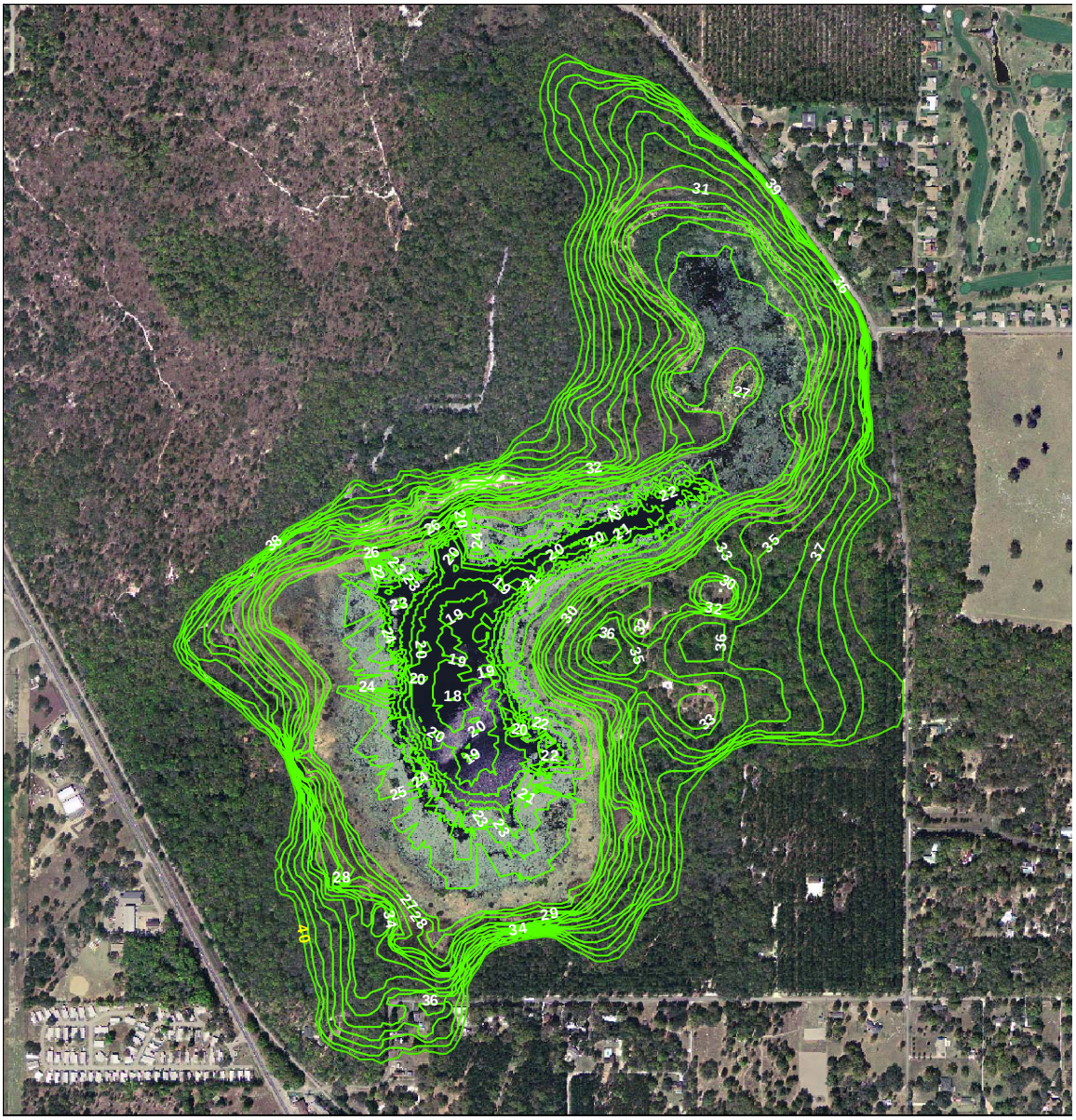


Figure 15. One-foot elevation contours within the Fort Cooper Lake basin. Values shown are elevations, expressed as feet above NGVD.



Map prepared on June 7, 2005 using elevation data from 1982 SWFWMD aerial photography with contours maps, elevation data collected by D.C. Johnson Associates on July 24, 2004 and USGS (2004) digital orthophotography (Natural Color - Preliminary, prepared by EarthData International)..

0 1,000 2,000 Feet

N

Previously Adopted Guidance Levels

The Southwest Florida Water Management District has a long history of water resource protection through the establishment of lake management levels. With the development of the Lake Levels Program in the mid-1970s, the District began establishing management levels based on hydrologic, biological, physical and cultural aspects of lake ecosystems. By 1996, management levels for nearly 400 lakes had been established. Management levels were not, however, previously developed for Fort Cooper Lake.

Summary Data Used for Minimum and Guidance Level Development

Minimum and Guidance Levels were developed for Fort Cooper Lake using the methodology for Category 3 Lakes described in current District Rules (Chapter 40D-8, F.A.C.). The levels and additional information are listed in Table 3, along with lake surface area values. Detailed descriptions of the development and use of these data are summarized in subsequent sections of this report.

Table 3. Minimum and Guidance Levels, lake stage percentiles, Normal Pool, Control Point elevation, Historic P50, significant change standards and associated surface areas for Fort Cooper Lake.

