

# CENTRAL AND SOUTHERN FLORIDA PROJECT COMPREHENSIVE EVERGLADES RESTORATION PLAN



## Topographic Technical Memorandum

# LAKE OKEECHOBEE WATERSHED PROJECT



**U.S. Army Corps of Engineers  
Jacksonville District**



**South Florida  
Water Management District**

Assisted By:



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## 1.0 Introduction

The basis of any successful endeavor involving hydrology is reliable vertical and topographic survey information. In the late 1800's, the United States Coast and Geodetic Survey (USC&GS) ran a series of elevation bench marks inland relative to the mean low water elevation of the Gulf of Mexico. These elevations, known as the "Punta Rassa datum," were used for Projects associated with Lake Okeechobee in the early 1900's. In the 1930's, the USC&GS found the elevations to be in error by 1.44 feet, and determined that the Herbert Hoover Levee, which was suppose to have been constructed at an elevation of 31 feet, was actually constructed at elevation 29.56 NGVD. The old datum, continues to be used by some, and has been designated as the "Lake Okeechobee Datum." Use of historic elevations in the Lake Okeechobee region must be carefully considered before using on any design project. Conversions between datum's impede production and are a constant source of potential error.

The National Geodetic Vertical Datum of 1929 (NGVD'29) has been a national standard for geodetic heights for 70 years. NGVD'29 was sometimes referred to as Mean Sea Level (MSL), but is now considered superseded by the North American Vertical Datum of 1988 (NAVD'88). The new NAVD'88 is about 1.5 feet lower than NGVD'29, however, the difference is not constant and varies with location.

The principle objective of the Lake Okeechobee Watershed Project (LOW Project) is to study, trace, define and control water flows throughout the upland contributory areas around the perimeter of Lake Okeechobee. This objective cannot easily be achieved without standardized, reliable, vertical information. Realizing this, the CERP Project Management Plan (PMP) set forth requirements that all surveys are to be relative to the Geodetic Vertical Control Survey (GVCS) established for the project. The GVCS has adopted the new North American Vertical Datum of 1988 (NAVD'88) as the basis for all elevations for field control and mapping, and for increased Global Positioning System (GPS) accuracy. Various government agencies have been in the process of providing a densified, vertical network on the ground, within the project area on the new datum. It is critical that all surveys be based upon this common network of monumentation in order to provide reliable survey information.

Specific information regarding description, location and vertical elevation can be obtained from the Internet by accessing the Land Boundary Information System (LABINS) site. (Refer to Section 2.3)

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## 2.0 Topographic Data Availability

The availability of current topographic survey information is limited to countless small surveys that have no common filing system or datum. There are large project surveys available, such as the South Florida Water Management District (SFWMD) Kissimmee River topographic aerial maps that commence at Lake Okeechobee and proceed north through the entire LOW Project area. Although the map coverage extends a mile on each side of the Kissimmee River and covers thousands of acres, it represents a minuscule portion of the entire LOW Project area.

Geographic Information System (GIS) information is available for limited portions of the project area. Although GIS information is a valuable resource for providing various geographic components relating to the horizontal and political aspects of land objects within the project limits, it rarely provides reliable vertical information that is so critical to the success of the principle objective. A typical disclaimer note found on nearly all GIS data is as follows: "This agency has not confirmed the accuracy of all the spatial data contained in its databases. Users of this data should therefore do so at their own risk." This type of disclaimer demonstrates the need to obtain survey information that is certified as correct to within specified tolerances, and meets the CERP guidelines. Otherwise, the entire project could be deemed irrelevant for drainage purposes.

Research indicates that every GIS topographic map available from public sources was based upon the various digital quadrangle maps (quad sheets) produced and published by United States Geological Survey (USGS). These maps are probably reliable for GIS purposes. However, the vertical accuracy of the five foot (5') contour lines shown on said quad maps were derived from elevations obtained within a tolerance of one (1) meter. A one meter (1m) vertical tolerance may be acceptable for general GIS purposes, or in geographical locations where there is substantial relief. However, in areas that are generally flat or where ground elevation differences of less than 1 meter occur, such as is the case in the majority of the LOW Project limits, a meaningful hydrographic drainage study requires greater vertical accuracy. There are no wide coverage maps available that are within acceptable vertical accuracy tolerances, nor are the USGS maps that are available in the CERP required NAVD'88 datum.

### 2.1 South Florida Water Management District

The SFWMD possesses the greatest amount of survey information regarding the location, cross-section and right-of-way of its major drainage canals and the Kissimmee River. The SFWMD is also probably the best resource for obtaining comprehensive historic and semi current (circa 1991) aerial

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photography images. The SFWMD has hundreds of 9" X 9" black & white photographs at various scales that were flown by the U. S. Navy during training exercises in the 1950's. These photos cover about 80% of the project area. Later date commercial aerial photos are also available in similar format in a more limited project by project basis. None of these aerials are associated with vertical control.

