Minimum and Guidance Levels for

Lake Tulane

in Highlands County, Florida

December 2007

Ecologic Evaluation Section

Resource Projects Department

Southwest Florida
Water Management District

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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 (MFLs) 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". Minimum flows and levels are established and used by the Southwest Florida Water Management District for water resource planning, as one of the criteria used for evaluating water use permit applications, and for the design, construction and use of surface water management systems.

Development of a minimum flow or level does not in itself protect a water body from significant harm; however, resource protection, recovery and regulatory compliance can be supported once the flow or level standards are established. State law governing implementation of minimum flows and levels (Chapter 373.0421, F.S.) requires development of a recovery or prevention strategy for water bodies if the " existing flow or level in a water body is below, or is projected to fall within 20 years below, the applicable minimum flow or level". Recovery or prevention strategies are developed to: "(a) achieve recovery to the established minimum flow or level as soon as practicable; or (b) prevent the existing flow or level from falling below the established minimum flow or level." Periodic re-evaluation and as necessary, revision of established minimum flows and levels are also required by state law.

Minimum flows and levels are to be established based upon the best available information with consideration given to "…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.). The Florida Water Resources Implementation Rule (Chapter 62-40.473, Florida Administrative Code; hereafter F.A.C.) provides additional guidance for the establishment of minimum flows and levels, requiring 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." The Water Resource Implementation Rule also indicates that "minimum flows and levels should be expressed as multiple flows or levels defining a minimum hydrologic regime, to the extent practical and necessary to establish the limit beyond which further withdrawals would be significantly harmful to the water resources or the ecology of the area".

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 the Water Levels 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 wetlands 0.5 acres or greater in size and for those without fringing cypress wetlands 0.5 acres or greater in size. 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, lake shore residents and local governments, or to aid in the management or control of adjustable water level structures. Two Minimum Levels and two 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 are described below.

The **High Guidance Level** is provided as an advisory guideline for construction of lake shore 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 (P10) 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 (P10) 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 (P50) on a long-term basis.

The **Low Guidance Level** is provided as an advisory guideline for water dependent structures, information for lake shore 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 (P90) on a long-term basis.

In accordance with Chapter 40D-8, F.A.C., Minimum and Guidance Levels were developed for Lake Tulane (Table 1), a Category 3 Lake located in Highlands County, Florida. The levels were established using best available information, including field data that were obtained specifically for the purpose of Minimum Levels development. Because the District is currently involved in a multi-year process of migrating all vertical elevation data from the National Geodetic Vertical Datum of 1929 (NGVD 29) to the North American Vertical Datum of 1988 (NAVD 88), tables in this report include elevation data values in both NGVD 29 and NAVD 88. Elevation data values shown on graphs and the topographic contours on the bathymetric map are presented in NGVD 29.

Table 1. Minimum and Guidance Levels for Lake Tulane.

Minimum and Guidance Levels	Elevation in Feet	
	NGVD 29	NAVD 88
High Guidance Level	118.7	117.7
High Minimum Lake Level	**117.9**	116.9
Minimum Lake Level	**116.6**	115.6
Low Guidance Level	116.2	115.2

Data and Analyses Supporting Minimum and Guidance Levels for Lake Tulane

Lake Setting and Description

Lake Tulane is located in Highlands County, Florida (Sections 22 and 27, Township 33 South, Range 28 East), in the Peace River Basin of the Southwest Florida Water Management District (Figure 1). White (1970) classified the area of west-central Florida containing Lake Tulane as the Intraridge physiographic region. Brooks (1981) characterized the area surrounding the lake as the Eastern Complex of the Central Ridge unit of the Lake Wales Ridge subdivision of the Central Lake District physiographic district and described the unit as containing some residual high hills (to 220 feet) with considerable amounts of Upper Miocene coarse clastics underlying the ridge. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Southern Lake Wales Ridge lake region, and described as the Intraridge Valley where there are mostly clear-water lakes. Elevations are 70–150 feet, and soils are generally in the sandy, well-drained Astatula-Paola-Tavares association. Lakes range from acidic to alkaline, but almost all are clear with low color and low nutrients (Griffith *et al.* 1997).

The lake is located in the Carter Creek drainage basin within the Kissimmee River watershed. Surface water inflow to Lake Tulane occurs through numerous stormwater discharge pipes that convey runoff from the surrounding residential development. Because Lake Tulane does not have an outlet conveyance system that is the principal control of surface water elevations, it is considered a closed basin lake (Figure 2). There are permitted ground water withdrawals within the surrounding lake area, but there are no surface water withdrawals from the lake currently permitted by the District. A public boat ramp on the western shore provides access to the lake.

The 1953 United States Geological Survey 1:24,000 Avon Park, Fla. quadrangle map (photorevised 1972 and 1987) indicates an elevation of 117 feet above NGVD 29 (116 feet above NAVD 88) for Lake Tulane. The "Gazetteer of Florida Lakes" (Florida Board of Conservation 1969, Shafer *et al.* 1986) lists the area of Lake Tulane as 89 acres at this elevation. A topographic map of the lake basin generated in support of Minimum Levels development (Figure 3) indicates that the lake extends over 92 acres at an elevation of 117 feet above NGVD 29 (116 feet above NAVD 88).