Level or Feature	Elevation (feet above NGVD)	Lake Area (acres)
Lake Stage Exceedance Percentiles		
Historic P10	30.9	158
Historic P50	29.5	143
Historic P90	26.7	112
Other Levels		
Normal Pool	34.0	204
Control Point	NA	NA
Guidance Levels and Historic P50		
Ten Year Flood Guidance Level	35.4	229
High Guidance Level	30.9	158
Historic P50	29.5	143
Low Guidance Level	26.7	112
Significant Change Standards and Other Information		
Cypress Standard	NA	NA
Connectivity Standard	NA	NA
Dock-Use Standard	NA	NA
Wetland Offset Elevation	28.7	135
Species Richness Standard	27.5	122
Mixing Standard	26.7	112
Aesthetic Standard	26.7	112
Recreation/Ski Standard	NA	NA
Minimum Levels		
High Minimum Lake Level	30.1	149
Minimum Lake Level	28.7	135

NA = not available or not applicable

Lake Stage Data and Exceedance Percentiles

Lake stage data (*i.e.,* surface water elevations) are available from the District Water Management Database for Fort Cooper Lake (District Universal Identification Number STA 826 3110) from April 2001 to the present (Figure 16, see Figure 2 for current location of the SWFWMD lake water-level gauge). The highest surface elevation for the lake in the database, 32.90 feet above NGVD, occurred on October 2, 2003. A higher elevation, 33 feet above NGVD is shown for the lake on the most recent USGS Inverness, Fla. quadrangle topographic map (USGS 1988). The lowest lake stage in the database, 22.20 feet above NGVD, was recorded on May 31 and June 1, 2001.

For the purpose of minimum levels determination, lake stage data are categorized as "Historic" for periods when there were no measurable impacts due to water withdrawals, and impacts due to structural alterations were similar to existing conditions. In the context of minimum levels development, "structural alterations" means man's physical alteration of the control point (*i.e.*, the highest stable point along the outlet conveyance system of a lake), to the degree that water level fluctuations are affected. Lake stage data are categorized as "Current" for periods when there were measurable, stable impacts due to water withdrawals, and impacts due to structural alterations were stable.

Based on water-use estimates and analysis of lake water levels and regional ground water fluctuations, available lake-stage data for Fort Cooper Lake were classified as Historic data. These data were, however, considered insufficient for calculating Historic lake-stage exceedance percentiles, because the record only extends over a relatively short period of time. Historic lake-stage exceedance percentiles were, instead, developed using a composite sixty-year record of monthly mean lake surface elevations based on available stage records that were supplemented with modeled estimates. The sixty-year period was considered sufficient for incorporating the range of lake-stage fluctuations that would be expected based on long-term climatic cycles that have been shown to be associated with changes in regional hydrology (Enfield et al. 2001, Basso and Schultz 2003, Kelly 2004).

Modeled monthly mean lake stage values for the composite data set were estimated using a linear fitting procedure known as the line or organic correlation (see Helsel and Hirsch 1992). The procedure was utilized to describe the relationship between available lake stage data for Fort Cooper Lake and the Hernando Pool of Tsala Apopka Lake (District Universal Identification Number STA 488 490). The line of organic correlation equation developed for the two data sets was used to estimate water surface elevation values for Fort Cooper Lake for the period from January 1946 through December 2005 (M. Hancock, SWFWMD unpublished data). A Historic, composite data set of monthly mean water surface elevations for Fort Cooper Lake was then developed using the modeled water surface elevations and available lake stage records (Figure 17). The composite record includes period when estimated water surface elevations were higher and lower than the values that have been measured since 2001. The highest value included in the composite data set, 33.1 feet above NGVD, was estimated for April 1960. The lowest value included in the composite data set, 20.8 feet above NGVD, was

estimated to have occurred in July 1957.

The Historic P10 elevation, the elevation the lake water surface equaled or exceeded ten percent of the time during the historic period, was 30.9 feet above NGVD. The Historic P50 elevation, the elevation the lake water surface equaled or exceeded fifty percent of the time during the historic period, was 29.5 feet above NGVD. The Historic P90 elevation, the elevation the lake water surface equaled or exceeded ninety percent of the time during the historic period, was 26.7 feet above NGVD.

Figure 16. Surface water elevations of Fort Cooper Lake through August 2006.