The SFWMD Kissimmee River topographic aerial maps commence at Lake Okeechobee and proceed north through the entire LOW Project. These survey maps dated 1991 have elevations and contours relative to the National Geodetic Vertical Datum of 1929 (NGVD'29). The coverage is limited to within about one mile on each side of the river basin. Also available are horizontal control maps for this project, which include sectional information along with boundary and conservation easements.

Other survey information is available on a project by project basis associated with a specific canal. The SFWMD has no uniform index of drawings, which is typical of all other government sources. Drawings prepared by hand prior to the early 1990's are filed in the map room at the east end of Building B1, at 3301 Gun Club Road in West Palm Beach main office. The drawings consist mainly of hand drawn right-of-way maps, localized topographic maps, canal cross sections, and horizontal control maps. The surveys are typically based in the 1927 horizontal datum, and the 1929 vertical datum, although many drawings are simply based upon arbitrary local datum's to conveniently fit the needs of a particular project. Virtually all survey maps are filed in drawers corresponding with a particular canal or project. Copies of the maps can be obtained at the map room upon filling out and submitting appropriate forms.

## 2.2 U.S. Army Corps of Engineers

The United States Army Corps of Engineers (USACE or aka the "Corps") is known to have extensive amounts of survey information. The USACE's many responsibilities include flood control, water management, navigation, shore protection and restoration, environmental restoration, disaster response and recovery, environmental restoration of formerly used defense sites, and support to the military. Corps information includes a wide range of survey types including boundary surveys, waterway surveys, cross section surveys and topographic maps. The Corps is also well known for providing high order horizontal and vertical control monumentation. All commissioned surveys are performed according to particular project assignments and are filed accordingly.

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Although the public has access to Corps information, there is no index available that sorts the surveys into Section, Township and Range, County, Coordinates, Latitude and Longitude, or any other cross referencing method. In order to obtain information from the USACE, the request must be associated with a known project or existing map number. If monumentation is found in the field such as a horizontal or vertical control station, the number designation stamped into the monument can be reported to the USACE, and information about that monument can be determined. The Corps is one of the agencies assigned to provide the LOW Project with high order vertical monumentation throughout the project area based in the required NAVD'88. Most (if not all) of the control monument information can be obtained from the Land Boundary Information System (LABINS) discussed in more detail in Section 2.3.

Requests for information from the Corps must be made in writing or by telephone, and must be associated with a known USACE project. The local office for Florida is located at: 701 San Marco Blvd., Jacksonville, FL 32207, and may be reached by telephone at (904) 232-1606. The web address is <http://www.saj.usace.army.mil/>.

### **2.3 Florida Department of Environmental Protection**

The Florida Department of Environmental Protection (FDEP) is a State regulatory agency that manages State owned land resources. The Department's immediate surveying and mapping interests are limited to the lands claimed by the Trustees of the Internal Improvement Trust Fund. Therefore, only those lands currently owned or are being purchased by the State (including conservation easements) such as public parks, lakes, rivers and wetlands, would be subject to surveying and mapping. A prominent example of current surveying and mapping activities by FDEP under the Everglades Forever Act is a survey of portions of the 151,000 acre Fisheating Creek in Glades County. But these types of surveys relate mainly to horizontal boundary controls and locations of easements. Little if any information refer to elevation or topographic information.

The FDEP also administers the Land Boundary Information System (LABINS) under the auspice of the Bureau of Survey and Mapping in conjunction with the Florida Resources and Environmental Analysis Center, Florida State University. LABINS is probably the most comprehensive on-line web source for obtaining base survey information for project control anywhere in the State of Florida. It receives and maintains input from a number of government agencies including the United States Geological Survey (USGS), United States Army Corps of Engineers (USACE), Florida Department of Transportation, Water Management Districts, Counties and

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private survey firms. Available survey information includes land records such as original General Land Office (GLO) township plats and field survey notes, certified corner records, and electronic images for thousands of active and historical documents maintained by the Division of State Lands. Horizontal and Vertical Control monument information is available in an interactive format and can be found by a variety of index methods including Section, Township and Range, county, coordinates or by quad sheet reference. LABINS also provides mean high water information for coastal environments. Digital Raster Graphic (DRG) images of scanned USGS quad sheets and aeriels are provided by LABINS.

Although LABINS is a comprehensive source of survey information on which to base a survey, there are no topographic maps with elevations available that meet LOW Project standards. The extensive aerial photography, in Digital Ortho Quarter Quad (DOQQ) format, covers all of the project area, and is reasonably current (circa 1995 or 1999). However, it is severely limited due to the extreme pixelation of the photo upon enlargement, making the photo useable for only rudimentary mapping and GIS purposes.

