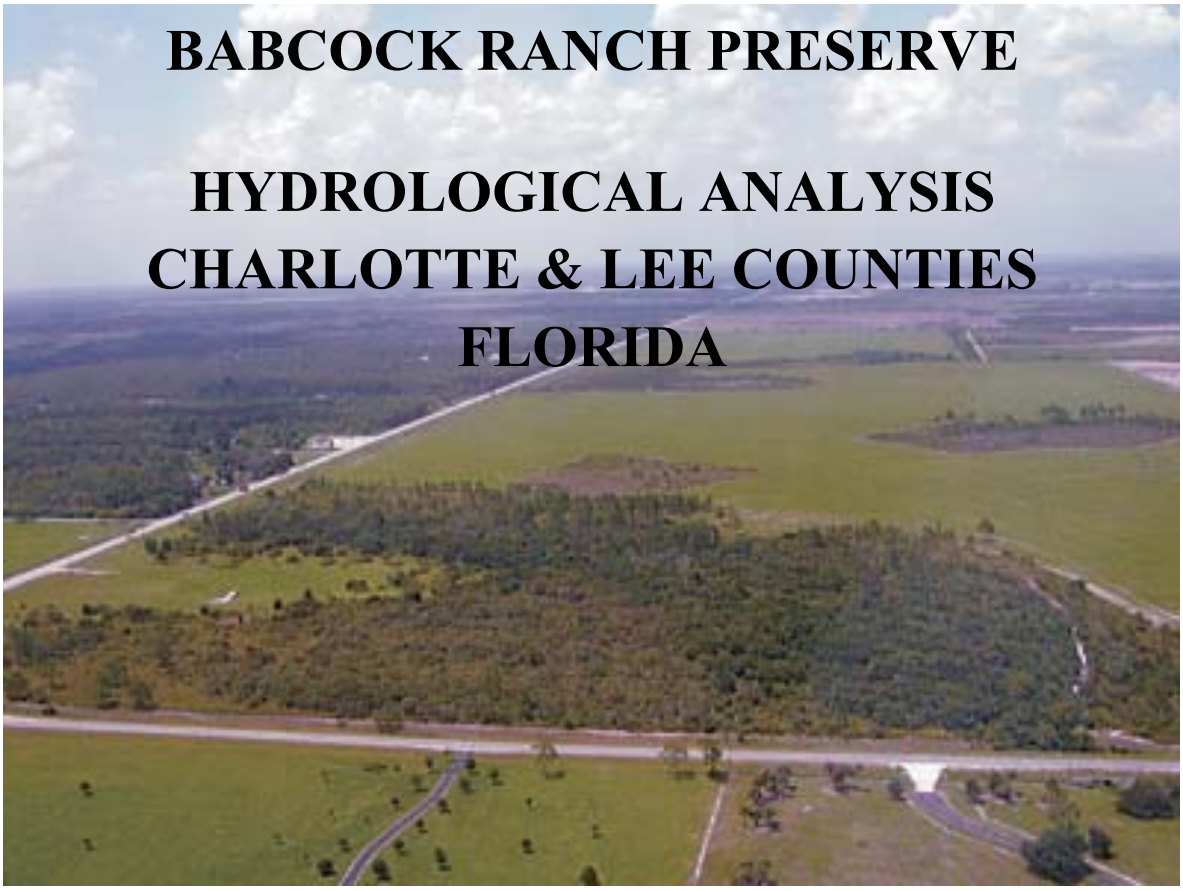
BABCOCK RANCH PRESERVE

HYDROLOGICAL ANALYSIS
CHARLOTTE & LEE COUNTIES
FLORIDA



PREPARED FOR:

FLORIDA DIVISION OF FORESTRY
STATE PROJECT NUMBER: SOQ/DA-08/09-47

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090381/0200-10/09

FINAL REPORT

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SECTION 1.0

PROJECT AUTHORIZATION AND INTRODUCTION

1.0 PROJECT AUTHORIZATION AND INTRODUCTION

1.1 AUTHORIZATION

Pursuant to the provisions of the Babcock Ranch Preserve (BRP) Management Plan, specifically Section 4.1, Natural Resource Goals & Objectives, Goal Number 3, Environmental Consulting & Technology, Inc. (ECT) has been engaged by the Division of Forestry (DOF) to conduct an assessment of the historic and current hydrological conditions of the state-owned 73,229.8 acre Babcock Ranch property. Primary to this effort was the assessment of the effects of past hydrologic alterations on the natural landscape.

This report provides a summary of the various tasks ECT was engaged to complete. For the most part, information gathered and knowledge gained during this effort has been converted to digital information in the form of geographical information system (GIS) shapefiles and associated geodatabase sets. The intent of the "paper" portion of this report is to provide a summary document detailing and discussing the digital information provided on the accompanying DVD. Discussion with respect to the specific protocols and methodologies applied in the completion of the various tasks is provided herein.

1.2 INTRODUCTION

As has been stated in numerous reports and various documents, the acquisition of the Babcock Ranch (**Map 1,** Regional Location Map) by the State of Florida is the single largest purchase of conservation land in the state's history. The acquisition also represents another milestone in public-private partnering in the State with the establishment of Babcock Ranch, Inc. (BRI) as the managing entity. Numerous other reports, including the Babcock Ranch Preserve Management Plan (BRPMP), provide specifics with respects to the composition and responsibilities of the Corporation; as such no additional discussion is warranted herein, other than to note the BRP is to remain a

self sustaining working ranch pursuant to the Management Plan and per the enabling legislation (Chapter 259.1052, Florida Statues).

As required by the Statute and the BRPMP, agricultural operations will remain an integral part of the BRP going forward. While the continuation of agricultural operations is required to achieve the primary goal of the facility being fiscally self sustaining, ongoing ranching operations must be conducted in a manner to facilitate the BRPMP stated goals as they relate to hydrologic and ecologic restoration.

1.3 BACKGROUND AND SETTING

BRP (a.k.a. the "Crescent B Ranch") is located north of the Caloosahatchee River in Charlotte and Lee Counties and is generally bounded on the north by State Road (SR) 74, along the west by SR 31 on the south by various private and public ownerships and along the east by Glades County (**Map 1**, Regional Location Map). As it is historically known, the Crescent B Ranch has been in operation since the early part of the 1900s. Initially, the Ranch included lands now known as the C.M. Webb Wildlife Management Area (WMA) and the Babcock Ranch Communities (BRC) properties that combined exceeded 100,000 acres.