Residential development exists along the northern, western and southern lake shore as well as most of the surrounding region. A CSX railroad line runs along the eastern shore of the lake. Dominant plant species observed along the shoreline include, torpedo grass (*Panicum repens*), and maidencane (*Panicum hemitomon*), along with smaller areas of cattail (*Typha sp.*), flat sedge (*Cyperus oderatus*), Carolina willow (*Salix caroliniana*), rush fuirena (*Fuirena scirpoidea*), southern naiad (*Najas guadalupensis*), and stonewort (*Nitella sp.*).

Figure 1. Location of Lake Tulane in Highlands County, Florida.

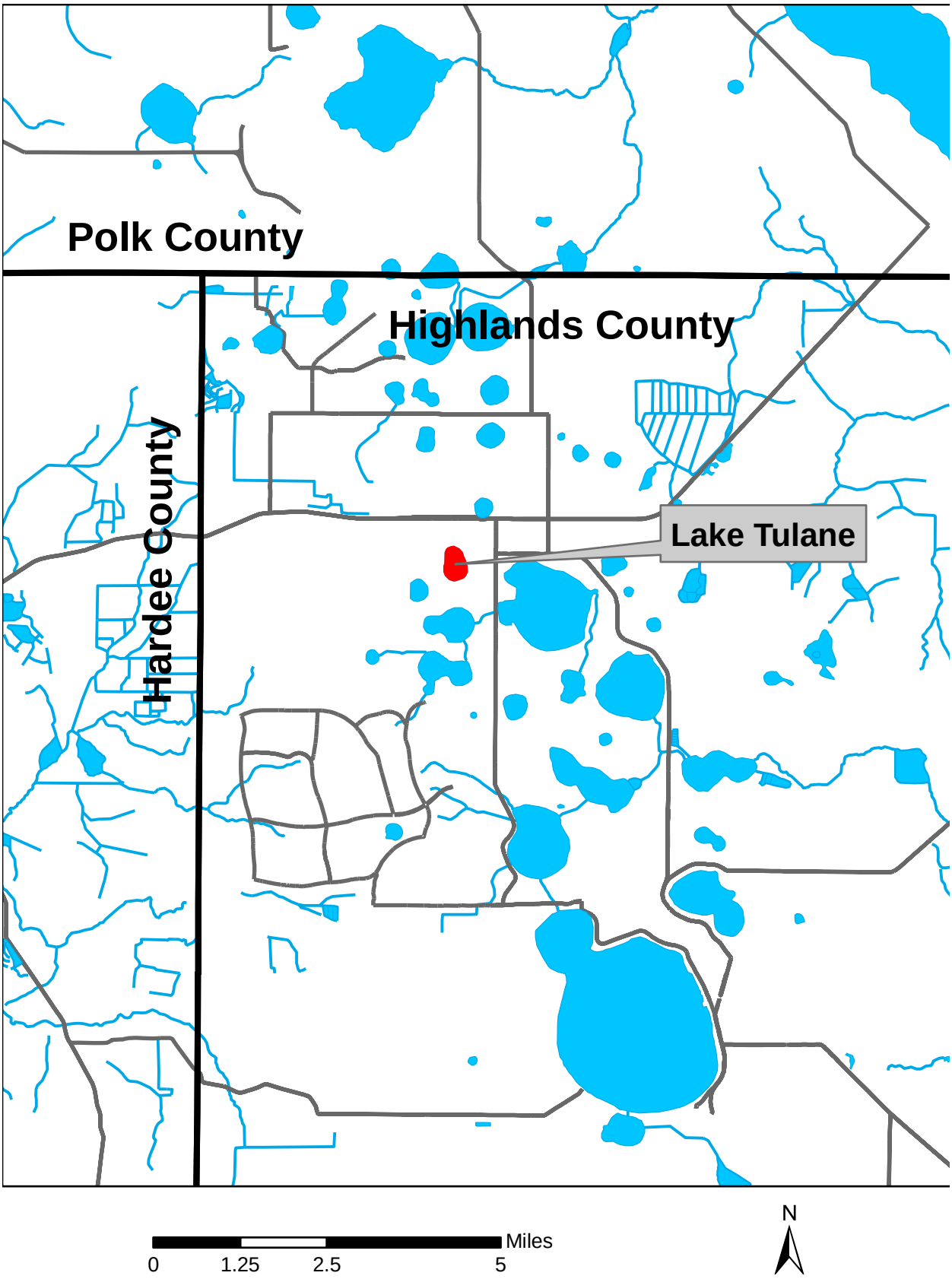
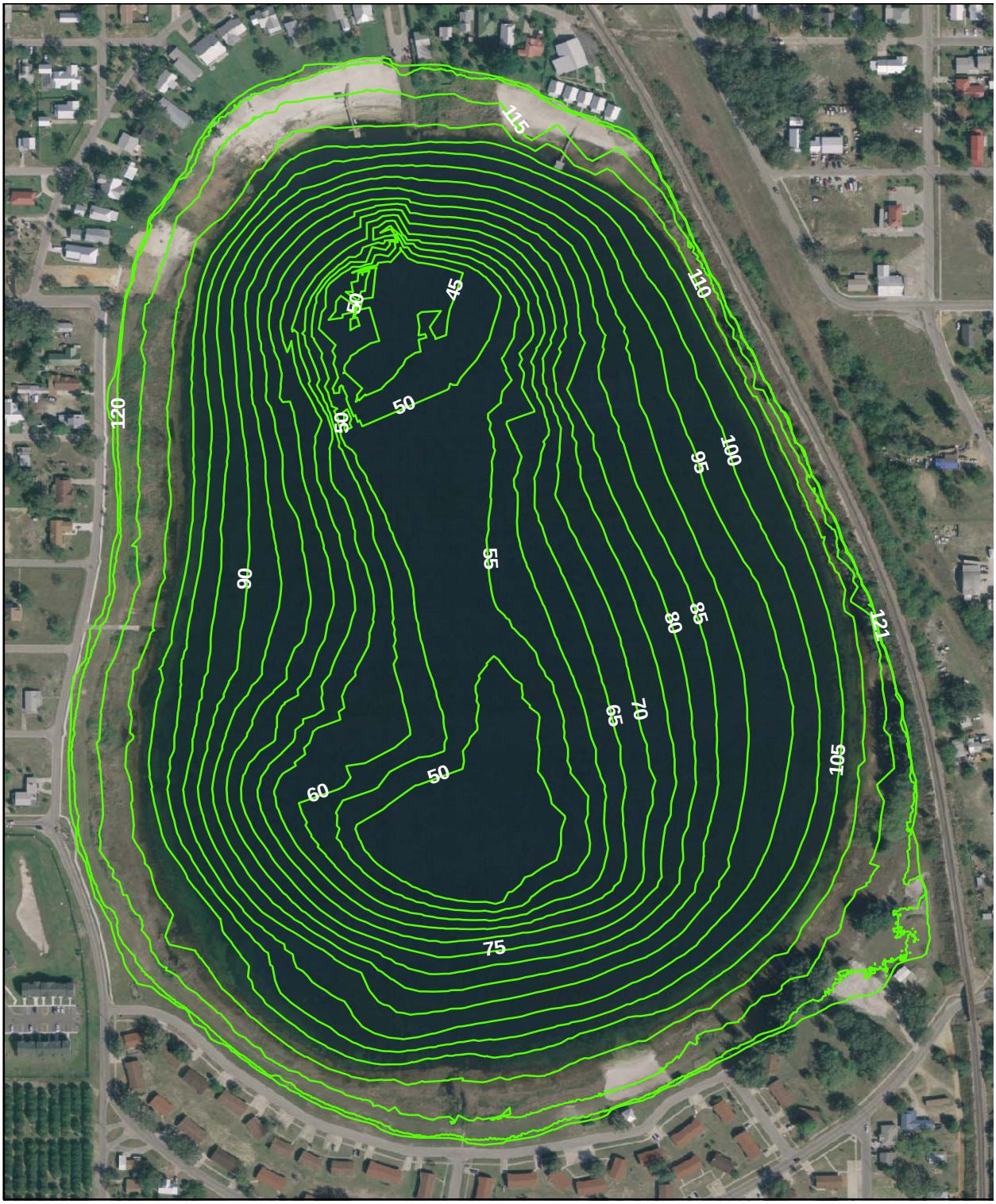