The LABINS website can be found on-line at: <http://www.labins.org/>.

#### **2.4 Florida Department of Transportation**

The Florida Department of Transportation (FDOT) is the best resource for obtaining survey information regarding the State's roads and highways. The FDOT indexes its survey information by project number, but can usually cross reference it by County into Section, Township and Range. The LOW Project is located in two separate FDOT Districts. The western portion located in Glades, Highlands and Okeechobee Counties lies in District 1, and the eastern portion of the project located in Martin and St. Lucie Counties lies in District 4. Large area boundary and topographic surveys with elevations outside of the State road construction limits are not performed by the FDOT.

The survey information available is limited to particular State roads in the form of right-of-way maps, control surveys, design plans and horizontal and vertical control stations. Surveys generally commence prior to any major road construction, and many times include drainage studies within the immediate limits of the project. All vertical data obtained by FDOT prior to the early 1990's was collected in NGVD'29. Since that time however, FDOT progressively mandated use of the NAVD'88 for all new work, which is compatible with the LOW Project directive. Much of the information was collected in metric units. However, the current FDOT requirements have reverted to English units. Information regarding many of the FDOT horizontal and vertical control monuments can be obtained from LABINS.

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The FDOT has a large volume of aerial photographs prepared by the U.S. Navy in the 1950's, as well as some current, project related aerials. Copies of the aerials can be obtained by contacting Reggie Bradley with the appropriate project number and /or county, Section, Township and Range, by phone at (850) 488-2250, or by internet at: [reginald.bradley@dot.state.fl.us](mailto:reginald.bradley@dot.state.fl.us) . Right of Way and other survey information may be obtained by similarly contacting the appropriate District at the following addresses:

**District 1 Address:**

**801 N. Broadway Street, Bartow, Florida 33830-3809**

**Phone: (863) 519-2300**

**District 4 Address:**

**3400 West Commercial Boulevard, Fort Lauderdale, Florida 33309**

**Phone: (954) 486-1400**

## **2.5 Counties**

Virtually no relative topographic survey information of any significance is available from county sources.

## **2.6 Other Agencies**

As noted in Section 2.0, there are no large scale topographic surveys with elevations available. The one exception is the USGS quadrangle maps, which all agencies use for GIS purposes. However, numerous links for a myriad of GIS information can be obtained via the Internet from the following sources:

**Federal Geographic Data Committee (FGDC):**

<http://www.fgdc.gov/>

**USGS South Florida Information Access (SOFIA):**

<http://sofia.usgs.gov/exchange/demapping.html>

**USGS National Geologic Map Database (NGMD):**

[http://ngmdb.usgs.gov/Other\\_Resources/rdb\\_topo.html](http://ngmdb.usgs.gov/Other_Resources/rdb_topo.html)

**U.S. DoC / NOAA / NOS / National Geodetic Survey: (NGS):**

<http://www.ngs.noaa.gov/>

**South Florida Water Management District (SFWMD):**

[http://www.sfwmd.gov/misc/3\\_otherlinks.html](http://www.sfwmd.gov/misc/3_otherlinks.html)

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### 3.0 Aerial Photography Availability

There are a variety of sources of historic aerial photography as previously noted. Those sources include the SFWMD, the FDOT and LABINS. The SFWMD has the most comprehensive coverage of the entire State of Florida taken in infrared. The infrared aerial photography can be used to document and monitor such items as tree types, infestations, water flows, and a myriad of other applications. Infrared film is sensitive to a certain portion of the spectrum of light, and the photographs usually appear in various shades of red. By associating a particular shade to a particular type of vegetation or other object, the objects can be traced and tracked over a period of time, giving information as to the source of contaminated water, or forest infestations. Examples of infrared aerial photography can be reviewed at: <http://www.wec.ufl.edu/coop/DigitalCamera/Default.htm> .

### 4.0 Utility Data Availability

The USGS Quad Sheets delineate some major utility lines and locations. On a limited basis, underground utility information can be obtained by contacting the free line locate service at "CALL SUNSHINE" (Previously known as U.N.C.L.E.) at 1-800-432-4770. This service has access to a comprehensive database of utility companies with grid locations indexed by street address, Section, Township and Range, legal description, and other variables. The system was initially established to assist with protecting underground utilities from being destroyed by excavation. Before a contractor excavates, he must notify the service of his intentions, and the service will contact the various utility companies who will mark the location of their respective utilities on the ground within 48 hours. A list of all utility companies and contact numbers within a particular county can also be supplied by fax by calling Sunshine, and requesting that information.