During the early part of the 1900's, the Ranch was utilized primarily for timber production with cattle production on mostly native range. Drainage improvements in the early 1900s were limited and, given the absence of significant development in the region, were of relatively little consequence. During the middle part of the 1900s, primarily during the 1930s and 1940s, onsite drainage efforts intensified likely in an effort to manage surface waters to allow greater access to more of the site during most of the year. Shortly thereafter, land conversion to improved pasture and row crop farming began, thus increasing the need for drainage. These efforts have over the years resulted in an overall shift in vegetative cover in some areas due to changes in the hydrologic regime.

The project area is designated by the South Florida Water Management District (SFWMD) as being within two separate watersheds, the Tidal Caloosahatchee watershed,

which discharges to the Caloosahatchee River downstream of the Army Corps of Engineers (ACOE) locks at Structure S-79 and the Western Caloosahatchee watershed, which discharges upstream of the S-79 locks. Historically, storm water runoff from the property reached the Caloosahatchee via one of six named tributaries, Trout Creek, Owl Creek, and Telegraph Creek that are in the tidal portion (downstream of S-79) of the Caloosahatchee and Fichter Branch, Cypress Creek, and Spanish Creek, which are within the Western Caloosahatchee basin upstream of Structure S-79. Tributaries, related to the BRP, their historical and current conditions will be discussed herein (**Map 2,** Pre-Development Streams).

SECTION 2.0

EXISTING DOCUMENT REVIEW AND ANALYSIS

2.0 EXISTING DOCUMENT REVIEW AND ANALYSIS

Task number one of ECT's engagement identified the need to compile publicly available data related to surface water systems, land use patterns and natural systems associated with the BRP. ECT has completed an extensive search intended to collect available information relevant to the overall project objective. Relevant data collected during this process has been included in the report appendices which are included herewith in DVD format as Appendix I & II.

2.1 GEOGRAPHICAL INFORMATION SYSTEM DATA

ECT gathered significant geographic information via an extensive source search using the internet and subsequently various documents and reports. It is noted that a good deal of the GIS data developed by Pandion Systems and the Genesis Group in the completion of earlier efforts prescribed by the BRPMP and the BRP Recreation Plan, respectively was extremely useful in the development of certain base maps. Their cooperation and assistance in making this information available is gratefully acknowledged and appreciated.

2.2 AERIAL PHOTOGRAPHY AND TOPOGRAPHIC MAPS

2.2.1 HISTORIC AND CURRENT AERIAL PHOTOGRAPHS

ECT utilized two sets of aerial photographs for our assessment of the historic and current conditions of the BRP and adjacent lands. Aerials from circa 1944 & 1946 were geo-rectified and stitched together to form complete coverage's of the project site and provide the basis for the "pre-development" condition. As discussed herein, data from earlier eras, 1929 topography and "pre-European" land uses, were also utilized in our assessment. Similarly, current aerials from 2004, 2007 & 2008 were also stitched together, geo-rectified and utilized in establishing the current conditions. These aerials are included in DVD Appendix I. The data presented on the DVD can be plotted at any

scale; however, the base scale of the 1944-1946 photographs is l-inch equals 400 feet (ft) as such plots at other scales may become distorted.

Although many aerial photographic series of the BRP are publicly available, review of these aerial photographs did not produce any significantly useful additional information relevant to the assessment of historical or current hydrological conditions. Therefore, copies of these additional aerial photographs are not included.

2.2.2 TOPOGRAPHIC MAPS

ECT prepared **Map 3**, (Current Conditions Topography) by extracting the contour lines from the latest USGS 7.5 Minute Topographic Quadrangle maps to provide a clearer view of the overall generalized current topography. As with all maps contained in this report, GIS files have been included digitally on the project DVD.

Topography of the historical condition is shown on **Map 4,** (Pre-Development Topography). For ease of comparison, when comparative graphics are provided, the second of the series is presented side by side with the previous condition graphic. This convention is followed throughout the report. The source of this data is a one-foot topographic contour map prepared by the ACOE and published in 1929. The 1929 data was scanned and converted into a GIS shape file that is presented on the DVD. **Map 5**, (Pre-Development Topography (1 foot contours)) presents the pre-development topography at 1-foot contours intervals.

2.3 SURFACE WATER MANAGEMENT PERMITS

ECT reviewed regulatory files maintained by SFWMD and the Southwest Florida Water Management District (SWFWMD). This research defined nearly 100 surface water management permit actions or permit applications within the SFWMD and SWFWMD databases that were either related to the BRP, were immediately adjacent to the west, north, or east boundary or downstream to the south. The approximate location of each permit action is provided herein as **Map 6,** (Permit Summary). **Table 1,** Water

Management District Permit Summary, provides an indexing of the information contained with each identified application/permit. Due to the volume of information in some of these permit files, the documents presented on the DVD are limited to a copy of the respective permit and associated staff report, copies of maps and illustrations related to surface water, copies of surface water reports including stage and flow data, and copies of modeling summaries. The permit and application information has been included as Table 1. Of significance to this assessment is information related to alterations to existing landscapes that would impede or alter natural flow regiments, allowable discharge rates, project control elevations, onsite mitigation, and preservation requirements. A detailed analysis of this information was not preformed due to budgetary constraints. It is suggested that a thorough and detailed assessment of this archived information would be useful prior to any detailed restoration planning effort.

2.4 BABCOCK RANCH PRESERVE MANAGEMENT PLAN

ECT has reviewed the BRPMP and associated documents related to its development. As noted previously, GIS databases in the development of the BRPMP and several subsequent documents were utilized in the development of this report. A copy of the BRPMP has been included in Report Appendix II for the user's convenience.

2.5 HYDRAULIC AND HYDROLOGIC DATA

ECT has compiled a hydrologic database for the project area including rainfall data, flow, and stage data for Telegraph Creek. Rainfall data was gathered from nine sites and provides good areal coverage of the project area. Four sites are located on the BRC site and are operated by the owner; three sites are located generally along the Caloosahatchee River at Olga, Alva and the Southern C.M. Webb WMA (operated by the Lee County Division of Natural Resources). Another site is located at ACOE Structure S-79 and is essentially a duplicate of the Lee County Olga site. The final site is located approximately four miles north of SR 74 and is operated by the University of Florida Institute for Food and Agricultural Sciences.