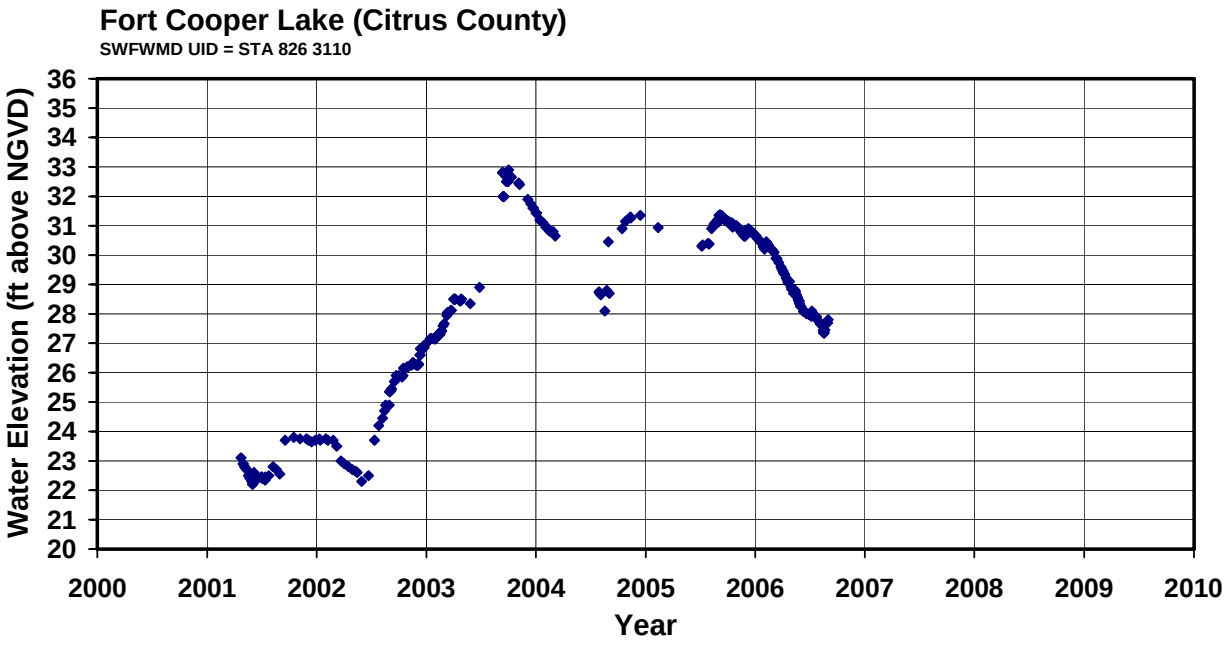
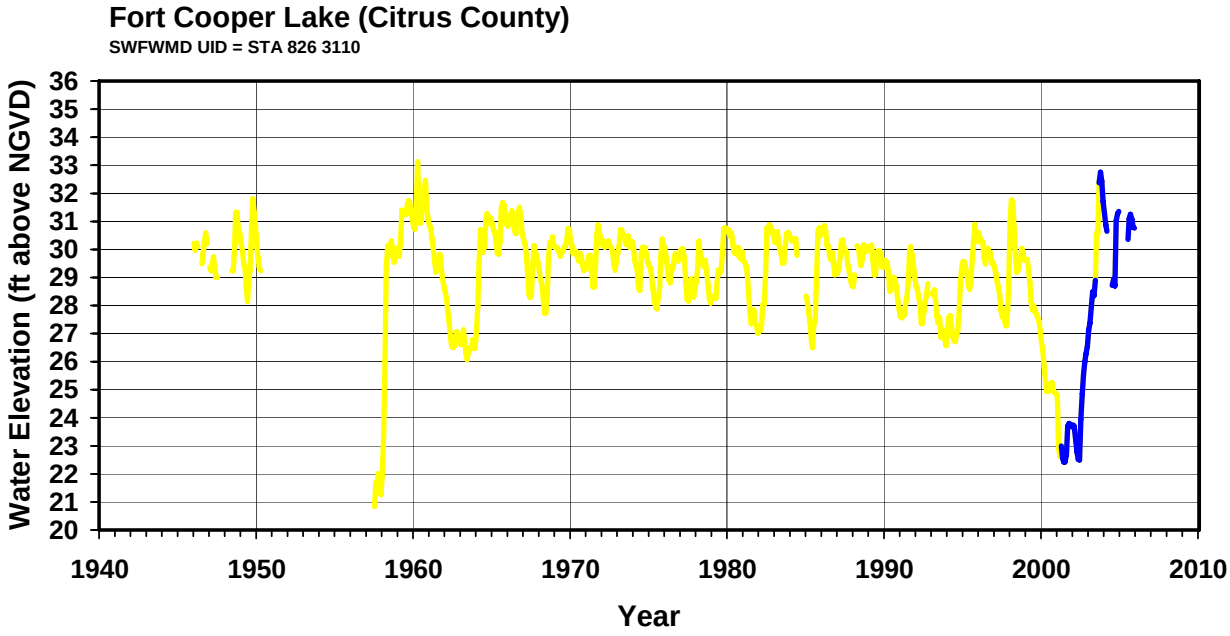


Figure 17. Composite monthly-mean surface water elevations for Fort Cooper Lake from January 1946 through December 2005. Composite data include values based on measured water surface elevations (blue) and modeled values (yellow).



Normal Pool, Control Point Elevation and Determination of Structural Alteration Status

The Normal Pool elevation, a reference elevation used for development of minimum lake and wetland levels, is established using elevations of Hydrologic Indicators of sustained inundation, including biological and physical features. Based on ground elevations at the base of saw palmetto shrubs along the lakeshore (Table 4, Figures 2 and 18), the Normal Pool elevation was established at 34.0 feet above NGVD.

