Minimum and Guidance Levels for Lake Linda in Pasco County, Florida

March 19, 2008

Ecologic Evaluation Section
Resource Projects Department

Southwest Florida
Water Management District

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Brooksville, Florida 34604-6899

Cover: Lake Linda shoreline in 2003 (Southwest Florida Water Management District files).

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Minimum and Guidance Levels for Lake Linda

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 flow for a given watercourse "shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area", and 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".

The Southwest Florida Water Management District has developed specific methodologies for establishing minimum flows or levels for lakes, wetlands, rivers and aquifers, subjected the methodologies to independent, scientific peer-review, and incorporated the methods 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 levels expected to fully maintain the integrity of the wetlands are classified as Category 2 Lakes. Lakes without at least 0.5 acre of 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. Information regarding the development of adopted methods for establishing Minimum and Guidance lake levels is provided in Southwest Florida Water Management District (1999a, b), Leeper *et al.* (2001) and Leeper (2006). Peer-review findings regarding the lake level methods are available in Bedient *et al.* (1999), Dierberg and Wagner (2001) and Wagner and Dierberg (2006).

Two Minimum Levels and three Guidance Levels have typically been established for lakes, and upon adoption by the District Governing Board, 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 October 2007, the District Governing Board approved rule amendments pertaining to the elimination of Ten Year Flood Guidance Levels and references to the levels from Chapter 40D-8, F.A.C. Work related to the development of ten-year flood levels and other flood-recurrence levels is currently conducted through the District Watershed Management Program, and information pertaining to flood levels is included in watershed management plans that result from program activities.

In accordance with Chapter 40D-8, F.A.C., proposed Minimum and Guidance Levels were developed for Lake Linda, a Category 3 Lake located in Pasco County, Florida (Southwest Florida Water Management District 2007a). The levels were established using best available information, including data that were obtained specifically for the purpose of minimum levels development. Following a public input process, the District Governing Board approved adoption of the proposed levels on December 18, 2007 and the levels (Table 1) were subsequently incorporated into Chapter 40D-8, F.A.C. The data and analyses used for development of the adopted levels are described in the remainder of this report.

Table 1. Minimum and Guidance Levels for Lake Linda.

Minimum and Guidance Levels	Elevation (feet above NGVD)
High Guidance Level	66.3
High Minimum Lake Level	66.2
Minimum Lake Level	64.7
Low Guidance Level	63.6

Data and Analyses Supporting Development of Minimum and Guidance Levels for Lake Linda

Lake Setting and Description

Lake Linda is located in south-central Pasco County, Florida (Section 26, Township 26 South, Range 18 East) in the Pinellas-Anclote River Basin of the Southwest Florida Water Management District (Figures 1 and 2). White (1970) classified the region of central or mid-peninsular Florida containing Lake Linda as the Northern Gulf Coastal Lowlands. Brooks (1981) categorized the area surrounding the lake as the Land O' Lakes subdivision of the Tampa Plain division of the Ocala Uplift District, and described the region as a plain with numerous small lakes imbedded in moderately thick silty-sand deposits lying above the Tampa Limestone formation. As part of the Florida Department of Environmental Protection's Lake Bioassessment/ Regionalization Initiative, the area has been identified as the Land-O-Lakes Region (Griffith *et al.* 1997). and described as an area of neutral to slightly alkaline, low to moderate nutrient, clear-water lakes interspersed in sandy uplands (Griffith *et al.* 1997).

Uplands in the immediate lake basin are used primarily for medium and high-density residential development (Figure 3). Historical photography (Figures 4-14) of the lake vicinity indicates that by the late 1930s, land alterations for agricultural purposed were already occurring within the immediate lake watershed. Construction of ditches for drainage and connection of the lake with other basins was evident by the late 1950s and continued into the 1970s. Residential development in the lake vicinity appears to have increased significantly by the early 1970s, continuing through recent times with the construction of a subdivision on land formerly used for citrus production along the northeastern lakeshore. There are no public boat ramps or parklands located on the lakeshore.

Wetland vegetation within the basin includes spatterdock (*Nuphar luteum*), water lily (*Nymphaea* c.f. *odorata*), pondweed (Potamogeton sp.), water pennywort (*Hydrocotyle* sp.), water primrose (*Ludwigia* sp.), willow (*Salix* sp.), cattail (*Typha* sp.), duck potato (*Sagittaria lancifolia*), *pickerelweed (Pontederia cordata),* bulrush (*Scirpus* sp.) and torpedograss *(Panicum repens).* The lake is not contiguous with any cypress (*Taxodium* sp.) dominated wetlands.

Lake Linda lies within the Upper Rocky Creek drainage basin in the Tampa Bay and Coastal Areas watershed (United States Geological Survey Hydrologic Unit Classification System), and has a drainage area of approximately 0.13 square miles (Ardaman & Associates, Inc. 2007). An inlet along the south shore provides conveyance into the basin from a wetland located between Lake Linda and Como Lake (Figures 2 and 3). Stormwater systems associated with a lakeshore development and State Road 54 provide conveyance from the lake when the lake water surface elevation exceeds 65.6 feet above the National Geodetic Vertical Datum of 1929 (NGVD). The systems include several water control structures, stormwater ponds and natural wetland

areas that direct flow towards Camp Lake (Figure 15). The current lake outlet system differs considerably from the system that was in place prior to the widening of State Road 54 and construction of the current residential development along the northeastern lake shore in the early 2000s (see Figures 3-5). A District survey from 2001 (Southwest Florida Water Management District 2001) indicates that at that time the controlling elevation for discharge from the lake was 64.8 feet above NGVD at a high spot in a ditch that connected the north shore of the lake with a borrow pit approximately 175 feet north of the lake. There are no surface withdrawals from the lake permitted by the District. Twelve currently permitted groundwater withdrawal sites are, however, located within one mile of the lake shoreline (Figure 16). The sites are permitted for a total daily average withdrawal of 513,600 gallons per day.

Lake Linda is not included in the "Gazetteer of Florida Lakes" (Florida Board of Conservation 1969, Shafer *et al.* 1986). The 1943 U.S. Geological Survey 1:24,000 Lutz quadrangle 7.5 minute topographic map does not include a water surface elevation for the lake, but the 1974 (and 1987 photorevised) versions of the map show the lake surface at an elevation of 66 feet above NGVD (see Figure 17 for an excerpted image from the most recent United States Geological Survey topographic map of the lake area). A topographic map of the lake basin generated in support of minimum levels development (Figure 18) indicates that the lake extends over 27 acres when it is staged at 66 feet above NGVD. Lake water surface elevations are currently monitored at a District-maintained gauge site located along the north shore of the lake (Figure 2).

Figure 1. Location of Lake Linda, other regional water bodies, highways and major roads in and around Pasco County, Florida (image sources: Southwest Florida Water Management District 2003a, c, d and United States Geological Survey 2004b).