While an abundance of rainfall data is available, there is limited stage/flow data publicly available for the relevant tributaries from the BRP. Lee County operates a stage recorder in the tidal portion of the Telegraph Creek. The following link provides access to stage data for Telegraph Creek at SR 78 from 1996 to the present:

http://www3.leegov.com/naturalresources/hydromonitor/Autopage_T27_R28.htm

The United States Geological Survey also operates a flow monitor station along Telegraph Creek. This data is available at:

http://waterdata.usgs.gov/fl/nwis/uv/?site_no=022929176

Review of the SFWMD site failed to reveal any significant hydrologic data for any of the streams or creeks related to this project.

ECT met with staff at the local USGS office to discuss availability of data related to the study area. ECT has been advised that there is limited data available for the subject area. As noted, the USGS is presently monitoring a single station in the tidal portions of Telegraph Creek. This station, USGS 022929176, collects real time stream velocity and gage height. This information could be useful in the calibration of any hydrodynamic modeling that would involve Telegraph Creek.

In all, it was determined that there was actually limited data publically available for these watersheds, however, ECT included on the project DVD several minor studies (see Hydrologic Studies, DVD Appendix II) conducted by various parties for various interests that are related to flows in the area of the BRP. ECT does not warrant the accuracy of any data or studies provided herein, but simply make them available for consideration.

2.6 ENGINEERING RECORDS AND ECOLOGICAL STUDIES

A comprehensive monitoring program is being developed on BRP in conjunction with the multi-use development located on the remainder of the former Babcock Ranch property and known as Babcock Ranch Communities (BRC). **Figures 1 through 3** present the

locations where water quality monitoring, water table piezometers, and stream flow measurements are being conducted, or are proposed, across the site. These monitoring points will be discussed in Section 7.0 with respect to recommended additional monitoring going forward.

2.7 FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

A review of the Florida Department of Environmental Protection (FDEP) archives for regulated activities at the project site produced six active petroleum cleanup sites within the limits of the BRP that are currently under FDEP oversight for monitoring or cleanup. Review of these six records did not indicate any issues of significant concern. However, it was noted that approximately fifty four (54) Discharge Report Forms (DRF) had been filed by the Babcock Florida Company during the period from May 2006 and August 2006. Discussions with FDEP staff familiar with the situation indicated that all of the DRF's had been dealt with adequately and were to the satisfaction of the Department. **Table 2**, (Active Petroleum Cleanup Sites) provides summary information regarding these six sites. In as much as the BRP is now under public ownership, it is recommended that a compliance audit be conducted to insure all activity at the site that is regulated by the FDEP is currently in compliance with regulatory requirements.

SECTION 3.0

FIELD ASSESSMENT

3.0 FIELD ASSESSMENT

ECT would like to begin this section by thanking Ranch Manager, Mr. Arnie Sarlo and his staff for their cooperation and hospitality during our field recognizance effort. Their efforts and professionalism greatly aided and assisted the timely completion of our efforts.

Earlier studies conducted pursuant to the goals and objectives of the BRPMP had generated an abbreviated inventory of hydraulic structures, primarily road crossing culverts, within the BRP. ECT was tasked with providing a site wide update to the existing hydraulic inventory for the preserve. DOF provided ECT with the existing inventory of culverts that had been determined to be insufficient due to locational inaccuracy and extent of coverage.

The original database provided by DOF listed 197 culverts of various sizes and conditions. ECT utilized the latitude and longitude provided by this earlier work and the site trails map developed during previous studies to map reported culverts locations for use by the ECT field crews. Following initial coordination with ranch staff, ECT mobilized two – two person teams and in the course of just over two weeks traversed the site using four-wheel drive vehicles and backpack Trimble® differential global positioning system (dGPS) units. ECT collected locational and dimensional information on 391 unique points of interest across the site including culverts and culverts with risers (312), weirs (3), spillways (5), bridges (3), pumps (21), wells (3) and ditch segments (47). For each culvert location, ECT identified pipe type, length, and diameter. ECT also noted the over all condition of the culvert at each location, the apparent flow direction and the degree of siltation at both ends of the pipe (upstream and downstream). Where applicable, ECT also identified the relative heights of the particular grade or road above the surrounding natural grade. This information along with picture identification (See DVD Appendix II) is provided on the data sheets which are provided in the Tables portion of the report as Table 3, Culvert and Structure (Facilities) Inventory.

Generally several photographs were taken at each site. The following convention was followed, where possible and appropriate: Photo No. 1 facing upstream end of culvert (weir,

riser, etc.), Photo No. 2 facing upstream approach channel; Photo No. 3 facing downstream end of culvert; and Photo No. 4 facing downstream departure channel. Field photographs are provided herewith in Appendix II on the project DVD.

As provided in **Table 3**, Culvert & Structure (Facilities) Inventory, ECT identified 368 culverts or culverts with risers at 312 culvert sites within the limits of the BRP. Several sites as noted on the attached inventory sheets contained multiple pipes. Of the 197 culverts identified in the previous survey, 19 appeared to have been removed and 14 were located outside the study area on the BRC site. As such, ECT identified and classified 204 new culverts at locations that had previously not been cataloged. As noted previously, ECT also located and cataloged 47 ditch points (not included on Map 13 for clarity), 21 agricultural discharge pumps, five spillways, three weirs, three bridges and three wells. It is noted that there are numerous other wells throughout the site. The wells identified were done so because they were artesian wells flowing at the surface. These were located using the GPS for further review to insure compliance with water use permitting requirements. Photographs were also taken of each of these facilities and are included with the photographs in Appendix II.

As to the actual culvert inventory, of the 312 sites identified, ECT classified 119 as being in good condition, 91 as fair, and 96 as poor and 6 that could not be classified due to obstruction. Of the 368 culverts assessed, size distribution was as follows: 12" or less - 19, 18" - 71, 24" – 133, 30" – 8, 36" – 85, 42" – 15, 48" – 20, 54" – 1, 60" – 4 and Size Undetermined – 12. These groups include several elliptical pipes which were counted in the round pipe equivalent size group. Siltation of the culverts were gauged in ranges from 0% to 100% and are distributed as follows: 0% - 44, 10% - 77, 25% - 50, 50% - 48, 75% - 15, 100% - 12 and unknown – 66 due to obstruction or submergence. Given that information, it appears that approximately 25% of the on-site culverts were operating at 50% or less capacity.