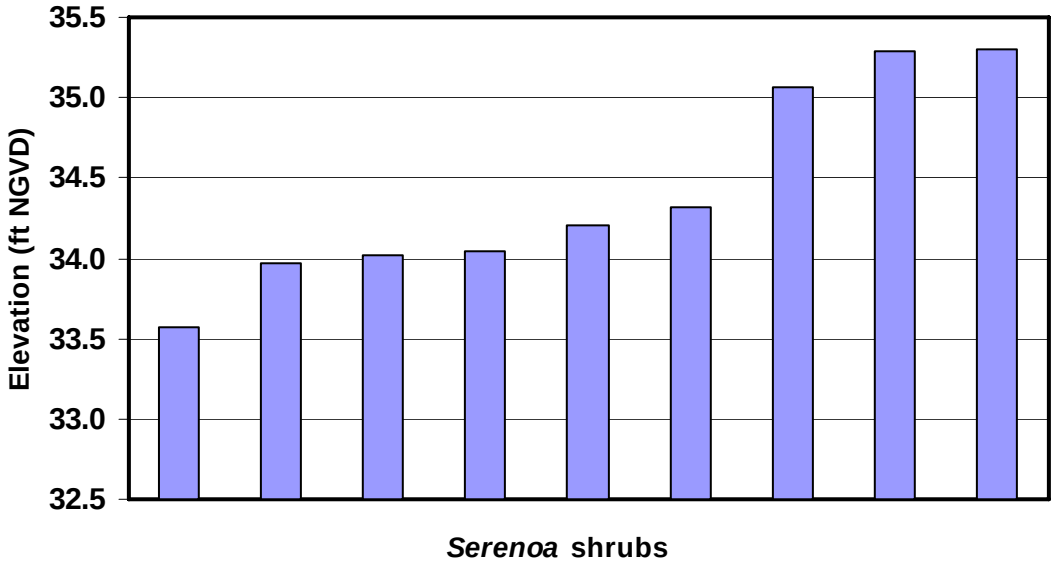
For development of minimum and guidance levels, lakes are classified as open or closed basin lakes. Open basin lakes are systems that are connected to, or are part of an ordered surface water conveyance system. Closed basin lakes are those that are not part of an ordered conveyance system. Because Fort Cooper Lake does not have an outlet, it was classified as a closed basin lake.

The Control Point elevation is the elevation of the highest stable point along the outlet profile of a surface water conveyance system (*e.g.,* weir, canal or culvert) that is the principal control of water level fluctuations in the lake. The Control Point may be established at high spots in a lake's outlet canal, or at crest/invert elevations associated with water control structures. Because Fort Cooper Lake does not have an outlet, a Control Point elevation was not established for the basin.

Table 4. Summary statistics for hydrologic indicator data (ground elevations at saw palmetto shrubs) used to establish the normal pool elevation for Fort Cooper Lake. Indicator elevations were measured by SWFWMD staff in February 2005.

Statistic	Statistic Value (N) or Elevation (feet above NGVD)
N	9
Median	34.0
Mean (SD)	34.2 (0.4)
Minimum	33.6
Maximum	34.9

Figure 18. Ground elevations at the base of *Serenoa repens* shrubs used to establish the Normal Pool elevation for Fort Cooper Lake.



Guidance Levels and the Historic P50

The Ten Year Flood Guidance Level is provided as an advisory guideline for lakeshore development and is the level of flooding expected on a frequency of not less than the ten-year recurring interval, or on a frequency of not greater than a ten percent probability of occurrence in any given year. The Ten Year Flood Guidance Level for Fort Cooper Lake was established at 35.4 feet above NGVD using the methodology for closed basin lakes described in current District Rules (Chapter 40D-8, F.A.C). For the analysis, various frequency distributions and probability plots were compared to establish the best estimate of flood frequency elevations, based on a probability analysis of annual peak stages for a sixty-one year period, from 1944 through 2004. Peak lake stages for this period were derived from available water level data (Figure 16) and simulated data developed using the HSPF continuous simulation model. Simulated data were developed using rainfall records from the Bushnell National Weather Service station (District Universal Identification Number RNF 265 265), and pan evaporation records from sites at the Archbold Biological Station (District Universal Identification Number EVT 8 8), Lake Alfred (District Universal Identification Numbers EVT 9 9 and EVT 31 31) and Belle Glade (available from the South Florida Water Management District).

The High Guidance Level is provided as an advisory guideline for construction of lakeshore development, water dependent structures, and operation of water management structures. The High Guidance Level is the expected Historic P10 of the lake, and is established at the Historic P10, the Current P10, the control point, or the

normal pool elevation. Because available Historic data were considered representative of high water conditions for Fort Cooper Lake, the High Guidance Level was established at the Historic P10 elevation, 30.9 feet above NGVD.

The Historic P50 elevation is the elevation that the lake surface is expected to equal or exceed fifty percent of the time on a long-term basis. The level is derived to support development of minimum lake levels, and is established using Historic or Current data and, in some cases, reference lake water regime statistics. Reference lake water regime statistics are necessary when adequate Historic or Current data are not available. Reference lake water regime statistics represent differences between P10, P50 and P90 lake stage elevations for typical, regional lakes that exhibit little or no impacts associated with water withdrawals (*i.e*., reference lakes). The statistics include the RLWR50, RLWR90 and RLWR5090, which are, respectively, median differences between P10 and P50, P50 and P90, and P10 and P90 lake stage percentiles for the set of reference lakes. Based on the availability of Historic data for Fort Cooper Lake, the Historic P50 was established at 29.5 feet above NGVD.

The Low Guidance Level is provided as an advisory guideline for water dependent structures, information for lakeshore residents and operation of water management structures. The Low Guidance Level is the elevation that a lake's water levels are expected to equal or exceed ninety percent of the time on a long-term basis, and is established using Historic or Current data and, in some cases, reference lake water regime statistics. Because Historic data are available for Fort Cooper Lake, the Low Guidance Level was established at the Historic P90 elevation, 26.7 feet above NGVD.

Lake Classification

Lakes are classified as Category 1, 2 or 3 for the purpose of Minimum Levels development. Those with fringing cypress wetlands greater than 0.5 acres in size where water levels currently rise to an elevation expected to fully maintain the integrity of the wetlands (*i.e.,* the Historic P50 is equal to or higher than the elevation 1.8 feet below the Normal Pool elevation) are classified as Category 1 lakes. Lakes with fringing cypress wetlands greater than 0.5 acres in size that have been structurally altered such that the Historic P50 elevation is more than 1.8 feet below the Normal Pool elevation are classified as Category 2 lakes. Lakes without fringing cypress wetlands or with cypress wetlands less than 0.5 acres in size are classified as Category 3 lakes. Because Fort Cooper Lake is not contiguous with any cypress wetlands, the lake was classified as a Category 3 Lake.