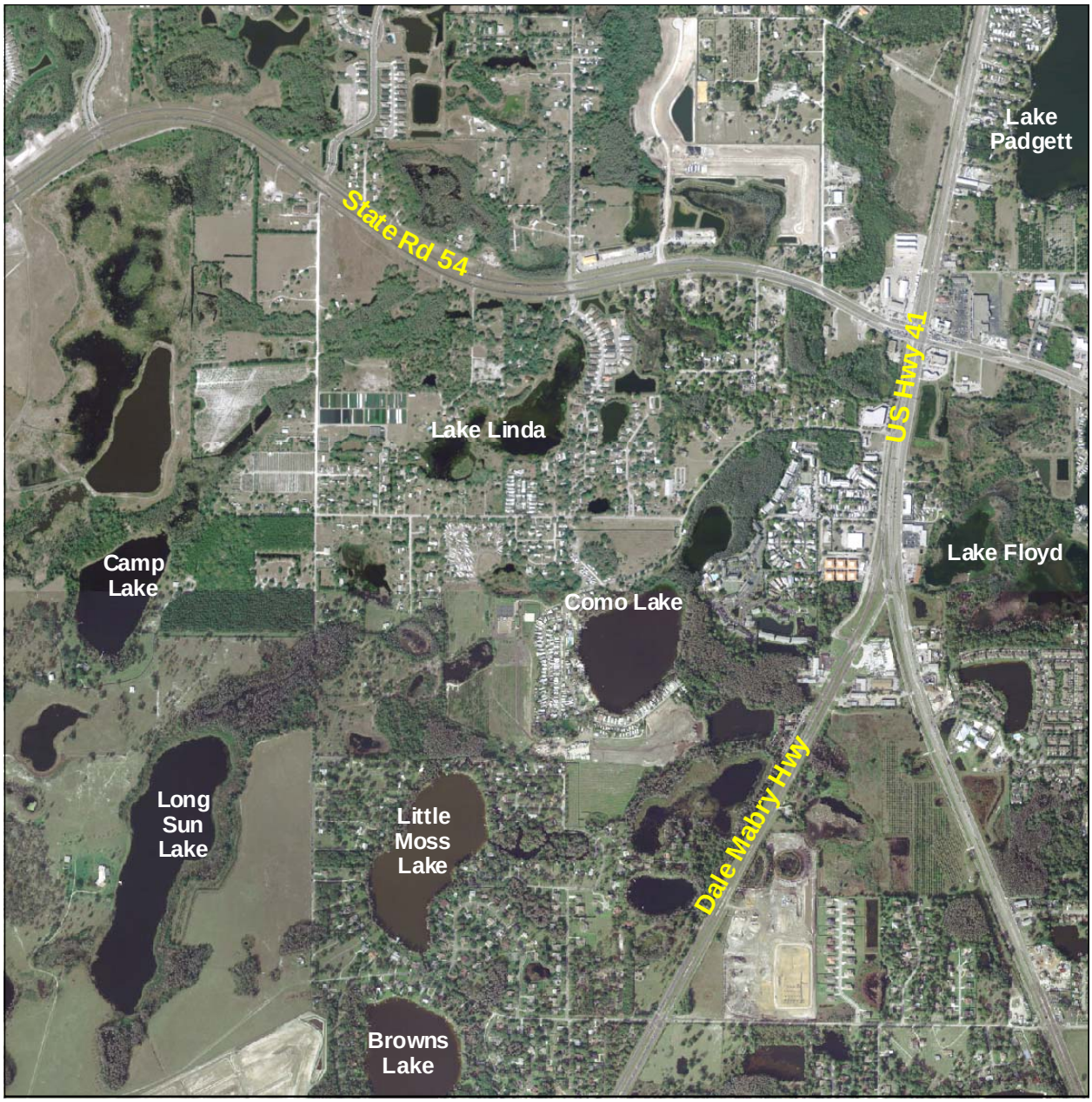


Figure 2. Aerial photograph of Lake Linda and other nearby lakes (photographic image source: EarthData International 2007).

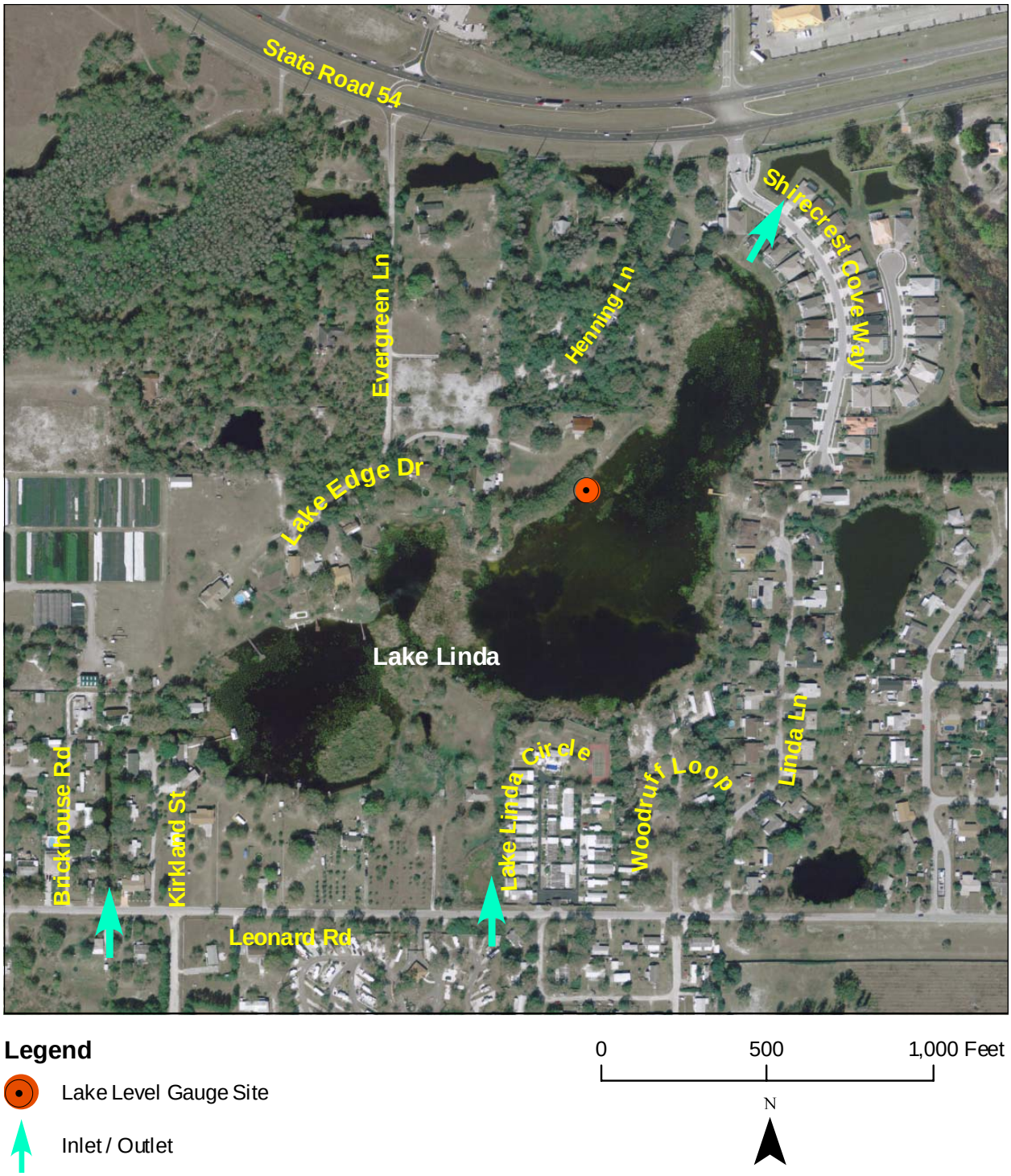


Figure 3. Aerial photograph of the immediate Lake Linda area in 2007 showing names of selected roads and the locations of the District lake-level gauge and lake inlets/outlets (photographic image source: EarthData International 2007).

Figure 4. Aerial photograph of Lake Linda in 2004 (image source: EarthData International 2004b).

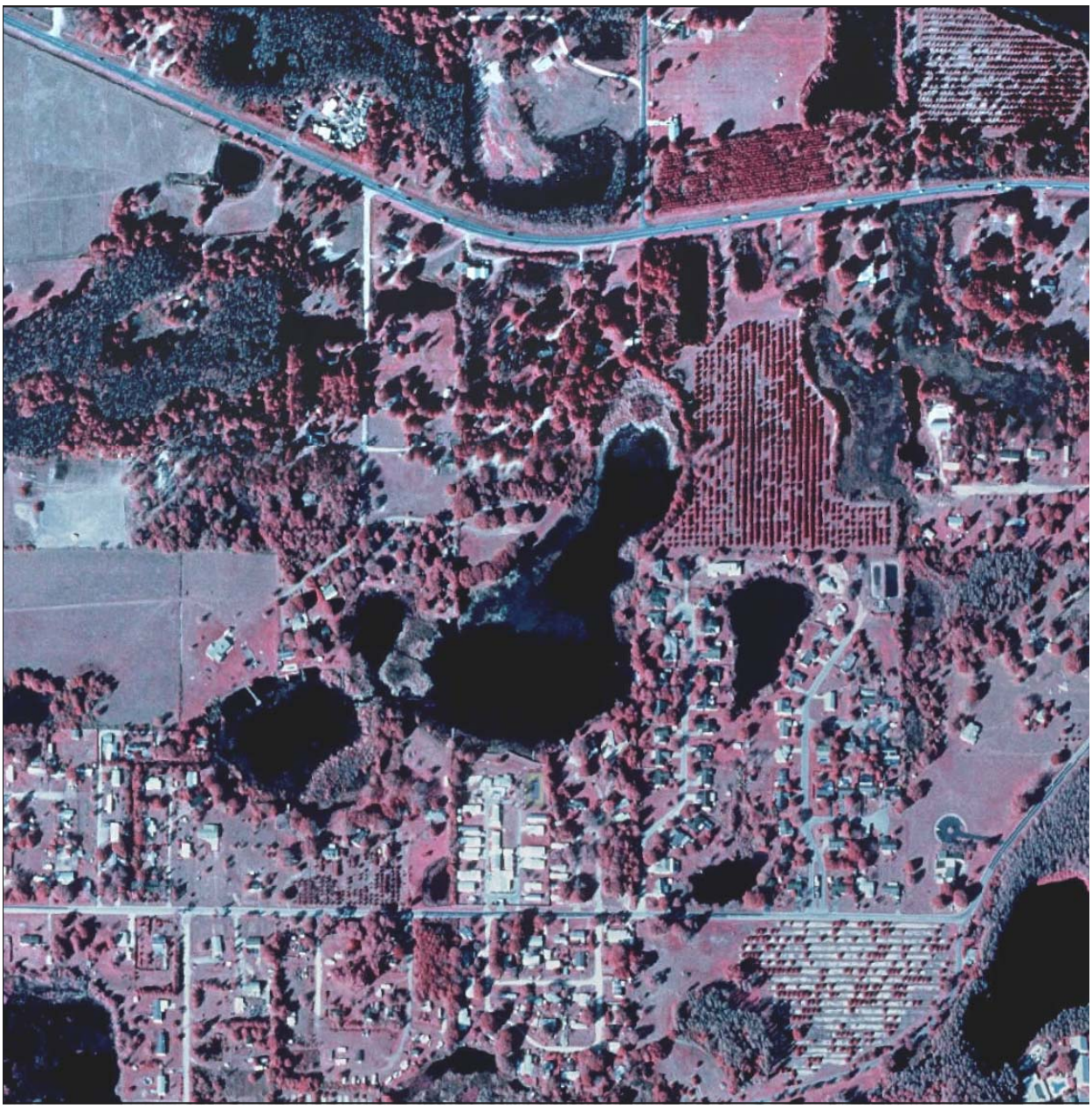


Figure 5. Aerial infrared photograph of Lake Linda in 1999 (image source: Southwest Florida Water Management District 2002a).