SECTION 4.0

HISTORIC SURFACE WATER CONDITION REPORT

4.0 HISTORIC SURFACE WATER CONDITION REPORT

4.1 BASIS

As noted previously, **Map 4,** Pre-Development Topography, was developed using an Army Corps of Engineers (ACOE) one foot contour maps from the Caloosahatchee River and Lake Okeechobee drainage basins surveys of 1929. This information was utilized as the basis for ECT's assessment of pre-development drainage patterns and basin mapping for the project. These maps were digitized and geo-rectified and have been included herewith in DVD - Appendix I.

These maps provided an excellent historical basis for assessing the pre-development condition as little significant alteration of the area had occurred up to that time. In addition to providing one foot topographical contour data, the 1929 maps provided stream locations, perceived basin limits and historical names as used at the time. It was noted during review of the 1929 basin delineation that several inconsistencies existed between the "historic" and current, commonly held basin limits. Specifically, the 1929 delineation combines the larger Cypress Creek basin with the lesser Spanish Creek basin into a single basin with two distinct outfalls. This appears to be based upon several mapped interconnections between the two primary stream lines as they progress northerly into the landscape. Secondly, the upper reaches of the Jack's Branch basin were mapped in 1929 as being tributary to the combined Spanish & Cypress Creeks basin. Jack's Branch basin is the easterly most basin affecting the BRP. The 1929 basin limits as shown on **Map 7**, Pre-Development Drainage Basins, indicates that the upper portion of the Jack's Branch basin (generally that portion north of what is now CR 720 in Glades County) as being tributary to the just described combined Spanish & Cypress Creeks basins rather than actually being tributary to Jack's Branch.

Comparative review of the 1929 contour map and the 1944-1946 aerials appears to indicate that the 1929 mapping was in error, at least as compared to the current condition and provides a clearer indication as to how this area could have been mapped as being tributary

to the combined Spanish & Cypress Creek basin rather than the actual outfall of Jack's Branch proper.

The 1944-1946 and later aerial photographs clearly show a forested slough connection between the upper and lower portions of Jack's Branch which is consistent with the modern day basin delineation. While the 1944-1946 aerial photographs provide evidence of a substantial slough interconnection between the area north of CR 720 with the area south of CR 720 and on to the southeast in Glades County, the topographic map and aerial photographs do provide some evidence of a possible historic hydraulic connection to the south-southwest from this area. This condition could possibly have been the basis for the way the 1929 basin limits were mapped as such in this area. Further, this is possibly substantiation that the upper portion of Jack's Branch may have been historically tributary to both the lower Jack's Branch and Cypress Creek basins particularly during larger storm events. Such connections are not unusual in flat land hydrology where a primary stream or slough will, during times of higher flow, exceed its normal limits and discharge to an adjoining basin.

4.2 TOPOGRAPHICAL SETTING

Review of the 1929 topography reveals a unique characteristic of the BRP in that the lands northeasterly of the site are the high point for several regionally significant watersheds. This area is the apex for not only the watershed's of the BRP and the afore mentioned Jack's Branch, but also for several regionally significant basins including Bee Branch watershed to the east of Jack's Branch, the Rainey Slough watershed and the Shell Creek basin. Land surfaces in this area generally vary from the low to mid 60's. Land surfaces slope radially downward from this apex. Related to the BRP, land surfaces generally slope westerly in the northern portion, southwesterly in the central portion and southerly in the eastern portion of the BRP.

The Telegraph Cypress Swamp (slough) slopes generally northwesterly to the southeasterly through its entire reach until near the southern limits of the BRP; where it tends to transition

from slough to incised natural and manmade channels and generally flows southerly or southwesterly to the Caloosahatchee River.

Slopes in this area are somewhat unique for this region and in some areas exceed 10 ft per mile. As the land surface approaches the slough, slopes begin to flatten and once in the slough, slopes become more typical of the region and are on the order of approximately 1.25 ft per mile. The general direction of slope within the slough is approximately 90 degrees to that of the slope coming off the ridge as previously described, with the slough flowing southeasterly towards the site's southern boundary. Towards the southerly boundary, the slough tends to broaden and the slopes flatten as flow widens out and is carried to the river by one of five creeks, branches, or gullies.

4.3 HISTORIC DRAINAGE BASIN LIMITS

With the understanding of the previous discussion regarding mapping, as noted, the historic drainage basins were developed using the 1929 ACOE contour maps. This information is provided in **Map 7,** Pre-Development Drainage Basins. The basins of relevance are from west to east, Trout Creek, Telegraph Creek, Fichter Branch, Cypress Creek, and Jack's Branch. ECT was unable to fully define the upper reaches of the Trout and Telegraph basins due to the limits of the 1929 map ending in these areas.

As discussed in the previous section there appears to be a possible relationship between the Jack's Branch and Cypress Creek basins along the site's eastern edge. The Cypress Creek basin covers approximately one third of the easterly portion of the site and includes minor drainages such as Spanish Creek and Miller's Gully. Similarly there are relationships between Telegraph, Fichter, and Cypress. Due to the lack of detailed topographic information the precise definition of these relationships is not fully definable and additional study would be required to establish the proportion of flows from Telegraph Swamp to each reach. The most likely circumstance is that although each reach functions under normal rainfall conditions as an independent flow path, when flows exceed the capacity of one it will overflow and interconnect with the next in a cascading fashion resulting in essence as a single watershed with multiple outfalls. As will be discussed later herein, the construction

of the Big Island and South Lightered canals have significantly altered this natural relationship between these historically intermingled watersheds.

This interconnectivity is illustrated by **Map 8**, Historic Flowways, where ECT, using reclassified soils and land uses, mapped hydric connections between the primary flow paths. This flowways map provides a view of the historic condition for the project site and illustrates the most likely flow paths as runoff meanders overland through marshes and prairies to sloughs and streams.