Significant Change Standards and Other Information for Consideration

Lake-specific significant change standards and other available information are developed for establishing Minimum Levels. The standards are used to identify thresholds for preventing significant harm to cultural and natural system values associated with lake ecosystems, in accordance with guidance provided in the Florida Water Resources Implementation Rule (Chapter 62-40.473, F.A.C.). Other information taken into consideration for Minimum Levels development includes potential changes in the coverage of herbaceous wetland and submersed aquatic plants.

For Category 1 or 2 lakes, a significant change standard is established at the elevation 1.8 feet below the Normal Pool elevation. This standard, referred to in this report as the Cypress Standard, is used to identify a desired median lake stage that may be expected to preserve the ecological integrity of lake-fringing cypress wetlands. Because Fort Cooper Lake is a Category 3 Lake, a Cypress Standard was not developed.

For Category 3 lakes, six significant change standards are developed, including a Basin Connectivity Standard, a Dock-Use Standard, an Aesthetics Standard, a Species Richness Standard, a Recreation/Ski Standard, and a Lake Mixing Standard. Potential changes in the coverage of herbaceous wetland vegetation and aquatic plants associated with use of standards for development of Minimum Levels for Category 3 lakes are also taken into consideration.

The Basin Connectivity Standard is developed to protect surface water connections between lake basins or among sub-basins within lake basins to allow for movement of aquatic biota, such as fish, and support recreational lake-use. The standard is based on the elevation of lake sediments at a critical high spot between lake basins or lake sub-basins, sufficient water depths for movement of aquatic biota or powerboats and other watercraft, and use of Historic lake stage data or region-specific reference lake water regime statistics. Based on the morphology of the Fort Cooper Lake basin, development of a Basin Connectivity Standard was not appropriate.

The Dock-Use Standard is developed to provide for sufficient water depth at the end of existing docks to permit mooring of boats and prevent adverse impacts to bottom-dwelling plants and animals caused by boat operation. The standard is based on the elevation of lake sediments at the end of existing docks, a two-foot water depth requirement for boat mooring, and use of Historic lake stage data or region-specific reference lake water regime statistics. A Dock-Use Standard was not developed for Fort Cooper Lake, because motorized watercraft are not permitted on the lake and the basin does not contain any docks.

The Aesthetics Standard is developed to protect aesthetic values associated with the inundation of lake basins. The standard is intended to protect aesthetic values associated with the median lake stage from degrading below the values associated with the lake when it is staged at the Low Guidance Level. For Fort Cooper Lake, the

Aesthetic Standard was established at the Low Guidance Level elevation, 26.7 feet above NGVD.

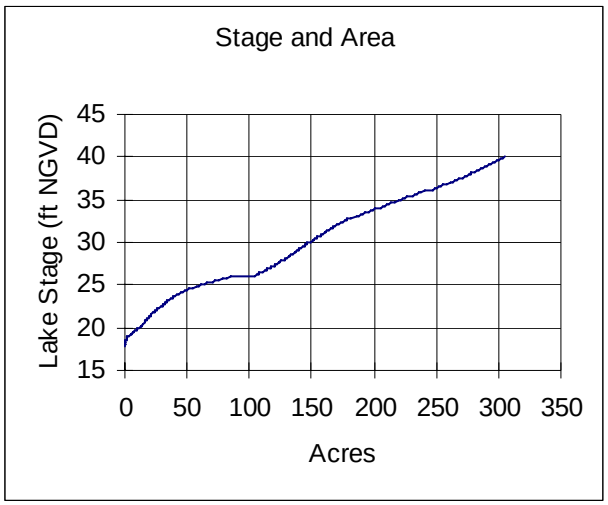
The Species Richness Standard is developed to prevent a decline in the number of bird species that may be expected to occur at or utilize a lake. Based on an empirical relationship between lake surface area and the number of birds expected to occur at a lake, the standard is established at the lowest elevation associated with less than a fifteen percent reduction in lake surface area relative to the lake area at the Historic P50 elevation. For Fort Cooper Lake, the Species Richness Standard was established at 27.5 feet above NGVD.

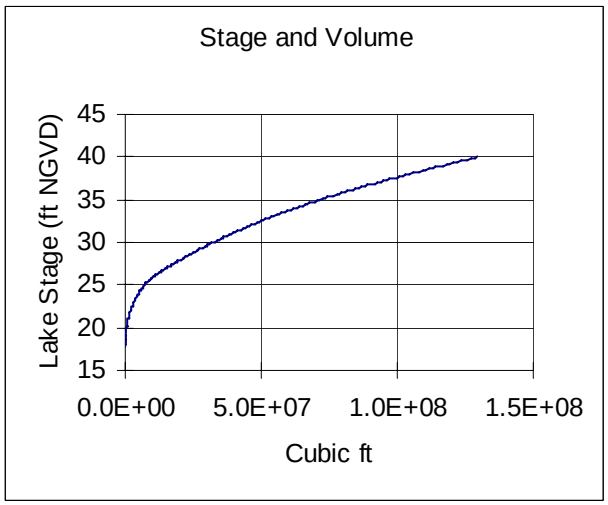
The Recreation/Ski Standard is developed to identify the lowest elevation within the lake basin that will contain an area suitable for safe water skiing. The standard is based on the lowest elevation (the Ski Elevation) within the basin that can contain a five-foot deep ski corridor delineated as a circular area with a radius of 418 ft, or a rectangular ski area 200 feet in width and 2,000 feet in length, and use of Historic lake stage data or region-specific reference lake water regime statistics. Because operation of motorized watercraft is not permitted on Fort Cooper Lake, a Recreation/Ski Standard was not developed.