Figure 6. Aerial infrared photograph of Lake Linda in 1994 (image source: Southwest Florida Water Management District, date unknown).

Figure 7. Aerial infrared photograph of Lake Linda in 1984 (image source: United States Geological Survey 2004a).

Figure 8. Aerial photograph of Lake Linda in 1973. (image source: Woolpert, Inc. 2005a).

Figure 9. Aerial photograph of Lake Linda in 1968 (image source: United States Department of Agriculture 1968).

Figure 10. Aerial photograph of Lake Linda in 1957 (image source: United States Department of Agriculture 1957a).

Figure 11. Aerial photograph of Lake Linda in 1952 (image source: United States Department of Agriculture 1952).

Figure 12. Aerial photograph of Lake Linda in 1948 (image source: United States Department of Agriculture 1948).

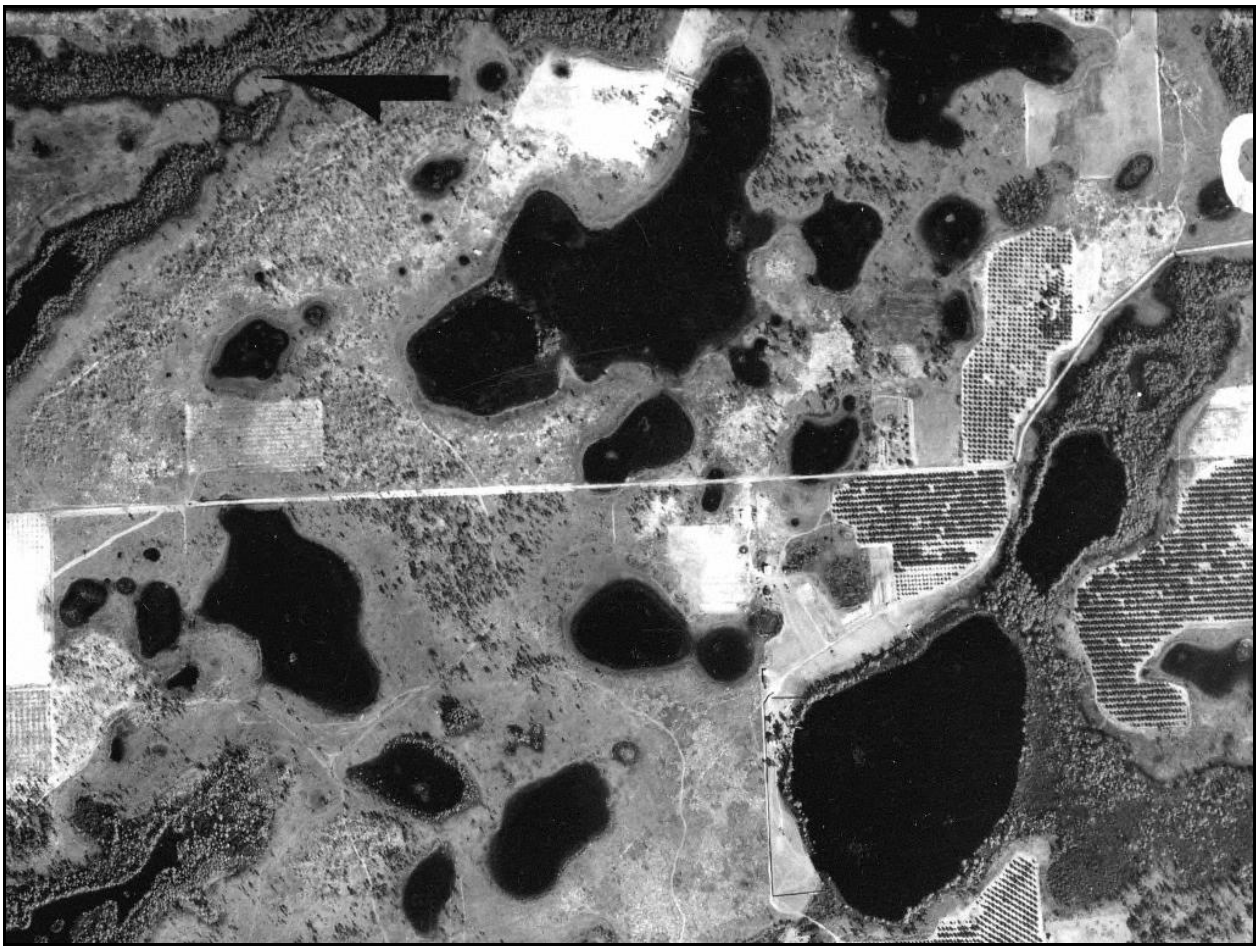


Figure 13. Aerial photograph of Lake Linda in 1941 (image source: United States Department of Agriculture 1941).

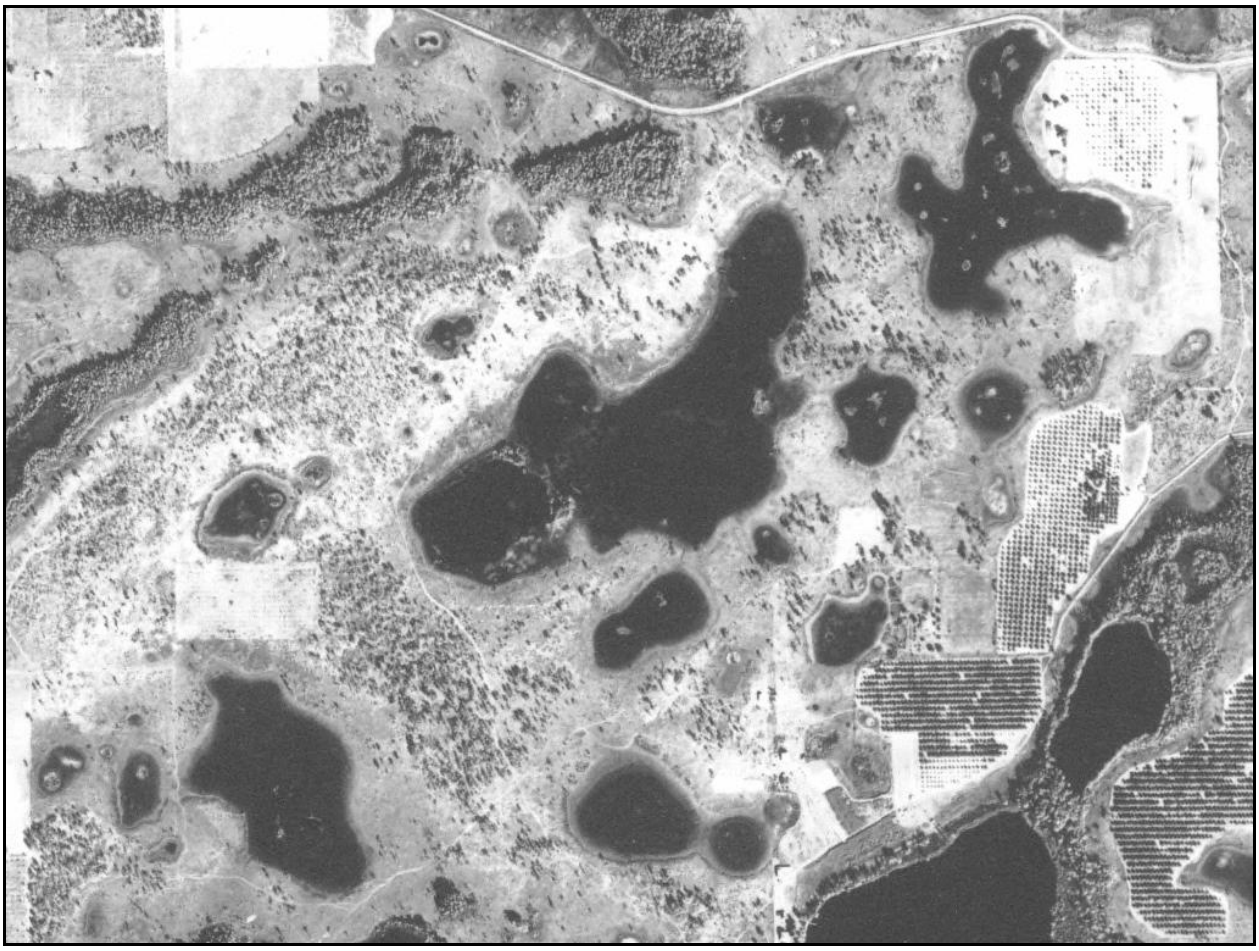


Figure 14. Aerial photograph of Lake Linda in 1938 (image source: United States Department of Agriculture 1938a).