4.4 HISTORIC STREAMS

In addition to mapping of the predevelopment watersheds, historic streams were also identified using the 1929 contour maps. This information is provided as **Map 2,** Pre-Development Streams. The line work provided is not intended to represent incised creeks or channels for the full length of the line work shown but simply to represent approximate centerlines of flow whether it is via slough or creek. This information is significant when viewed in conjunction with the intensified drainage improvements that began around the middle of the last century. **Map 9,** 1940's Ditching, reflects the early stages of increased drainage improvements within the BRP. ECT utilized circa 1940s aerials for the purpose of defining the extent of early drainage efforts. The majority of the major canals that exists today are evident in this mapping establishing their existence presumably in a condition similar to that which they are in today for the past nearly 70 years. The mapping shows the Curry Lake Canal, the Big Island Canal, South Lightered Canal, Clay Gully Canal, Sugar Hill Canal, and North Unit Grade Canal are all evident. ECT estimates that there were approximately 170 miles of ditching onsite at the time of the 1940's aerial photography. It is noted that little ditching was done in or near the Telegraph Cypress Swamp proper at that time. With the exception of those noted, the majority of the ditching appears to have followed the tried and true method of connecting the wetland ponds with relatively short reaches of ditches/swales dug between various wet prairies and marshes to facilitate improved drainage.

4.5 ECOLOGICAL AFFECTS

Discussion with respect to the affects of the earlier drainage on the overall wetland extent and wetland condition, please refer to Section 6.0 herein below for information related to the ecological impacts of this early effort.

SECTION 5.0

SURFACE WATER CURRENT CONDITIONS

5.0 SURFACE WATER CURRENT CONDITIONS

5.1 INTRODUCTION

In order to establish a meaningful baseline for assessing the current surface water conditions at the BRP, ECT began by first assessing the historic condition and then evaluating changes over time as discussed previously in Section 4.0. This allowed for the contrast and comparison of the same system during two distinct eras, first without drainage improvements (1929/1944/1946) and then with drainage improvements (circa 2008). By comparing the historic condition with the current condition, it becomes evident, at least at a planning level, where restoration activity might be most productive.

5.2 TOPOGRAPHY

ECT compared the topographic information developed from the 1929 survey (**Map 4**, Pre-Development Topography and Current Conditions Topography) with that of the latest revision of the USGS quadrangle map contours (**Map 3**, Current Conditions Topography) for the project site. It is noted that ECT also reviewed the SFWMD Digital Elevation Model (DEM). However, given the DEM's grid spacing of 300 m and general questions related to the origins of the base data, it was determined that this information would be of little use to this project at this time. It is noted however, that as detailed topographical information, say in the form of additional LiDAR coverage becomes available; the use of a DEM for the site would prove very effective in establishing the basis for detailed regional hydrologic modeling.

Comparison of Maps 3 and 4, as provided on Map 4, indicates remarkably good continuity between the two topographic data sets, particularly given the vastly different technologies that were employed in the development of both.

5.3 CURRENT DRAINAGE BASIN LIMITS

Utilizing the current topographic information in conjunction with other GIS information including ditches, culverts, spillways, and streams, ECT remapped the current drainage

basin limits for the project. For the most part, the westerly most basin, Trout Creek, remained within the realm of interpretive error with the historic basin line as defined by the ACOE 1929 mapping and as shown on Maps 7 & 10 herein. The division between Jack's Branch and Cypress Creek was remapped in accordance with the discussion in the previous section with the current condition reflecting inclusion of the upper portion being tributary to Jack's Branch rather than Cypress Creek as mapped by the ACOE maps.

The most significant deviation from the historic to the current condition was the definition of the Telegraph Creek and Cypress Creek basins as functionally being one unit. While each system generally functions independent of the other during lesser storm events with durations less than the time of concentration for the watershed, storms with a duration approaching and exceeding the systems time of concentration would result in these systems' functioning as a single unit. Under normal design conditions this merger would not be a significant issue; however, when considered as a function of a hydrologic restoration project, it must be considered in the restoration planning. As such, ECT has mapped this unit as a single unit, referring to it as the Telegraph/Cypress Creek basin **(Map 10,** Current Conditions Drainage Basins**)** and recommends that any future modeling efforts should provide a detailed analysis of the interrelationship of these sub-basins.

5.4 STREAMS, CANALS, AND DITCHING

As illustrated in **Map 11**, Current Conditions Streams & Canals, the site has few remaining natural streams. For the most part the natural streams within the limits of the site have been improved by a primary and secondary canal and ditch system. The primary canal system has altered the hydrologic regiment for the overall site by redirecting surface runoff, in some cases across historic basin boundaries, and by improving the conveyance efficiency when compared to the historic sheetflow or slough flow condition. The most significant effect of this efficiency upgrade has been the alteration of the timing of runoff over the length of the basins. A good example of this is the affect of the South Lightered Canal in the lower eastern portion of the site. The South

Lightered canal is approximately 5 miles in length and has an elevation differential of around 20 ft or 4 ft per mile. Even a moderate cross section would provide a significant increase in discharge capacity when compared to historic overland flow conditions. Similarly, the North Unit, Sugar, Clay Gully, and Big Island canals have all substantially improved the conveyance capacity which has significantly shortened the flow timing for the majority of the site.

Of particular interest to this report is the channelization that has occurred in and adjacent to the Telegraph Cypress swamp itself. These channels have altered the timing of flow through the slough wetland system. It is noted that the impoundment of this slough by the dam along Hercules Grade has to some extent mitigated the impact of over drainage due by maintaining the hydroperiod of this system. While ECT did not conduct a quantitative analysis of this system, such an analysis could ascertain the effects the channelization and impoundment has had on the swamp system and its hydroperiod.

Map 12, Current Conditions Ditching, provides an illustration of the areal extent of ditching at the site. ECT estimates that there are approximately 556 miles of ditches within the limits of the BRP. For the purposes of this report, the term ditches is inclusive of ditches, canals and major swales. This represents just over a 325 percent increase in ditching since the time of historical assessment (circa 1940's). As discussed previously these ditches have altered the natural sheetflow condition for large portions of the site which has resulted in a decrease in the time it takes runoff to reach the site outfall points. This directly affects the sites historic capacity to store, infiltrate and purify waters discharging from the site. Development of a restoration plan for the BRP should consider the extent and necessity of the existing ditch network. Consideration should be given to abandonment, plugging and other alterations to the network to achieve desired restoration goals.