Figure 2. Location of the lake water level gage and public boat ramp for Lake Tulane.

Figure 3. Five-foot contours within the Lake Tulane basin. Values shown are elevations in feet above NGVD 29.



Map prepared using 2007 true color digital ortho photography, spot elevation data collected in 2007 by D.C. Johnson and Associates, Inc., and LiDAR data collected in 2005 by EarthData International, Inc.

N

0 200 400 800 Feet

Currently 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 an initiative for establishing lake management levels based on hydrologic, biological, physical and cultural aspects of lake ecosystems. By 1996, management levels for nearly 400 lakes had been established.

Based on work conducted in the 1970s (see SWFWMD 1996), the District Governing Board adopted management levels (currently referred to as Guidance Levels) for Lake Tulane in October 1981. These levels have been incorporated into Chapter 40D-8, F.A.C. (Table 2). A Maximum Desirable Level of 119.00 feet above NGVD 29 (118.00 feet above NAVD 88) was also developed, but was not adopted. The adopted Guidance Levels and Maximum Desirable Level were developed using a methodology that differs from the current District approach for establishing Minimum and Guidance Levels. The levels do not, therefore, necessarily correspond with levels developed using current methods. Minimum and Guidance Levels developed using current methods will replace existing Guidance Levels upon adoption by the District Governing Board into Chapter 40D-8, F.A.C.

Annually since 1991, a list of stressed lakes has been developed to support the District's consumptive water use permitting program. As described in the District's Consumptive Use of Water Rule (Chapter 40D-2, F.A.C.), "a stressed condition for a lake is defined to be chronic fluctuation below the normal range of lake level fluctuations". For lakes with adopted Guidance Levels, chronic fluctuation below the Low Level is considered a stressed condition. For lakes without adopted levels, evaluation of stressed condition is conducted on a case-by-case basis. Lake Tulane is considered a stressed lake and is included on the 2007 Stressed Lakes List (Gant 2007).