Figure 15. Outlet conveyance systems for Lake Linda in 2007 (photographic image source: EarthData International 2007).

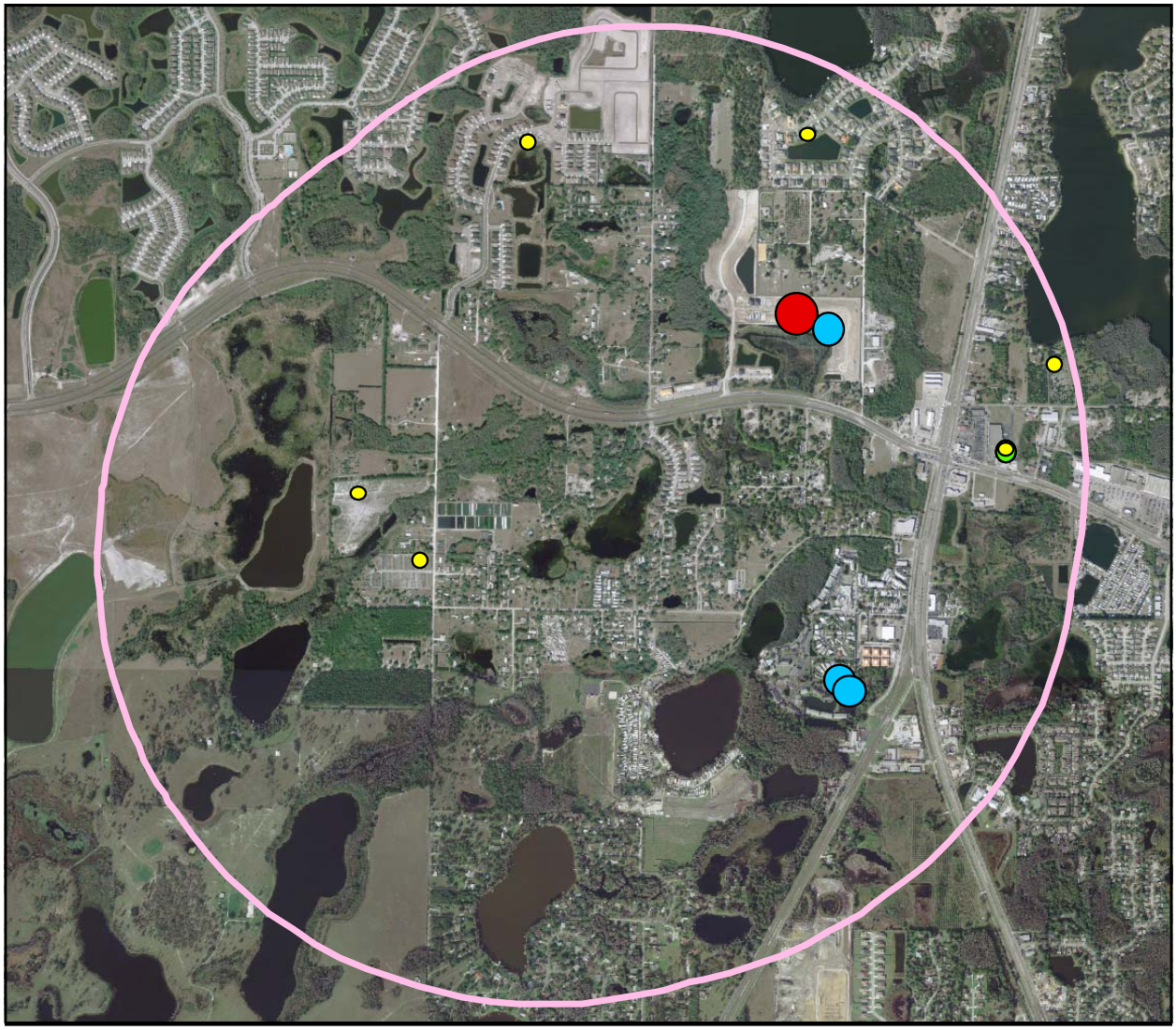
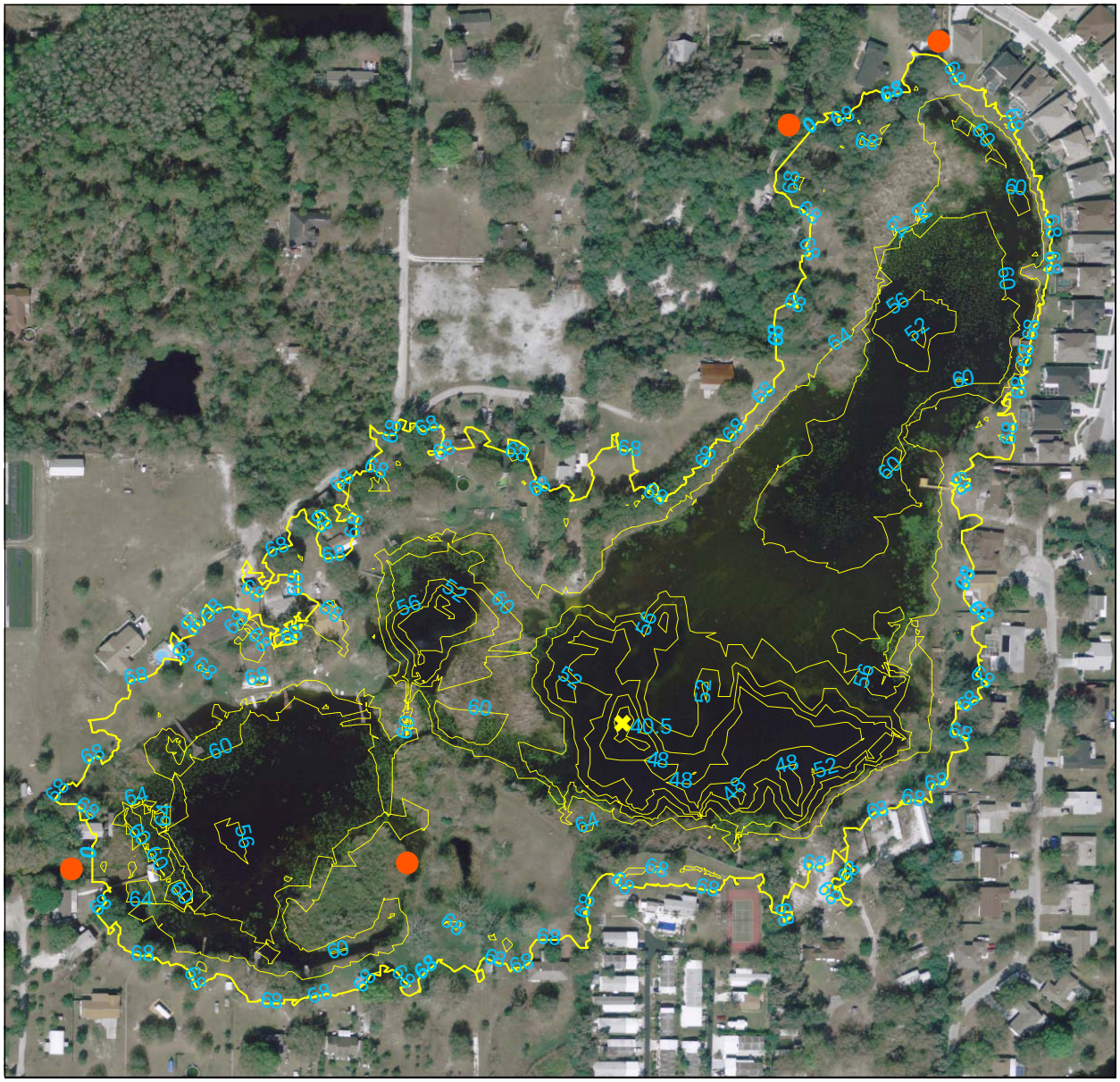


Figure 16. Locations and permitted daily average withdrawal quantities (gallons per day) for permitted groundwater withdrawal points located within one mile of the Lake Linda shoreline (as delineated by the pink polygon) as of September 2007 (photographic image source: EarthData International 2007; permitted quantity data source: Southwest Florida Water Management District 2007b).

Figure 17. Five-foot elevation contours in the vicinity of Lake Linda. Note that the lake water surface is listed at 66 feet above NGVD 1929 (image source: Southwest Florida Water Management District 2002b).



Legend

- Four-foot elevation contours (feet above NGVD 1929).
- Low spot in the lake basin (feet above NGVD 1929).
- Areas where data were not available for contour development (within the mapped area) or contours were truncated (at the margin of the mapped area).