### 5.0 Conversion of existing data to required datums

Conversion to new datums should only be accomplished when there is no other alternate method available. Conversions represent one of the biggest sources for the introductory of error that exists. It generally is no more expensive to collect new, current survey data in the field, than it is to convert old data. Data conversions should be relegated to situations where the survey data can no longer be duplicated due to changes in field conditions. Newer data that was digitally collected can usually be converted safely to new datums. Every conversion project has its own quirks and pitfalls which much be individually addressed and rectified. Field checking newly converted data is paramount.

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## 6.0 Work Plan for Data Collection

The Global Positioning System (GPS) coupled with aerial photography will provide the majority of comprehensive topographic maps with elevations and contours. There are three basic systems of aerial photography available for use depending upon the accuracy required and extent of coverage.

The most accurate photo method is conventional controlled aerial photography. This method employs extensive ground controls in the form of aerial targets. About nine (9) ground targets per square mile are required, and the coordinates and top elevation of each target must be obtained. The targets must be set in open areas. In dense foliage, an area must be cleared in order for the target to be observed by the aerial camera. Aerial targets can be placed by survey crews, and GPS methods can be employed to obtain the coordinates and elevations of each target. Conventional aerial photography can reliably produce topographic maps with contour accuracy of one (1') foot, at a convenient scale of 1"=200'. This will produce a 30" X 30" sheet for each square mile of coverage. Generally, these sheets are set up to cover a particular Section in a Township, and can be filed accordingly. The limitation of conventional aerial mapping is that it requires daylight flying with clear skies (minimal clouds), and all aerial targets must be visible. Summer and fall provide a limited number of clear flying days, whereas winter and spring generally provide more favorable weather conditions.

GPS aerial mapping (or airborne GPS) is currently considered an intermediate form of controlled aerial photography, requiring a minimal amount of ground targeting. This method relies on GPS to locate the exact position of the aerial camera at the time of exposure while in flight. Ground targeting is required basically for checking purposes. A total of twenty-five (25) targets covering an entire project area may be sufficient. GPS aerial photography can reliably produce topographic maps with contour accuracy of two (2') foot, at a convenient scale of 1"=200'. The flight limitations are the same as those for conventional aerial photography.

The National Geodetic Survey (NGS), an office of NOAA's National Ocean Service, coordinates a network of Continuously Operating Reference Stations (CORS) that provide Global Positioning System (GPS) carrier phase and code range measurements in support of 3-dimensional positioning activities throughout the LOW Project area.

Surveyors and airborne GPS photogrammetrists can apply CORS data to position points at which GPS data has been collected. The CORS system enables positioning accuracies that approach a few centimeters relative to the National Spatial Reference System, both horizontally and vertically. CORS

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data are used to greatly improve the accuracy of GPS positioning activities through the use of differential GPS (DGPS) techniques. The CORS station "OKCB" maintained by FDOT is located in the City of Okeechobee, and will assist the GPS community with providing a permanent ground linked control station for many GPS operations. Additional information regarding CORS and the nearest CORS stations can be found at the following website: <http://www.ngs.noaa.gov/CORS>

A third aerial method that is new and still considered somewhat in the development and study phase, is LIDAR (Light Detection And Ranging). A main component of LIDAR is a laser that is mounted in an aircraft that uses a mirror to deflect a beam across a swath of ground (as opposed to a single line). Working in conjunction with GPS and an Inertial Navigation System, the laser collects ground information at a rate of about 5000 points per second. These points are assembled and provide a three dimensional image of the ground below. Although not a photograph in the typical sense, the LIDAR image possesses qualities not available in conventional photography. The image produced is referred to as a Digital Elevation Model (DEM), which is a continuous mathematical representation describing the shape of the surface. There are two types of DEMs: 1.) the Digital Surface Model (DSM) and 2.) the Digital Terrain Model (DTM). The DSM includes surfaces of all objects on the ground like buildings and trees. The DTM is derived from the DSM, and reflects only the elevations of the terrain.

The accuracy claimed by some companies that offer LIDAR services reports vertical and horizontal errors of less than 10 cm (4") and 50 cm (20"), respectively. However, contacts made at the USACE indicated that consistent results provided a much lower vertical accuracy approximating closer to one (1') foot. However, considering the speed and vast expanses of ground that are covered, and considering the project budgetary restraints, the LIDAR method may provide the bulk of survey mapping information required for a large portion of the project for hydrographic drainage study. Other advantages of the LIDAR method are that very few ground targets are required, and the flights can take place during times of poor visibility. Even night flying is possible.

In addition to aerial targeting, conventional survey crews will be required for providing canal cross sections, detailed measurements of structures, and design surveys of proposed construction areas.