Table 2. Adopted Guidance Levels for Lake Tulane.

Guidance Levels	Elevation in Feet	
	NGVD 29	NAVD 88
Ten Year Flood Guidance Level	120.50	119.50
High Level	120.00	119.00
Low Level	116.00	115.00
Extreme Low Level	114.00	113.00

Summary Data Used for Development of Minimum and Guidance Levels

Minimum and Guidance Levels for Lake Tulane were developed using the methodology for Category 3 Lakes described in Chapter 40D-8, F.A.C. The levels and additional information are listed in Table 3, along with lake surface areas for elevations in NGVD 29. Detailed descriptions of the development and use of these data are provided in the remainder of this report.

Table 3. Minimum and Guidance Levels, Historic P50, lake stage percentiles, normal pool and control point elevations, and significant change standards for Lake Tulane.

Levels	Elevation in Feet		Lake Area (acres)
	NGVD 29	NAVD 88	
Lake Stage Percentiles			
Historic P10*	118.7	117.7	95
Historic P50*	117.4	116.4	93
Historic P90*	116.2	115.2	91
Current P10	116.1	115.1	91
Current P50	112.6	111.6	83
Current P90	110.2	109.2	79
Normal Pool and Control Point			
Normal Pool	NA	NA	NA
Control Point	NA	NA	NA
Significant Change Standards			
Wetland Offset Elevation	116.6	115.6	92
Aesthetics Standard	116.2	115.2	91
Species Richness Standard	110.5	109.5	79
Recreation/Ski Standard	78.2	77.2	36
Basin Connectivity Standard	56.5	55.5	15
Dock-Use Standard	NA	NA	NA
Lake Mixing Standard	NA	NA	NA
Minimum and Guidance Levels			
High Guidance Level	118.7	117.7	95
High Minimum Lake Level	**117.9**	116.9	94
Minimum Lake Level	**116.6**	115.6	92
Low Guidance Level	116.2	115.2	91

NA = not available/not appropriate

* = based on modeled surface water elevations

Lake Stage Data and Exceedance Percentiles

Lake stage data, *i.e.,* surface water elevations for Lake Tulane (District Universal Identification Number STA 11 11) were obtained from the District's Water Management Data Base (WMDB). Lake stage data in the WMDB for Lake Tulane are recorded in feet above NGVD 29. The period of record for the data extends from June 1981 through the present date (Figure 4, see Figure 2 for current location of the SWFWMD lake water level gauge). The highest surface water elevation for Lake Tulane recorded in the Water Management Data Base, 117.60 feet above NGVD 29 (116.60 feet above NAVD 88), occurred on November 4, 2005. The low of record, 106.84 feet above NGVD 29 (105.84 feet above NAVD 88), occurred on June 21, 2001. The data record for Lake Tulane is not continuous, *i.e.*, there are some months during the period of record when lake surface elevations were not recorded.

For the purpose of Minimum Levels determination, lake stage data are classified 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, or highest stable point along the outlet conveyance system of a lake, to the degree that water level fluctuations are affected. Lake stage data are classified 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 Lake Tulane from June 1981 through December 2006 were classified as Current data (see Table 3 for lake stage percentile elevations). Because Historic lake stage data are not available, a Historic composite data set of monthly mean lake surface elevations for Lake Tulane was developed using a sixty-year record of modeled lake surface elevations for the period January 1946 through December 2005. The composite sixty-year record is based on lake stage data for Lake Tulane, Historic lake stage data for Lake Letta (District Universal Identification Number STA 294 294), and rainfall data measured at the Avon Park rain gage site (District Universal Identification Number STA 146 146) in Polk County (SWFWMD, draft report, 2007) (Figure 5). 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.

The Historic composite data set of modeled lake surface elevations was used to calculate the **Historic P10, P50, and P90** lake stage percentile elevations. The Historic P10 elevation, the elevation the lake water surface equaled or exceeded ten percent of the time during the historic period, was **118.7 feet above NGVD 29** (117.7 feet above NAVD 88). The Historic P50 elevation, the elevation the lake water surface equaled or exceeded fifty percent of the time during the historic period, was **117.4 feet above NGVD 29** (116.4 feet above NAVD 88). If Historic data were not available, the Historic P50 would be estimated using Current data, reference lake water regime (RLWR)

Figure 4. Measured surface water elevations in feet above NGVD 29 through December 2006 for Lake Tulane.