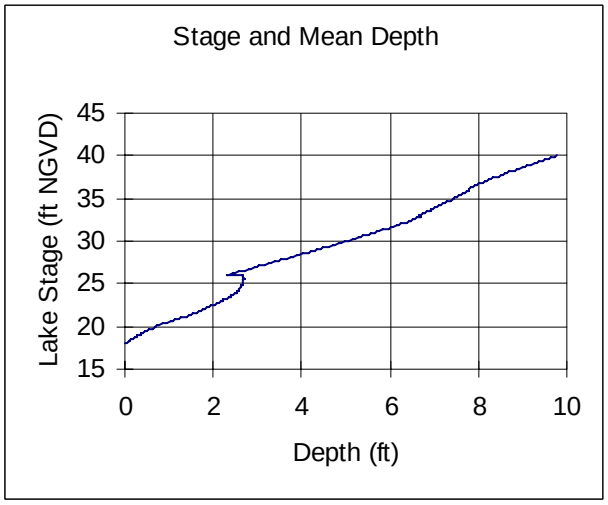
The Lake Mixing Standard is developed to prevent significant changes in patterns of wind-driven mixing of the lake water column and sediment resuspension. The standard is established at the highest elevation at or below the Historic P50 elevation where the dynamic ratio (see Bachmann *et al.* 2000) shifts from a value of <0.8 to a value >0.8, or from a value >0.8 to a value of <0.8. Based on these criteria, the Lake Mixing Standard was established at 26.7 feet above NGVD (Figure 19).

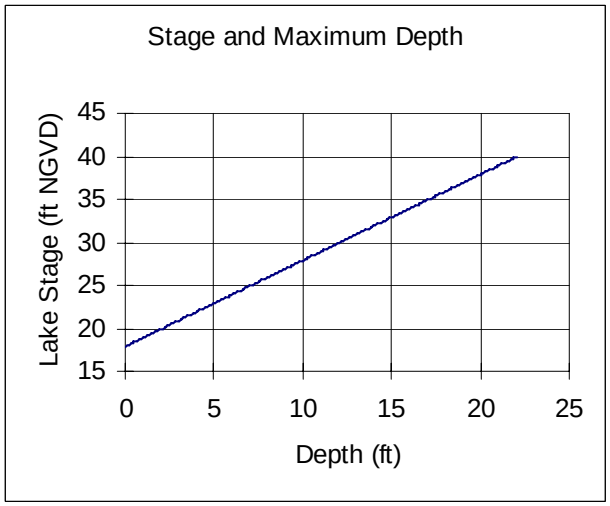
Herbaceous Wetland Information is taken into consideration to determine the elevation at which change in lake stage would result in substantial change in potential wetland area within the lake basin (*i.e*., basin area with a water depth of four or less feet). Review of changes in potential herbaceous wetland area in relation to change in lake stage did not indicate that of use of the applicable significant change standards would be inappropriate for establishment of the Minimum Lake Level (Figure 19). However, because herbaceous wetlands are common within the lake basin, it was determined that an additional measure of wetland change should be considered for minimum levels development. Based on a recent review (Hancock 2006) of the development of minimum level methods for cypress-dominated wetlands, it was determined that up to an 0.8 foot decrease in the Historic P50 elevation would likely not lead to significant change in the herbaceous wetlands occurring within lake basins. A wetland-offset elevation of 28.7 feet above NGVD was therefore established for Fort Cooper Lake by subtracting 0.8 feet from the Historic P50 elevation.

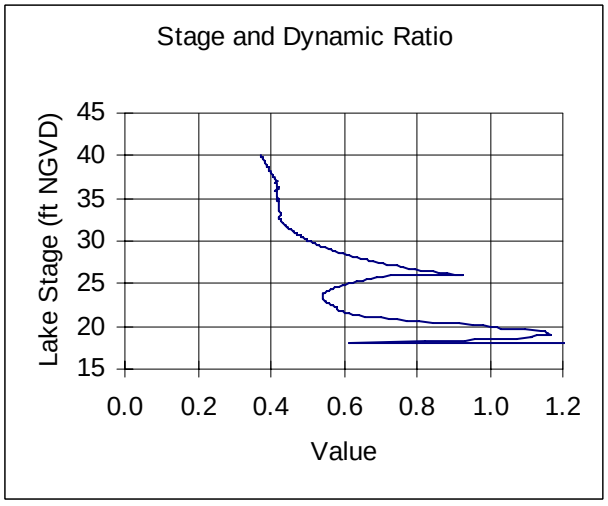
Figure 19. Surface area, volume, mean depth, maximum depth, dynamic ratio (basin slope), and potential herbaceous wetland area versus lake stage for Fort Cooper Lake.