5.5 CULVERTS, PUMPS, AND WELLS

As noted in Section 3.0 above, a primary goal of ECT's engagement was to gather data for existing hydraulic facilities within the limits of the BRP. To that end, ECT identified

368 on-site culverts, 21 discharge pumps, 5 spillways, 3 weirs and 3 bridges (**Table 3**, Culvert/Structures Inventory Field Notes). **Map 13**, Structures Inventory, provides an illustration of the locations of these facilities relative to the mapped ditch system. While this particular graphic is quite busy, it reflects the relative intensity of the drainage improvements within the BRP. While the graphic is busy, the associated GIS data set should prove helpful to DOF staff in the establishment of future maintenance, assessment and restoration activities. For the most part, the culverts are concentrated along the major east to west roadways and in the areas around the more active agricultural centers such as the North Unit or South Lightered Area.

Qualitative information was gathered for each culvert such as general condition, direction of flow, degree of siltation. ECT also noted the relative height of the respective roadway above natural grade. This is significant in that elevated roadways effectively divert sheet flow from its general southwesterly direction to a more due westerly channelized direction towards the Telegraph Cypress swamp, in many instances crossing historic basin limits. Assessment of the capacity of the more significant culverts to determine their adequacy would be an appropriate initial restoration step. As part of an overall restoration plan, assessment of the effects of redirection of flow and restoring the sheet flow conditions also would be appropriate initial steps.

ECT also identified 21 surface water discharge pumps. These are primarily located in the South Lightered and Lee County farming areas. Typically, these pumps discharge from the farm operations into adjacent above ground impoundments that have been permitted by the South Florida Water Management District (SFWMD). **Map 14,** Crescent B Ranch – Agricultural Fields, provides an illustration of the locations of the impoundments that have been permitted by SFWMD for the BRP. ECT did not conduct a qualitative analysis of the condition of these facilities during the field recognizance effort; however, it was noted during the regulatory review that remedial maintenance of several of these systems was prescribed by the SFWMD. It is noted that pursuant to the rules of the SFWMD these facilities are required to be inspected in March of each year to evaluate the integrity of the system and its readiness for the oncoming rainy season. These reports

are required to be retained by the property owner and produced upon request by SFWMD. ECT is familiar with this process and has conducted such inspections at numerous agricultural facilities throughout southwest Florida over the years. It is assumed that these inspections will be handled in the coming spring as they have in the past by the Ranch management. It is suggested that BRI obtain copies of the above ground impoundment inspection reports and retain them on file. Further, it is suggested that an overall compliance audit be conducted to insure that all permitted facilities are in compliance with SFWMD requirements and permit conditions.

Several flowing artesian wells were located during the field recognizance effort. It is noted that these wells are required by Florida Administrative Code (F.A.C) to have working values so that flow can be controlled and that they are to be used in accordance with the requirements and limitations of a Consumptive Use Permit (CUP) issued by SFWMD. ECT was unable to ascertain whether or not these particular wells were covered by a current CUP. As such it is suggested that a site wide assessment to identify existing and abandoned wells on the BRP be conducted to confirm compliance with the requirements of the applicable SFWMD requirements and permit conditions.

It is noted that during our inspections, ECT did not identify any overt signs of permit non-compliance. Our recommendations herewith for Environmental Resource and Consumptive Use permit compliance audits are strictly for purposes of establishing a baseline datum to insure compliance with all SFWMD regulatory requirements and to establish an ongoing monitoring program for the BRP going forward.

5.6 EXISTING SURFACE WATER MONITORING

As noted previously herein, there is very limited surface water monitoring data within the area of the BRP. With the exception of the Lee County stage monitoring of Telegraph Creek and the USGS flow and stage monitoring station, also on Telegraph Creek, very little information is available. It is suggested that a viable source of valuable data is in fact the regulatory files accompanying this report. Mining of data, both relatively recent and historic could prove beneficial for use in future hydrologic modeling efforts.

ECT has reviewed the details of the monitoring proposed by the BRC. Therein the BRC is proposing long term monitoring of multiple data stations for the purpose of developing model quality field parameters for ongoing and future model calibration efforts. While, for the most part, the BRC program is focused on lands within its own limits, there are numerous groundwater and surface water monitoring stations existing and proposed on the BRP and its tributaries. As will be discussed in Section 7.0, ECT believes that given the unique relationship between the BRC and BRP that a joint monitoring program would be most beneficial.

SECTION 6.0

HISTORIC & CURRENT WETLAND & FLOWWAY MAPPING ANALYSIS

6.0 HISTORIC & CURRENT WETLAND & FLOWWAY MAPPING ANALYSIS

Historically, the BRP was dominated by mesic flatwoods and cypress swamps. Other wetland communities, particularly hydric flatwoods, herbaceous marshes and wet prairies were also located throughout the property. Although mesic flatwoods are considered to be an upland plant community, these pinelands characteristically have water at or above the ground surface for at least short periods during wetter portions of the rainy season. As the water level rises and exceeds land surface, it will tend to move down gradient at a rate dependent upon slope and land cover. This condition is known as sheetflow. It is likely that significant portions of the BRP would have been subject to this condition during normal rainfall years.

In order to better control this condition, prior to the mid 1940's, drainage improvements were implemented in association with the working Crescent B Ranch to create a system of swales, ditches, canals and associated culverts and other structures to manage and control surface waters at the BRP. The resulting drainage network has, over time, altered the historic hydroperiod and affected seasonal high water levels generally resulting in: (1) A waterward migration of flatwood/hammock species such as cabbage palm (*Sabal palmetto*), South Florida slash pine (*Pinus elliottii var. densa*) and hardwoods; (2) The migration of transitional wetland plant species into areas that were historically permanent open water features such as the centers of marshes and cypress domes and openings in cypress strands; and (3) Provided opportunities for invasive vegetation such as Brazilian peppers (*Schinus terebinthifolius*) and melaleuca (*Melaleuca quinquefolia*) to become established.

Historically the Ranch has, and to this day, continues to employ sound land stewardship practices by retaining large tracts of flatwoods intact and by replanting pines as they are harvested, limiting the past harvesting of cypress to certain areas, eliminating the harvest of cypress from the future land management plan and by implementing a prescribed burning program for timber management and exotic species controls throughout the

property. Proper implementation of these stewardship practices has resulted in the BRP being predominantly native upland and wetland habitats that link with other conservation lands and lands under private ownership to form a critically important, interconnected wildlife and hydrological corridors.