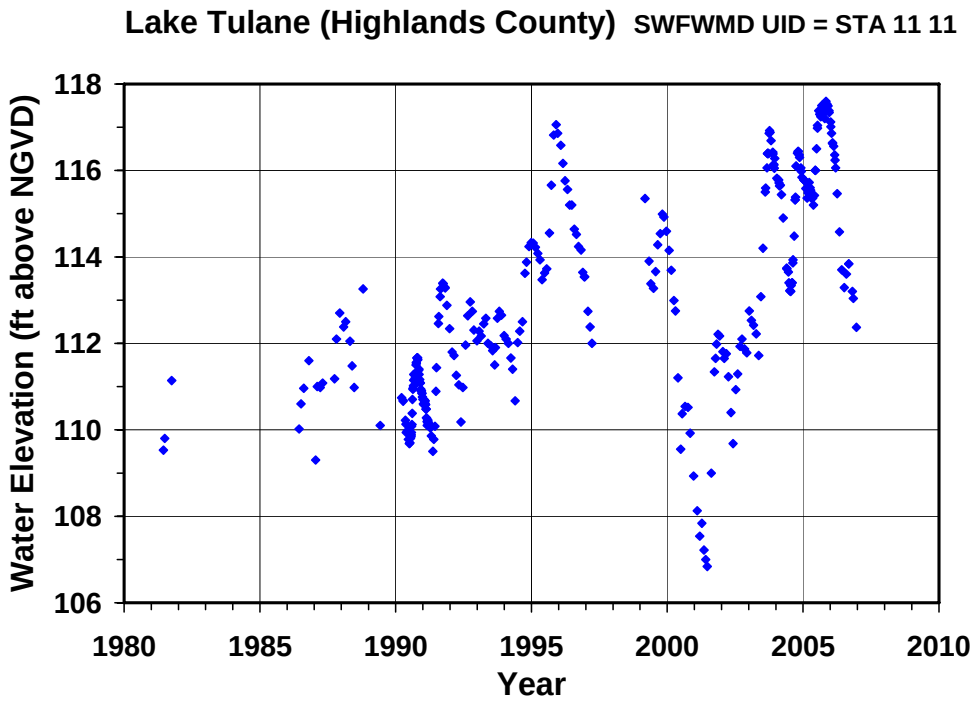
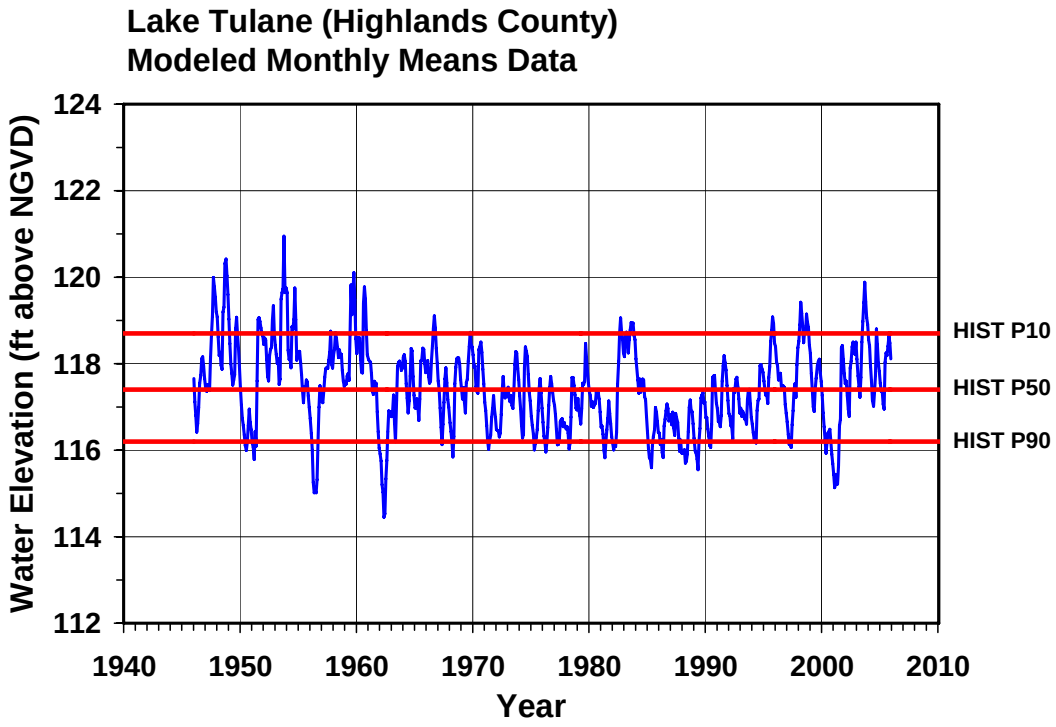


Figure 5. Modeled monthly-means surface water elevations in feet above NGVD 29 for the composite data set from January 1946 through December 2005 for Lake Tulane, and the Historic P10, P50, and P90 lake stage percentile elevations.



statistics, and the High Guidance Level. The Historic P90 elevation, the elevation the lake water surface equaled or exceeded 90 percent of the time during the historic period, was **116.2 feet above NGVD 29** (115.2 feet above NAVD 88).

Normal Pool Elevation, Control Point Elevation and Structural Alteration Status

The **Normal Pool** elevation, a reference elevation used for development of minimum lake and wetland levels, is established based on the elevation of Hydrologic Indicators of sustained inundation. Because Hydrologic Indicators of Normal Pool do not exist on Lake Tulane, **establishment of the Normal Pool elevation is not possible**.