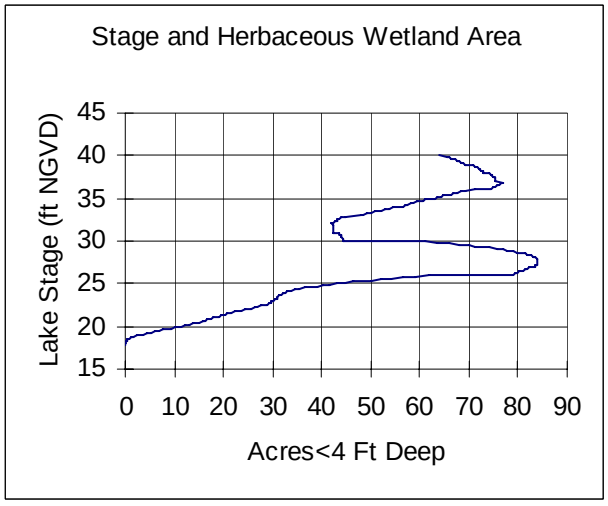












Minimum Levels

The High Minimum Lake Level and the Minimum Lake Level are developed using lake-specific significant change standards and other available information, including substantial changes in the coverage of herbaceous wetland vegetation and aquatic macrophytes; elevations associated with residential dwellings, roads or other structures; frequent submergence of dock platforms; faunal surveys; aerial photographs; typical uses of lakes (*e.g.,* recreation, aesthetics, navigation, irrigation); surrounding land-uses; socio-economic effects; and public health, safety and welfare matters. Minimum Level development is also contingent upon lake classification*, i.e.,* whether a lake is classified as a Category 1, 2 or 3 Lake.

The Minimum Lake Level is the elevation that a lake's water levels are required to equal or exceed fifty percent of the time on a long-term basis. For Category 3 Lakes, the Minimum Level is established at the elevation corresponding to the most conservative significant change standard*, i.e.,* the standard with the highest elevation, except where that elevation is above the Historic P50 elevation, in which case, the Minimum Level is established at the Historic P50 elevation. Because all appropriate significant change standards were below the Historic P50 and the Wetland Offset elevation, the Minimum Lake Level for Fort Cooper Lake was established at the Wetland Offset elevation, 28.7 feet above NGVD.

The High Minimum Lake Level is the elevation that a lake's water levels are required to equal or exceed ten percent of the time on a long-term basis. For Category 3 Lakes, the High Minimum Lake Level is developed using the Minimum Lake Level, Historic data or reference lake water regime statistics. If Historic Data are available, the High Minimum Lake Level is established at an elevation corresponding to the Minimum Lake Level plus the difference between the Historic P10 and Historic P50. If Historic data are not available, the High Minimum Lake Level is set at an elevation corresponding to the Minimum Lake Level plus the region-specific RLWR50. Because Historic data are available for Fort Cooper Lake, the High Minimum Lake Level was established at 30.1 feet above NGVD, by adding the difference between the Historic P50 and Historic P10 (1.4 feet) to the Minimum Lake Level.

Minimum and Guidance Levels for Fort Cooper Lake are shown in Figure 20 along with monthly mean water surface elevations through August 2006. Review of available data indicated that staging of the lake at the minimum levels would not cause flooding of any man-made features within the immediate lake basin (Table 7; see Figure 21 for the approximate lake margins when the water surface is at the minimum levels).

Figure 20. Mean monthly surface water elevation of Fort Cooper Lake through August 2006, and Guidance and Minimum Levels. Levels include the Ten Year Flood Guidance Level (10-YR), High Guidance Level (HGL), High Minimum Lake Level (HMLL), and Minimum Lake Level (MLL).