6.1 METHODS

In an evaluation of how the existing wetlands and flowway systems could be restored to a pre-development condition, it is important to establish a historic planning baseline of vegetation patterns and then to assess how those patterns have changed over time. In order to assess changes in vegetative cover from historical to current conditions, ECT utilized two sets of existing vegetation maps. For the historic condition, ECT utilized the Southwest Florida Pre-Development Vegetation Map (Duever, 2009). For the purposes of this work, Dr. Duever defined "pre-development" as the condition of the landscape prior to the arrival of Europeans in southwest Florida. Dr. Duever opted to use this point in time as it was an era when native hydrology and fire regimes were the primary determinants of plant community distributions. The "Duever map", as it has come to be known and as it will be referred to herein, was designed to show "pre-development" vegetation as a function of primarily soil type and relative landscape position.

As illustrated on **Map 15,** Pre-Development Land Cover, many areas within the BRP currently have very different land covers from those predicted by the Duever map. Changes in plant community types over time can be the result of altered hydrologic, fire regimes and/or the presence of invasive exotic plants. Dr. Duever's classification system was limited to fifteen (15) distinct community types. On the BRP, Dr. Duever identified eleven (11) of the fifteen plant communities. Given the scale of the original mapping effort that resulted in the development of the Duever map, ECT conducted a truthing effort by overlaying the map onto 1944 & 1946 aerials. This exercise resulted in minor corrections and the inclusion of several smaller, previously omitted, wetlands.

For the existing or post-development vegetation map, ECT used the 2004 land use/cover map produced by SFWMD for both easterly Charlotte and Lee Counties. The SFWMD

map was overlaid onto 2008 aerial photographs and revised, where necessary, to address identified inconsistencies. **Map 16,** Current Conditions Land Cover, presents the post-development vegetative cover.

It is noted that a more recent vegetation map was produced by the Florida Natural Areas Inventory (FNAI) of the BRP in 2008. Even though the SFWMD map is earlier than the FNAI map, it was found to be more accurate and, unlike the FNAI map, uses a classification system similar to that used by the Duever map. The Duever map utilized an older system of land use/cover classification, while the SFWMD map used a more recent version of the Florida Land Use Cover and Forms Classification System (FLUCFCS). In order to evaluate the changes in plant community acreages and percentages between the two maps and utilize a standard, accepted system of land use/cover classification. ECT converted the pre-development and post-development land use/cover map classifications into the most current version of FLUCFCS (FDOT, 1999) on both Map 15 and Map 16. In as much as the Duever mapping project predicts historic communities, the level of discernment was by the nature of the objective, limited. This is illustrated by there only being fifteen classifications utilized in the effort. This limitation makes it difficult to compare apples with apples. As such ECT;s perspective focused more on the trends and areas of mass shifts rather than looking at issues on an acre per acre basis.

As noted previously, FNAI conducted a thorough assessment of the plant communities and animal populations on the BRP in 2008. The assessments included a native plant species inventory by vegetation type, a mapping of listed and rare plant and animal species, and a mapping of invasive plants. Because the reports generated by FNAI include detailed descriptions and plant species lists, this report will only endeavor to provide enough information to properly describe the historic and existing plant community types on the BRP.

ECT reviewed and relied heavily on the Babcock Ranch Preserve Management Plan and the FNAI ecological survey reports (May 2008 a through d) as well as other available research data and field surveys conducted in May 2009 for the ecological information

provided in this report. The following narrative discusses the historic and existing plant communities and land uses on the BRP.

6.2 DESCRIPTION OF HISTORIC AND EXISTING VEGETATION COMMUNITIES/LAND USES

On the pre-development map (Duever map), the upland plant communities were originally identified as mesic and xeric flatwood and mesic and xeric hammock, while the wetlands included cypress, swamp forest, hydric hammock, hydric flatwood, marsh, and wet prairie. Small areas were also mapped as open water. The existing conditions map includes most of the same historic community types and several additional community types that are a product of man-made disturbances and/or natural succession. A table indicating the acreages and percentages of land uses & cover types for both pre-development and post-development conditions on the BRP is provided (**Table 4**, Pre & Post Development Land Use/Cover Types). The following provides a comparative discussion of the Pre and Post Development conditions.

6.2.1 FORESTED UPLANDS

Since the exact plant species composition cannot be determined for the pre-development condition, the closest representative FLUCFCS codes for the historic upland forest types on the BRP were utilized: 411-Pine Flatwoods (Mesic Flatwood), 412-Longleaf Pine-Xeric Oak (Xeric Flatwood), 421-Xeric Oak (Xeric Hammock), and 425-Temperate Hardwood (Mesic Hammock). The current conditions map identifies the native upland plant community types as 411-Pine Flatwoods (historic Mesic Flatwood), 420-Upland Hardwood Forests (historic Mesic Hammock), 427-Live Oak (historic Xeric Hammock), 432-Sand Live Oak (historic Xeric Flatwood) and 434-Hardwood-Conifer Mixed (historic Mesic Hammock).

Pine flatwoods can be characterized as open, poorly drained flat lands with sandy soils and an open canopy of pines. These piney woods require frequent burning to maintain an open character. The upland pine flatwood communities on the BRP can be characterized

as either mesic flatwoods (i.e., occurring on sites with a water table close to the ground surface for most of the summer rainy season, but only above ground for short periods during most years) or xeric flatwoods (i.e., occurring at the higher topographic elevations and on well-drained, deep sands). A little over half of the historical mesic flatwood on the site either were converted to agriculture or had the pines harvested (i.e., the percent cover of mesic flatwood has decreased from 64.6 to 35.0 percent on the BRP). Nevertheless, mesic flatwood is still the major plant community type on the BRP.

On the BRP, the mesic to xeric pine flatwoods are mostly dominated by an open canopy of South Florida slash pine, except in the northeastern portion of the BRP where longleaf pine (*Pinus palustris)* predominates (approximately 5,626 acres). The present transition from South Florida slash pine to longleaf pine is probably close to the historical transition line of the property (Kappes and Costa, 2008). The growth of longleaf pines is most probably dictated by hydrological gradients more than to past logging practices in that South Florida slash pine tends to replaces longleaf pine in the transition from drier to wetter conditions within the forest canopy.