The **Control Point** elevation is the elevation of the highest stable point along the outlet profile of a surface water conveyance system (*e.g.,* structure, ditch, culvert, or pipe) that is the principal control of water level fluctuation in the lake. Based on review of one-foot contour interval maps and field survey data, it was determined that Lake Tulane does not have an outlet conveyance system that is the principal control of surface water elevations within the lake. The lake is considered a closed-basin system and **there is no Control Point elevation** (Figure 2).

Structural Alteration Status is determined to support development of Minimum and Guidance Levels. Because there is no outlet or Control Point elevation controlling surface water elevations, **Lake Tulane is not considered to be Structurally Altered**.

Guidance Levels

The **High Guidance Level** is provided as an advisory guideline for construction of lake-shore development, water dependent structures, and operation of water management structures. The High Guidance Level is the expected Historic P10 of the lake. Because Historic data are available, the High Guidance Level was established at **118.7 feet above NGVD 29** (117.7 feet above NAVD 88), the Historic P10 elevation.

The **Low Guidance Level** is provided as an advisory guideline for water dependent structures, information for lake shore 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 (P90) on a long-term basis. The level is established using Historic or Current data, and in some cases, RLWR statistics. Because Historic data are available, the Low Guidance Level was established at **116.2 feet above NGVD 29** (115.2 feet above NAVD 88), the Historic P90 elevation.

Lake Classification

Lakes are classified as Category 1, 2, or 3 for the purpose of Minimum Levels development. Those with fringing cypress wetlands greater that 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 an 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 Lake Tulane does not have fringing cypress wetlands, it is classified as a **Category 3 Lake.**

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 for Category 3 Lakes. The standards are used to identify thresholds for preventing significant harm to cultural and natural system values associated with lakes in accordance with guidance provided in the Florida Water Resources Implementation Rule (Chapter 62-40.473, F.A.C.). Other information taken into consideration includes potential changes in the coverage of herbaceous wetland vegetation and aquatic plants.

Six significant change standards are developed, including a Species Richness Standard, an Aesthetics Standard, a Lake Mixing Standard, a Recreation/Ski Standard, a Dock-Use Standard, and a Basin Connectivity Standard. Although potential changes in the coverage of herbaceous wetland vegetation and aquatic plants associated with use of the standards is taken into consideration in the development of Minimum Levels, there is no significant change standard to determine a threshold for preventing significant harm to fringing non-cypress wetlands. Based on the Cypress Wetland Standard for Category 1 Lakes, however, a Wetland Offset Elevation was developed for Category 3 Lakes to provide protection for non-cypress fringing wetlands. Since Lake Tulane is a Category 3 Lake system, the applicable significant change standards and the Wetland Offset Elevation were developed (Table 3).

The **Wetland Offset Elevation** is developed to protect lake fringing non-cypress wetlands. Based on the rationale used to develop the Cypress Wetland Standard for Category 1 Lakes (1.8 feet below the Normal Pool elevation), a Wetland Offset Elevation for Category 3 Lakes was developed. Because Hydrologic Indicators of sustained inundation used to determine the Normal Pool elevation usually do not exist on Category 3 Lakes, another datum, in this case the Historic P50 elevation, was used in the development of the Wetland Offset Elevation. Based on an evaluation of the relationship of the Cypress Wetland Standard with the Historic P50 for hydrologically unimpacted cypress wetlands, the Wetland Offset Elevation for Category 3 Lakes was established at an elevation 0.8 feet below the Historic P50 elevation (Hancock, draft report, 2007). For Lake Tulane, the Wetland Offset Elevation was established at **116.6 feet above NGVD 29** (115.6 feet above NAVD 88).

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 becoming degraded below the values

associated with the lake when it is staged at the Low Guidance Level. The Aesthetic Standard was established at the Low Guidance Level, which is **116.2 feet above NGVD 29** (115.2 feet above NAVD 88).

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 Florida lakes, the standard is established at the lowest elevation associated with less than a 15 percent reduction in lake surface area relative to the lake area at the Historic P50 elevation. For Lake Tulane, the Species Richness Standard was established at **110.5 feet above NGVD 29** (109.5 feet above NAVD 88).

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 feet, or a rectangular 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 Historic data are available, the Recreation-Ski Standard was established at **78.2 feet above NGVD 29** (77.2 feet above NAVD 88) based on the sum of the ski elevation (77.0 feet above NGVD 29, 76.0 feet above NAVD 88) and the difference between the Historic P50 and the Historic P90 (1.2 feet).

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 uses. The standard is based on the elevation of lake sediments at a critical high spot between lake basins or lake sub-basins, a water depth requirement 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. Because Historic data are available, the Basin Connectivity Standard was established at **56.5 ft above NGVD** (55.5 feet above NAVD 88), based on the sum of the critical high spot elevation (53.3 feet above NGVD 29, 52.3 feet above NAVD 88), the clearance value for power boats and movement of biota (2 feet), and the difference between the Historic P50 and Historic P90 (1.2 feet).

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. Because only two dock platforms are located on Lake Tulane, **there is not enough information to develop the Dock-Use Standard**.