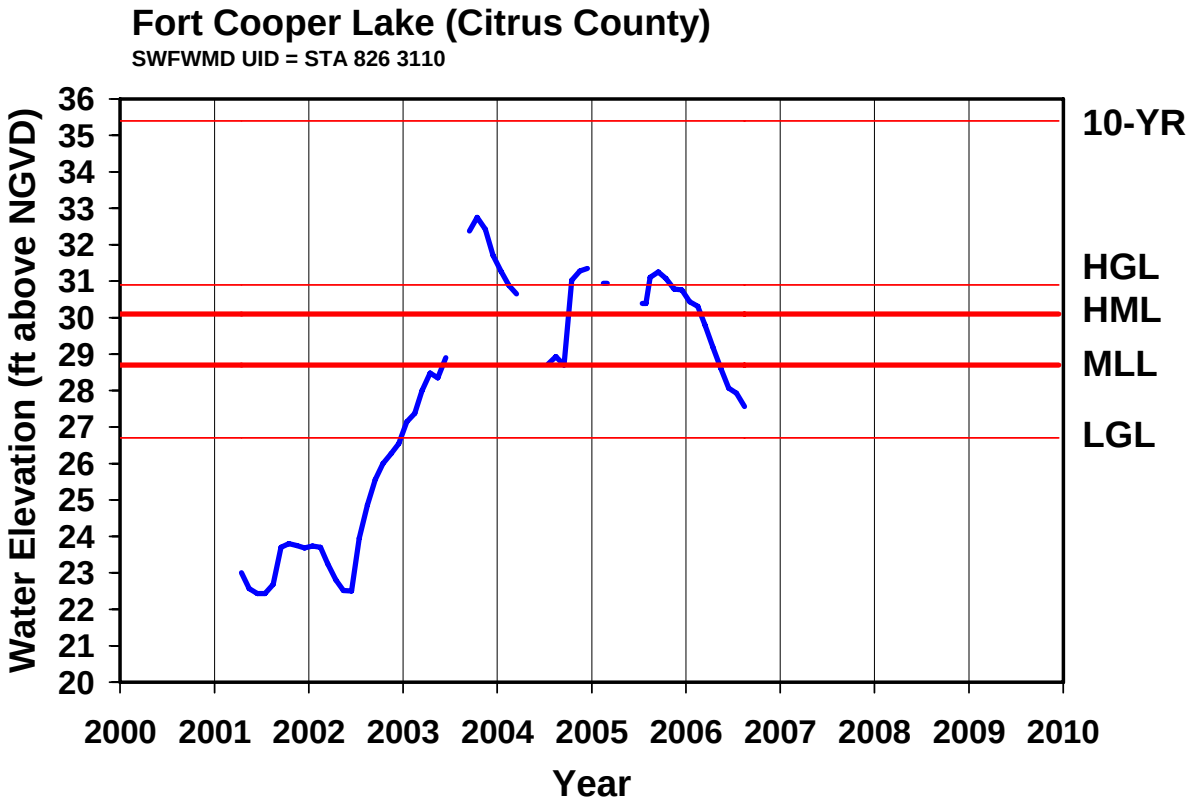
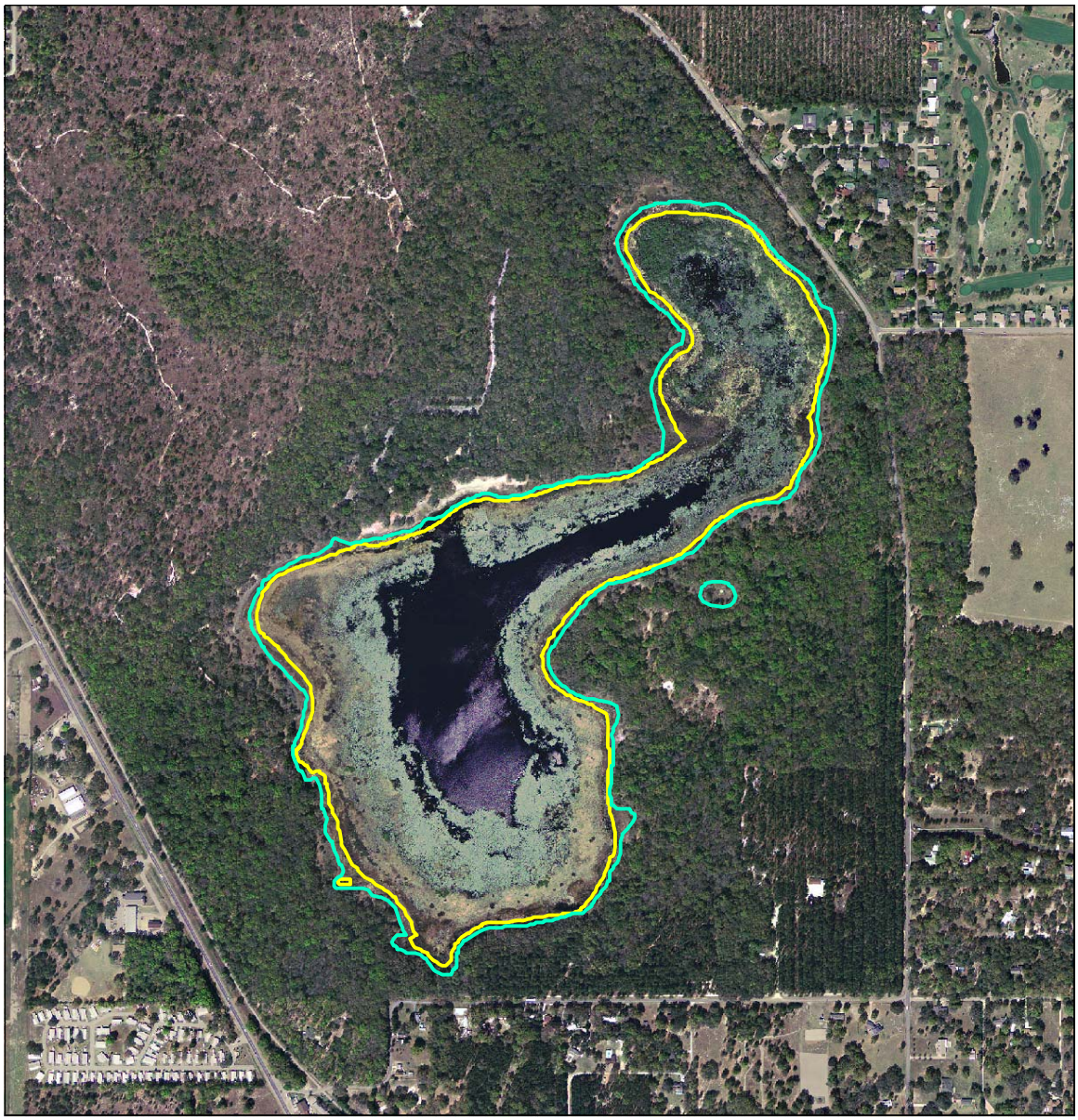


Table 7. Elevation of selected features in the immediate Fort Cooper Lake basin.

Features	Elevation (feet above NGVD)
Slab elevation for park restrooms	40.13
Concrete floor of utility shed with electricity	36.83
Low road (asphalt park road)	35.55

Figure 21. Approximate location of the Minimum Lake Level (MLL) and High Minimum Lake Level (HMLL) for Fort Cooper Lake.



Minimum Levels

MLL = 28.7 feet above NGVD

HMLL = 30.1 feet above NGVD

0 500 1,000 Feet

N

Map prepared on September 28, 2006 using elevation data from SWFWMD (1982) aerial photography with contours maps, elevation data collected by D.C. Johnson Associates (2004) and USGS (2004) digital orthophotography.

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