Contours were created using spot elevation data collected by District staff in February 2003 and August 2007, and LiDAR data collected by EarthData International, Inc. in 2004

Figure 18. Four-foot elevation (feet above NGVD) contours within the Lake Linda basin (photographic image source: EarthData International 2007).

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.

In April 1987, the District adopted management levels (currently referred to as Guidance Levels) for Lake Linda and incorporated the levels into Chapter 40D-8, F.A.C. (Table 2). A Maximum Desirable Level of 66.25 feet above NGVD was also developed but was not adopted by rule. The levels were developed using a methodology that differs from the current District approach for establishing Minimum and Guidance Levels, and do not, therefore, necessarily correspond with levels developed using current methods. Following the December 2007 adoption of Minimum and Guidance Levels for Lake Linda that were developed using the current methods, the previously adopted Guidance Levels were removed from 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 High, Low and Extreme Low Levels, chronic fluctuation below the Low Level is considered a stressed condition. For lakes without adopted levels, the evaluation of stressed condition is conducted on a case-by-case basis.

Lake Linda was not included on recent Stressed Lakes Lists (Gant 2005, 2006, 2007), but was previously classified as a stressed lake (Gant 1999b, 2002, 2003, 2004). Based on adoption of Minimum Levels for the lake in December 2007, Lake Linda will not be included in future Stressed Lakes List evaluations. Evaluation of water level fluctuations within the basin will instead be incorporated in annual determinations of compliance with adopted Minimum Levels.

Table 2. Previously adopted guidance Levels for Lake Linda.

Minimum and Guidance Levels	Elevation (feet above NGVD)
Ten Year Flood Guidance Level	67.30
High Level	66.75
Low Level	64.00
Extreme Low Level	62.00

Summary Data Used For Minimum and Guidance Levels Development

Minimum and Guidance Levels were developed for Lake Linda 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 each elevation. 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 exceedence percentiles, normal pool, control point elevation, significant change standards and associated surface areas for Lake Linda.

	Elevation (feet above NGVD)	Lake Area (acres)
Lake Stage Exceedance Percentiles		
Historic P10	66.3	28
Historic P50	64.8	23
Historic P90	63.6	20
Current P10	65.7	26
Current P50	64.3	21
Current P90	62.5	19
Period of Record P10	65.7	26
Period of Record P50	64.5	22
Period of Record P90	62.5	19
Normal Pool and Control Point		
Normal Pool	NA	NA
Control Point	65.6	26
Significant Change Standards		
Dock-Use Standard	65.9	27
Basin Connectivity Standard	64.7	23
Wetland Offset Elevation	64.0	21
Aesthetic Standard	63.6	20
Species Richness Standard	63.2	20
Recreation/Ski Standard	NA	NA
Lake Mixing Standard	NA	NA
Guidance and Minimum Levels		
High Guidance Level	66.3	28
High Minimum Lake Level	66.2	27
Minimum Lake Level	64.7	23
Low Guidance Level	63.6	20

NA = Not available or not applicable.

Lake Stage Data and Exceedance Percentiles

Lake stage data, *i.e.,* surface water elevations, are available in the District Water Management Database for a single site (District Universal Identification Number STA 191 191) in Lake Linda from October 1969 through the present date, *i.e.,* October 2007 (Figure 19, see Figure 3 for the location of the District water level gauge). The highest surface water elevation for the lake included in the database, 67.13 feet above NGVD, occurred on August 21, 1979. The low of record, 60.07 feet above NGVD, was recorded on May 21, 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, 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 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, lake-stage data collected from January 1974 to the present were classified as Current data and data collected prior to January 1974 were classified as Historic data. The Current P10 elevation, the elevation the lake water surface equaled or exceeded ten percent of the time during the current period, was 65.7 ft above NGVD. The Current P50 elevation, the elevation the lake water surface equaled or exceeded fifty percent of the time during the current period, was 64.3 ft above NGVD. The Current P90 elevation, the elevation the lake water surface equaled or exceeded 90 percent of the time during the current period, was 62.5 ft above NGVD.

Although a few years of Historic data were available for Lake Linda, the pre-1974 water level record was considered to be of insufficient length for characterization of Historic lake stage fluctuations. Historic lake-stage exceedence percentiles were, therefore, developed using a composite 60-year record of monthly mean lake surface elevations based on available stage records that were supplemented with modeled estimates. The 60-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 used to describe the relationship between monthly water surface elevations for Lake Linda derived from measured Historic data and regional rainfall, as measured at the St. Leo rainfall station (District Universal Identification Number RNF 306 306), a long-term rainfall gauging station located in Pasco County about 16.6 miles northeast of Lake Linda. Lake stage data used for the

regression analyses consisted of monthly mean values based on lake surface elevations recorded from October 1969 through December 1973. Rainfall values used for the analysis consisted of weighted twelve month cumulative totals for the same period that were derived using a linear-decay series to weight monthly rainfall values for the twelve month periods. The line of organic correlation equation was used to estimate water surface elevation values for Lake Linda for the period from January 1946 through December 2005 (unpublished District data). A Historic, composite data set of monthly mean water surface elevations was developed using the modeled water surface elevations and available lake stage records. The Historic composite data set included monthly mean water surface elevation values based on the stage records for the period from October 1969 through December 1973 and modeled values for the remainder of the Historic period (Figure 20). The composite, Historic record includes periods when estimated monthly mean water surface elevations were higher than the values that have been measured at the lake gauging station. The highest value included in the composite data set, 68.21 feet above NGVD, was estimated for September 1960.

The Historic P10 elevation, the elevation the lake water surface equaled or exceeded ten percent of the time, based on the composite, Historic data set, was 66.3 feet above NGVD. The Historic P50, the elevation the lake water surface equaled or exceeded fifty percent of the time during the historic period, was 64.8 feet above NGVD. The Historic P90, the lake water surface elevation equaled or exceeded ninety percent of the time during the historic period, was 63.6 feet above NGVD. The Historic lake stage exceedance percentile elevations are 0.6, 0.3 and 1.1 feet higher than the P10, P50 and P90 values (65.7, 64.5 and 62.5 feet, respectively) derived from the empirical data collected during the past 38 years.

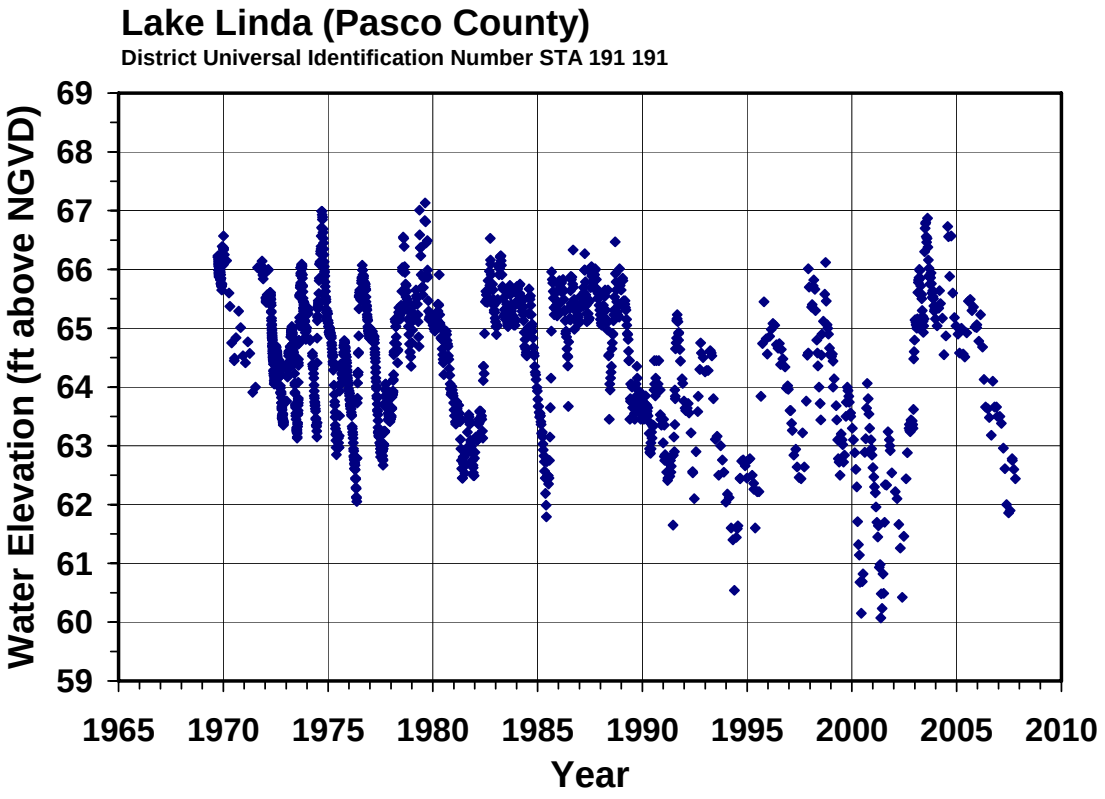


Figure 19. Measured surface water elevations for Lake Linda through October 2007.