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 <0.8. Because the dynamic ratio does not shift across the 0.8 threshold, **the Lake Mixing Standard is not applicable** (Figure 6).

Minimum Levels

The method used for establishing Minimum Levels for a lake is dependent on its lake category. For Category 1 Lakes, the High Minimum Lake Level and Minimum Lake Level are established 0.4 feet and 1.8 feet below the Normal Pool elevation, respectively. For Category 2 Lakes, the High Minimum Lake Level is established at the High Guidance Level, and the Minimum Lake Level at the Historic P50 elevation. For Category 3 Lakes, the High Minimum Lake Level is established using Historic data or region-specific reference lake water regime statistics, and the Minimum Lake Level using lake-specific significant change standards or the Historic P50 elevation. Other available information taken into consideration in the establishment of Minimum Levels for all three lake categories includes: 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, and irrigation); surrounding land-uses; socio-economic effects; and public health, safety and welfare matters.

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 Minimum Lake Level for Category 3 Lakes 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 Lake Level is established at the Historic P50 elevation. Using current rule criteria, the Minimum Lake Level for Lake Tulane could be established at the Aesthetics Standard (116.2 feet above NGVD 29, 115.2 feet above NAVD 88). However, because the Wetland Offset Elevation is higher than the Aesthetics Standard, the Minimum Lake Level was established at the Wetland Offset Elevation, **116.6 feet above NGVD 29** (115.6 feet above NAVD 88), which is lower than the Historic P50, but higher than the significant change standards below the Historic P50 (Figures 7 and 8). Review of changes in potential wetland area in relation to change in lake stage indicated there would not be a substantial increase or decrease in potential wetland area within the lake basin at the Minimum Lake Level (9.1% of the lake basin) relative to the potential wetland area at the Historic P50 elevation (8.7% of the lake basin) (Figure 6).

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. Because Lake Tulane is a Category 3 lake and Historic data are available, the High Minimum Lake Level was established at **117.9 feet above NGVD 29** (116.9 feet above NAVD 88), an elevation corresponding to the Minimum Lake Level elevation plus the difference between the Historic P10 and the Historic P50 (1.3 feet) (Figures 7 and 8).

Figure 6. Surface area, maximum depth, mean depth, volume, dynamic ratio (basin slope), and potential herbaceous wetland area versus lake stage in feet above NGVD 29 for Lake Tulane.