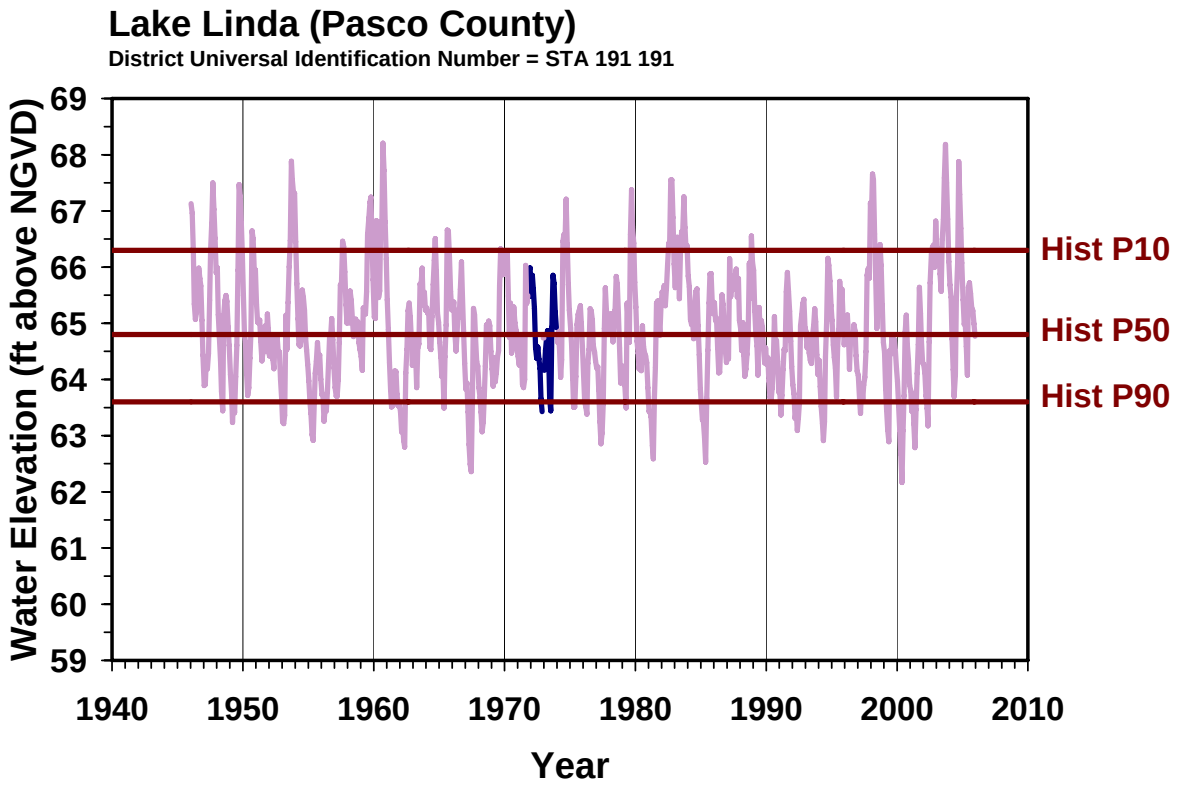


Figure 20. Composite monthly-mean surface water elevations and Historic lake-stage exceedence percentiles for Lake Linda, from January 1946 through December 2005. Composite data include values based on measured water surface elevations (blue) and modeled values (light purple). Historic exceedence percentiles include the Historic P10 (Hist P10), Historic P50 (Hist P50) and Historic P90 (Hist P90).

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 based on the distribution of Hydrologic Indicators of sustained inundation. For development of Minimum Lake Levels, the Normal pool elevation is considered an approximation of the Historic P10. Because reliable hydrologic indicators on normal pool were not observed in the Lake Linda basin, a Normal Pool elevation was not established for the lake. Information from the Florida Department of Environmental Protection indicates that neither an ordinary high water line nor a safe upland line has been established for the lake (Wilkinson 2001, Richard Malloy, Bureau of Surveying and Mapping; personal communication, December 19, 2006)

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, i.e., they have outlets or inlets for conveyance of surface water. Closed basin lakes are those that are not part of an ordered conveyance system. Based on the existence of the lake outfall structure, which conveys water from the north shore of Lake Linda to stormwater systems that drain towards Camp Lake, Lake Linda was classified as an open basin lake.

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The Control Point elevation is the elevation of the highest stable point along the outlet profile of a surface water conveyance system (*e.g.,* a weir, canal or culvert) that is the principal control of water level fluctuations in the lake. A Control Point may be established at the invert or crest elevation associated with a water control structure at a lake outlet, or at a high, stable point in a lake-outlet canal, ditch or wetland area. The control point elevation for Lake Linda was established at 65.6 feet above NGVD, the invert elevation associated with the drop-box structure that provides for conveyance to the stormwater system at the north end of the lake (Figures 3 and 15).

Structural alteration status is determined to support development of the High Guidance Level. In addition to identification of outlet conveyance system modifications, comparison of the Control point elevation with the Normal Pool is typically used to determine if a lake has been structurally altered. If the Control Point elevation is below the Normal Pool, the lake is classified as a structurally altered system. If the Control Point elevation is above the Normal Pool or the lake has no outlet, then the lake is not considered to be structurally altered. Although a Normal Pool elevation was not established for Lake Linda, the existence of the outlet conveyance system was used to classify the lake as structurally altered.

Guidance Levels

The Ten Year Flood Guidance Level has historically been provided as advisory information 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. District rules (Chapter 40D-8, F.A.C.) previously included a Ten Year Flood Guidance Level of 67.30 feet above NGVD for Lake Linda. Recent work completed in support of the District's Watershed Management Program has yielded a new, provisional ten-year recurrence flood stage for the lake. Storm-event modeling based on a 5-day rainfall volume yielded a provisional ten-year flood level of 67.2 feet above NGVD (Ardaman and Associates, Inc. 2007). It should be noted that the Watershed Management Plan that includes the provisional flood elevation for Lake Linda will be subjected to public review prior to finalization of project results.

In October 2007, the District Governing Board approved rule amendments to remove all adopted Ten Year Flood Guidance Levels from Chapter 40D-8, F.A.C. The intent of this action was not to discontinue development of regional and site-specific flood stage information, but rather to promote organizational efficiency by eliminating unnecessary

rules. Flood stage levels continue to be developed under the District's Watershed Management Program, but ten year flood recurrence levels are not incorporated into Chapter 40D-8, F.A.C. In accordance with this policy, Chapter 40D-8, F.A.C. does not currently include a Ten Year Flood Guidance Level for Lake Linda.

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 using historic data if it is available, or is estimated using the Current P10, the control point and the normal pool elevation. Based on the availability of the Historic composite data set for Lake Linda, the High Guidance Level was established at the Historic P10 elevation, 66.3 feet above NGVD.

The Low Guidance Level is provided as an advisory guideline for water dependent structures, and as 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. Reference lake water regime statistics are used when adequate historic or current data are not available. These 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). Reference lake water regime 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 a set of reference lakes. Based on the availability of Historic data for Lake Linda, the Low Guidance Level was established at the Historic P90 elevation, 63.6 feet above NGVD.

Lake Classification

Lakes are classified as Category 1, 2 or 3 for the purpose of Minimum Levels development. Systems with fringing cypress wetlands greater than 0.5 acres in size where water levels regularly rise to an elevation expected to fully maintain the integrity of the wetlands (*i.e.,* the Historic P50 is not more than 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 is more than 1.8 feet below the Normal Pool elevation are classified as Category 2 Lakes. Lakes without fringing cypress wetlands or with less than 0.5 acres of fringing cypress wetlands are classified as Category 3 Lakes. Based on the lack of lake-fringing cypress wetlands within the lake-basin, Lake Linda 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 3 lakes, six significant change standards, including a Dock-Use Standard, a Basin Connectivity Standard, an Aesthetics Standard, a Species Richness Standard, a Lake Mixing Standard, and a Recreation/Ski Standard, are developed. These standards identify desired median lake stages that if achieved, are intended to preserve various natural system and human-use lake values.

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 for boat mooring, and use of Historic lake stage data or region-specific reference lake water regime statistics. The Dock-Use Standard for Lake Linda was established at 65.9 feet above NGVD, based on the elevation of sediments at the end of ninety percent of the 15 docks within the basin (62.7 feet above NGVD, Table 4), a two-foot water depth based on use of powerboats in the lake, and the 1.2-foot difference between the Historic P50 and Historic P90. Based on the Historic composite water level record, the Dock-Use Standard was equaled or exceeded seventeen percent of the time, *i.e.*, the standard corresponds to the Historic P17.

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 use of the lake. The standard is based on the elevation of lake sediments at a critical high spot between lake basins or lake sub-basins, identification of water depths sufficient for movement of biota and/or watercraft across the critical high spot, and use of Historic lake stage data or region-specific reference lake water regime statistics. The Basin Connectivity Standard was established at 64.7 feet above NGVD, based on the elevation that ensures connectivity between the eastern and western sub-basins of the lake (61.5 feet above NGVD), a two-foot water depth in the area of connectivity to allow for movement of boats between the sub-basins, and the difference between the Historic P50 and Historic P90 elevations (1.2 feet). Based on the Historic composite water level record, the Basin Connectivity Standard was equaled or exceeded fifty-five percent of the time, *i.e.*, the standard corresponds to the Historic P55.

The Aesthetics Standard is developed to protect aesthetic values associated with the inundation of lake basins. The standard is intended to limit potential change in aesthetic values associated with the median lake stage from diminishing beyond the values associated with the lake when it is staged at the Low Guidance Level. The Aesthetic Standard is established at the Low Guidance Level, which for Lake Linda occurs at an elevation of 63.6 feet above NGVD. Because the Low Guidance Level was established at the Historic P90 elevation, water levels equaled or exceeded the Aesthetics Standard ninety percent of the time during the Historic period.

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 Lake Linda, the Species Richness Standard was established at 63.2 feet above NGVD. The Species Richness Standard was equaled or exceeded ninety-seven percent of the time during the Historic period; *i.e*., the standard elevation corresponds to the Historic P97.

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 5-foot deep ski corridor delineated as a circular area with a radius of 418 feet, 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. Based on the small size and shallow depth of Lake Linda, development of a Recreation/Ski Standard was not appropriate.

The Lake Mixing Standard is developed to prevent significant changes in patterns of wind-driven mixing of the lake water column and sediment re-suspension. 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. Because the dynamic ratio does not vary across the 0.8 threshold at lake water surface elevations up to 68 feet above NGVD (Figure 21), a Lake Mixing Standard was not established for Lake Linda.

Herbaceous Wetland Information is taken into consideration to determine the elevation at which changes in lake stage would result in substantial changes in potential wetland area within the lake basin (*i.e*., basin area with a water depth of four or less feet). Similarly, changes in lake stage associated with changes in lake area available for colonization by rooted submersed or floating-leaved macrophytes are also evaluated, based on water transparency values. Review of changes in potential herbaceous wetland area as a function of change in lake stage from the Historic P50 elevation did not indicate that of use of the significant change standards would be inappropriate for establishment of the Minimum Lake Level (Figure 21). Evaluation of potential change in

area available for rooted submersed or floating-leaved macrophytes was not possible due to a lack of water transparency values used for determining colonization areas.

Because herbaceous wetlands are common within the Lake Linda 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 64.0 feet above NGVD was therefore established for Lake Linda by subtracting 0.8 feet from the Historic P50 elevation. Based on the Historic composite water level record, the Wetland Offset was equaled or exceeded eighty percent of the time, *i.e*., the offset elevation corresponds to the Historic P80.

Table 4. Summary statistics and elevations associated with docks in Lake Linda, based on measurements made by District staff in February 2003 and August 2007. Percentiles (P10, P50, P90) represent elevations exceeded by 10, 50 and 90 percent of the docks.

Summary Statistic	Statistic Value (N) or Elevation (feet above NGVD) of Sediments at Waterward End of Docks	Statistic Value (N) or Elevation (feet above NGVD) of Dock Platforms
N	15	15
Mean (Standard Deviation)	60.9 (1.2)	67.0 (0.5)
P10	62.7	67.8
P50 or Median	60.6	66.9
P90	59.8	66.6
Maximum	63.7	68.0
Minimum	59.6	66.6

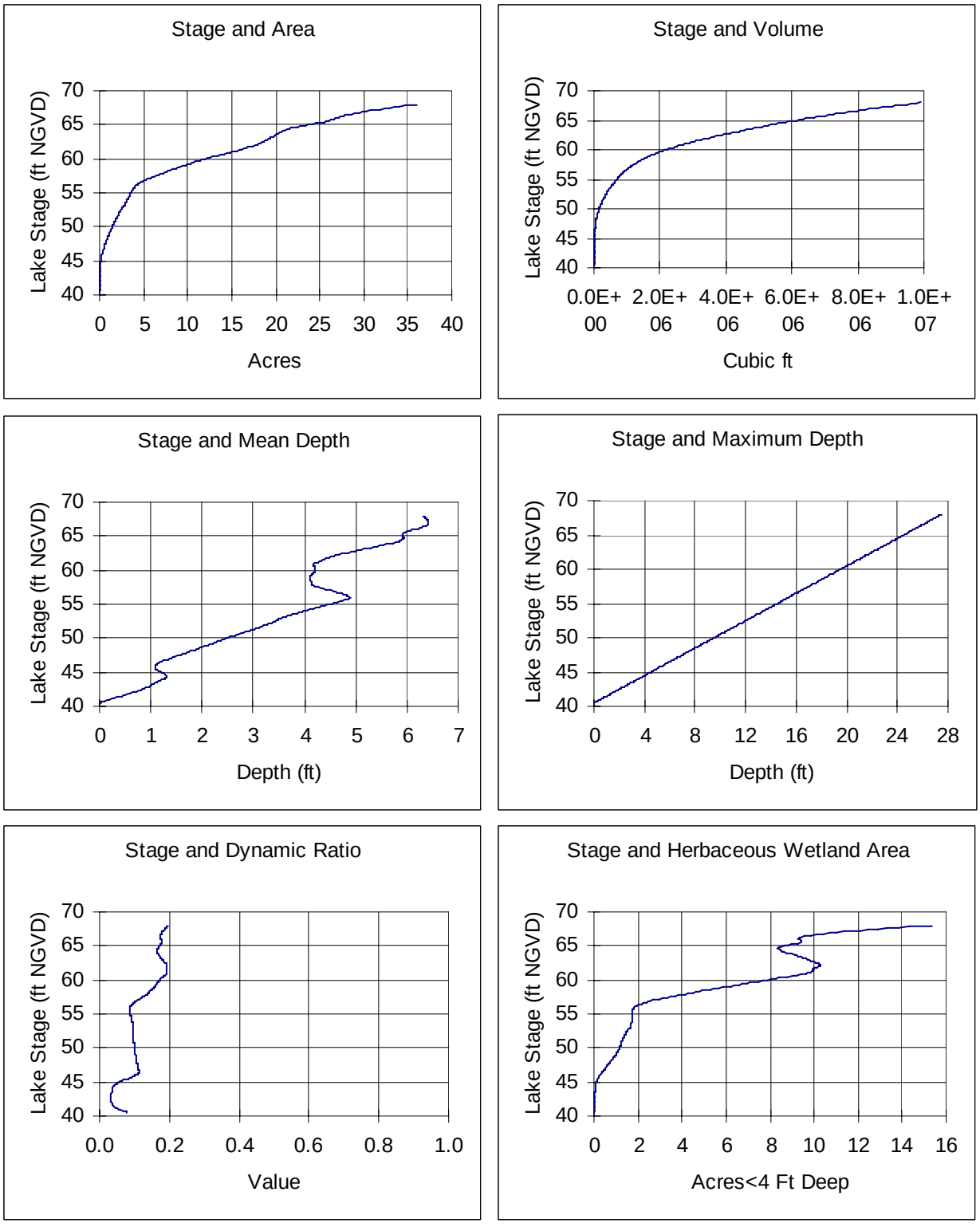


Figure 21. Lake surface area, volume, mean depth, maximum depth, dynamic ratio (basin slope) and potential herbaceous wetland area of Lake Linda as a function of lake stage (water surface elevation).

Minimum Levels

Minimum Lake Levels, including the Minimum Lake Level and the High Minimum Lake Level, are developed using specific lake-category significant change standards and other available information or unique factors, including: potential 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 typically 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 the Dock-Use Standard for Lake Linda is higher than the Historic P50 elevation, the Minimum Level could be established at the Historic P50 elevation, 64.8 feet above NGVD. However, because the Dock-Use Standard for the lake corresponds to the Historic P17 elevation, and because establishment of the Minimum Lake Level at the Historic P50 elevation would mean that any withdrawal impact, no matter how small, would not be permitted, it was determined that it would not be appropriate to use the Dock-Use Standard for establishing the Minimum Lake Level.

The Minimum Lake Level was, instead, established at 64.7 feet above NGVD, the elevation corresponding to the Basin Connectivity Standard. Because the Basin Connectivity Standard is higher than the Wetland Offset elevation and the other available significant change standards (with the exception of the Dock-Use Standard) it may be expected to be protective of lake values represented by the standards associated with lower surface water elevations. The 0.1-foot decrease in the median lake stage associated with use of the Basin Connectivity Standard for development of the Minimum Lake Level (the standard is 0.1 feet lower than the Historic P50) would also not be expected to significantly change the amount of time water levels equal or exceed the Dock-Use Standard. Assuming a 0.1 foot reduction in water levels over the entire range of lake water levels for the Historic composite water level record, the amount of time that water levels would have equaled or exceeded the Dock-Use Standard would have been decreased from seventeen percent of the time to fifteen percent of the time, based on the unmodified and modified Historic water level record.