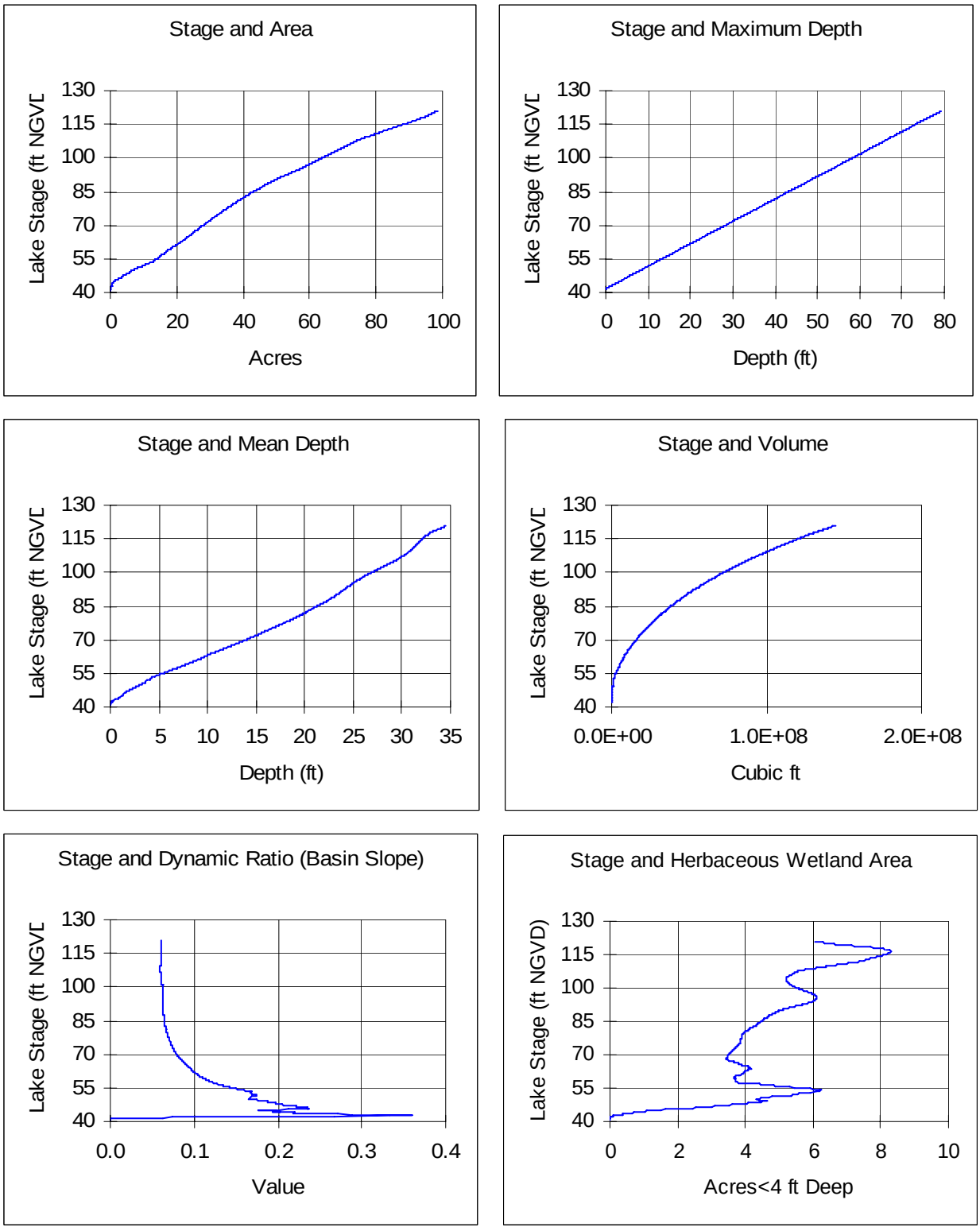


Figure 7. Mean monthly surface water elevations in feet above NGVD 29 through December 2006 based on measured lake stage records, and Minimum and Guidance Levels for Lake Tulane. Levels include the High Guidance Level (HGL), Low Guidance Level (LGL), High Minimum Lake Level (HMLL), and Minimum Lake Level (MLL).

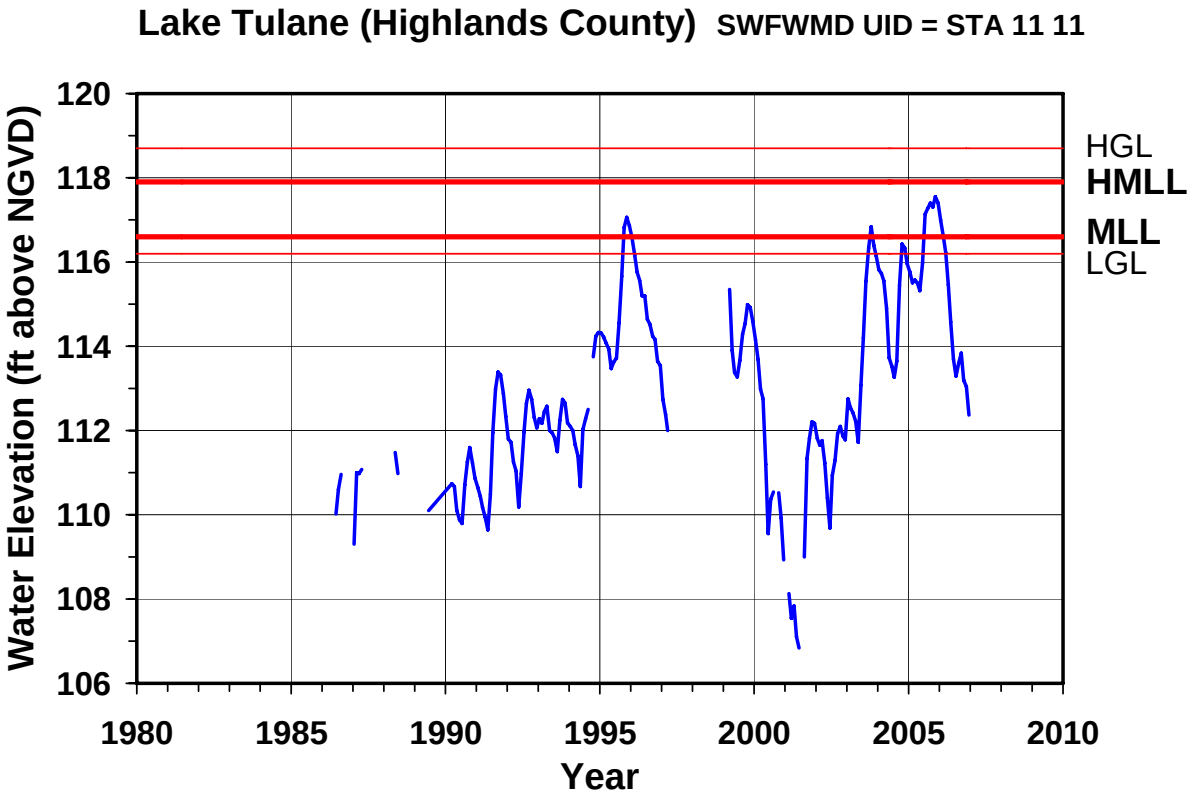


Figure 8. Approximate location of the Minimum Lake Level (MLL) and High Minimum Lake Level (HMLL) for Lake Tulane.

Legend

Tulane Minimum Levels

116.6 feet above NGVD 29 = MLL

117.9 feet above NGVD 29 = HMLL

N

0 200 400 800 Feet

Map prepared using 2007 true color digital ortho photography, spot elevation data collected in 2007 by D.C. Johnson and Associates, Inc., and LiDAR data collected in 2005 by EarthData International, Inc.

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