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. Based on the availability of the Historic composite water level record for Lake Linda, the High Minimum Lake Level was established at 66.2 feet above NGVD, by adding the 1.5 foot difference between the Historic P50 and Historic P10 elevations to the Minimum Lake Level.

Minimum and Guidance levels for Lake Linda are shown in Figure 22 along with monthly mean water surface elevations based on period of record water level measurements. Review of available data indicated that staging of the lake at the Minimum Levels would not flood any man-made features within the immediate lake basin (see Figure 23 for the approximate lake margins when the water surface is at the minimum levels). Based on recent field survey data (Southwest Florida Water Management District 2003f, D.C. Johnson Associated 2006b), the High Minimum Lake Level is approximately 2.4 feet below the lowest residential home floor slab within the immediate lake basin, and about 1.1 feet below the centerline of the lowest paved road surrounding the lake (Table 5).

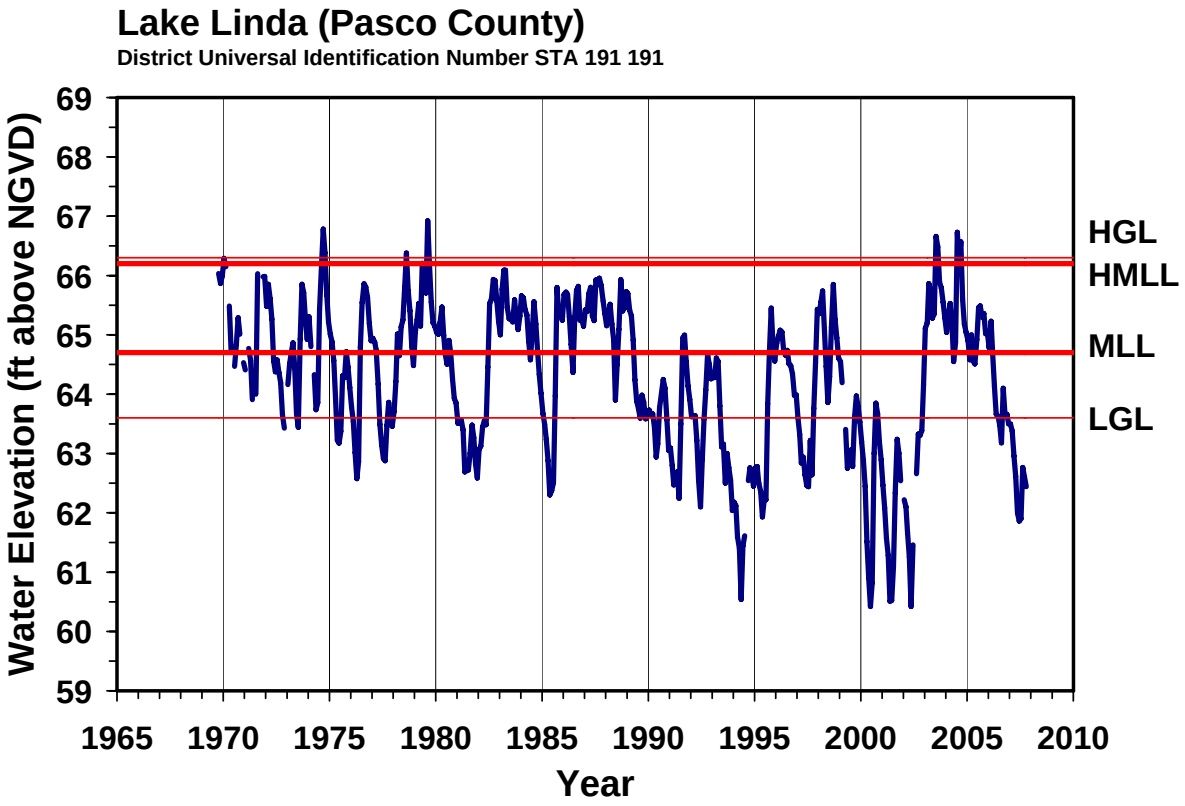
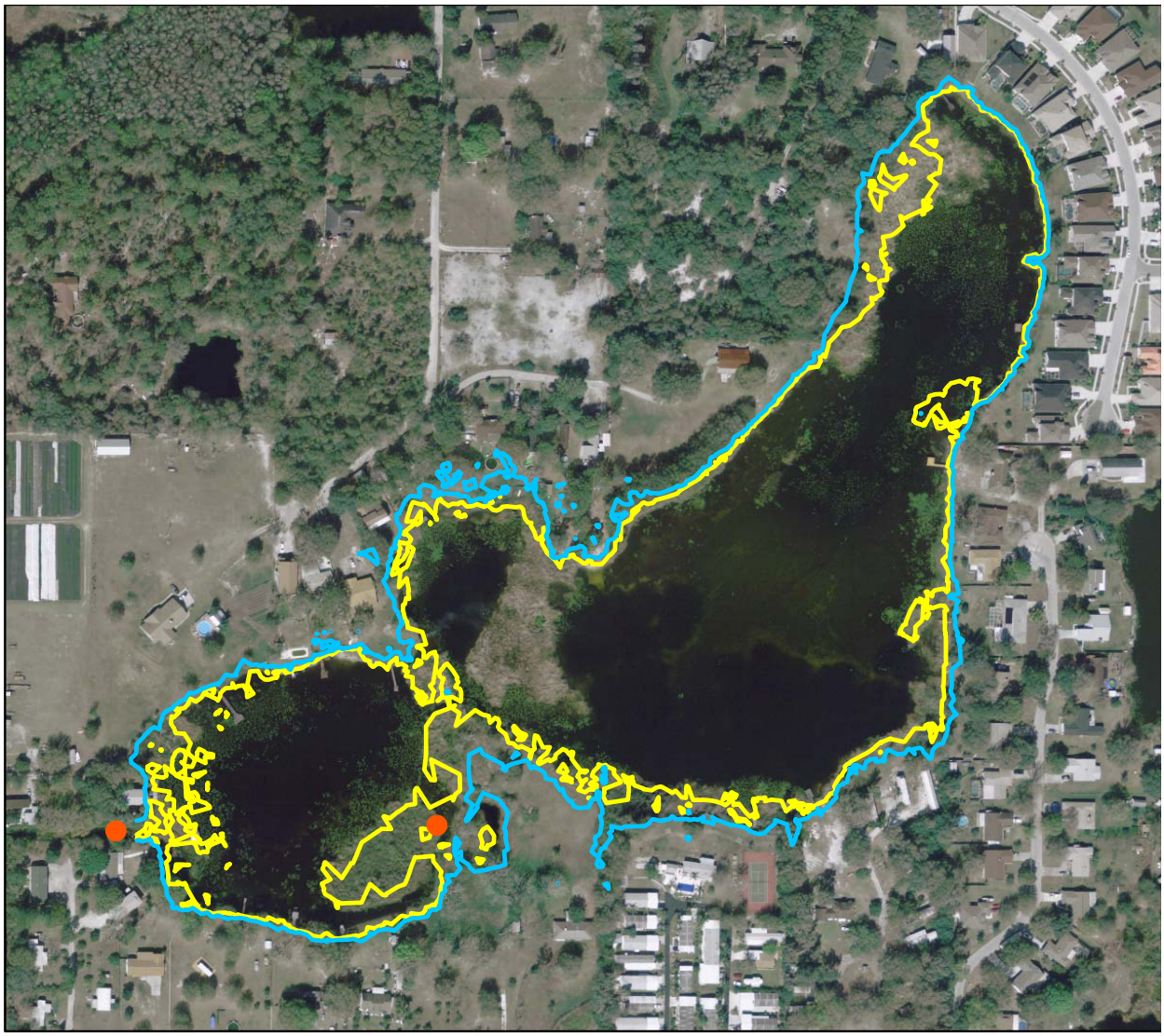


Figure 22. Mean monthly surface water elevations of Lake Linda through October 2007 (blue line) based on measured lake stage records, and Guidance and Minimum Levels (red lines). Adopted levels include the High Guidance Level (HGL), High Minimum Lake Level (HMLL), Minimum Lake Level (MLL) and Low Guidance Level (LGL).

Table 5. Elevations of selected man-made features occurring at relatively low elevations within the immediate in the immediate Lake Linda basin.

Lake Basin Features	Elevation (feet above NGVD)
Finished floor of the low residence (at 2150 Brickhouse Road) along the lake shore.	68.8
Finished floor of the low residence (at 2052 Woodruff Loop) along the lake shore.	68.62 – 68.68
Centerline of lowest paved road (Henning Lane)	67.3



Legend

Minimum Lake Level = 64.7 ft NGVD

High Minimum Lake Level = 66.2 ft NGVD

Areas where data were not available for contour development (within the mapped area) or contours were truncated (at the margin of the mapped area).

0 500 Feet

N

Contours were created using spot elevation data collected by District staff in February 2003 and August 2007, and LiDAR data collected by EarthData International, Inc. in 2004

Figure 23. Approximate location of the Minimum Lake Level and High Minimum Lake Level for Lake Linda (photographic image source: EarthData International 2007). The orange dots indicate canal areas where elevation data were unavailable for mapping purposes.

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