Depending upon the frequency and duration of fire, the understory of pine flatwoods are typically dominated by saw palmetto (*Serenoa repens*) on moister or mesic sites and scrub oaks (i.e., *Quercus geminata, Q. chapmanii, and/or Q. myrtifolia)* on drier or xeric locations.

Approximately 39.4 acres of mesic hammock historically occurred at the northeast corner of the BRP. Currently, the former mesic hammock area is mostly open mesic and hydric flatwoods. As a rule, when wild fires are suppressed for long periods in mesic flatwoods, hardwood trees such as live oaks (*Quercus virginiana*) tend to establish a mesic hammock. As such, it is apparent that the BRP burn management program has been successful in maintaining the open character of the pine flatwoods over the years.

There are areas throughout the mesic flatwoods at the BRP where fire has suppressed the growth of hardwoods, but where cabbage palms have become a subcanopy component. Cabbage palms tolerate burning and flooding and are usually associated with calcareous

or loamy soils overlying bedrock within one meter of the ground surface (Browder and Ogden, 1999).

The Duever map identified limited areas of xeric flatwoods and hammocks in a few locations in the southern end of the BRP. The Duever map indicates there were historically 146.8 acres of these xeric communities (i.e., 42.8 acres of xeric flatwoods and 104.0 acres of xeric hammock). The current era mapping shows approximately 16.6 acres of xeric oaks occur on the BRP, which well could be remnant xeric flatwoods with the pines removed. It further indicates approximately 213.6 acres of wooded pasture occurs at the southeastern corner of the property, which could be remnant xeric hammock.

In addition to the native lands discussed thus far, there are five upland plant community types of significance on the site. All of which are a consequence of man's intervention. They are 422-Brazilian Pepper, 424-Melaleuca, 441-Coniferous Plantations, 442-Hardwood Plantations, and 443-Forest Regeneration Areas. The first two classifications refer to uplands which have been disturbed and invaded by exotic shrubs and trees.

Neither the Brazilian Pepper nor the melaleuca are prevalent within the BRP, but they do occur in dense local populations or as scattered individuals. The BRP has and continues to control the growth of these two exotic species on the BRP. In addition to these two exotic-dominated upland community types, there are portions of the flatwoods on the property that have been completely harvested of pines and then re-planted with South Florida slash pine. These occur as areas that are planted in pine (FLUCFCS 441) and areas that are planted or will be planted in pine and not used for another land use (FLUCFCS 443). Finally, the 442-Hardwood Plantations on the BRP refer to areas that were planted with eucalyptus trees.

6.2.2 NON-FORESTED UPLANDS

Open natural treeless grasslands, known as Dry Prairie, were not mapped by Duever on the pre-development map, but are presumed to have occurred. Native dry prairie is

similar to pine flatwoods in that it is frequently burned and shares the species compositions of the shrub and ground layers. The presumably the native grasslands were converted for use as pasture for beef cattle production. Currently, the open grassy uplands on the BRP mostly consist of improved pastures, sod farms, fallow croplands, and wildlife food plots. FLUCFCS code of 310-Herbaceous (historic Dry Prairie) was used for areas where the tree and shrub layer of the former pine flatwoods has been removed and native grasses became predominate or where crop and pasture areas have been abandoned with native grasses becoming established, or where natural remnant dry grasslands may still occur.

6.2.3 FORESTED WETLANDS

Forested wetlands on the BRP are dominated by pine, cypress, mixed hardwoods, or a combination thereof. Currently, the BRP contains 617-Wetland Mixed Hardwoods (historic Swamp Forest or Hydric Hammock), 620-Wetland Coniferous Forests, 621-Cypress (historic Cypress Swamp), 624-Cypress-Pine-Cabbage Palm, 625-Hydric Pine Flatwoods (historic Hydric Flatwood), and 630-Wetland Forested Mixed.

Wetland Mixed Hardwoods are forested wetlands with a canopy dominated by a large variety of hardwoods tolerant of hydric conditions, but which typically exhibit an ill-defined mixture of species. These swamps typically dominate sites that burn infrequently and are located where cypress was a significant component on the pre-development landscape. These forested wetlands are dominated in the canopy by a mix of Carolina ash (*Fraxinus caroliniana*), swamp tupelo (*Nyssa sylvatica var. biflora*), swamp red bay (*Persea palustris*), red maple (*Acer rubrum*), dahoon (*Ilex cassine*), laurel oak (*Quercus laurifolia*), cabbage palm, and/or American elm (*Ulmus americana*). Depending upon the canopy dominants, this forested wetland classification could be what were historically referred to as swamp forest or hydric hammock.

Historically, there was much more hardwood swamp on the BRP. The majority of this wetland forest type now appears to be cypress swamp. Cypress is more tolerant to fire than hardwoods, which could be the reason why there is more cypress currently present

on the property. Cypress swamp occurs on the BRP within circular depressions (Cypress Domes) and elongated flow-ways (Cypress Strand).

Cypress domes mostly occur in mesic/hydric flatwoods, but can also be found in large areas of wet prairie and basin marsh. Cypress domes are characterized by a dominance of pond cypress in the canopy layer. Other wetland trees that occur in the canopy or subcanopy layers include red maple, South Florida slash pine, laurel oak, and cabbage palm. Cypress strands are low-lying drainages of slow moving water that are dominated by pond cypress and bald cypress. Other wetland trees found in the canopy/subcanopy include red maple, Carolina ash, dahoon, swamp tupelo, swamp red bay, South Florida slash pine, laurel oak, water hickory (*Carya aquatica*), and cabbage palm.

The most prominent representative examples of cypress strand on the BRP are Telegraph Swamp and Jack's Branch. Jack's Branch is a relatively undisturbed cypress swamp system occurring in the northeast corner of the BRP.

Jack's Branch is discussed elsewhere herein, but briefly, is dominated by pond cypress in the canopy. Other trees/large shrubs in Jack's Branch include Carolina ash, cabbage palm, dwarf palm (*Sabal minor*), hybrid sabal palms (*Sabal minor x S. palmetto*), buttonbush (*Cephalanthus occidentalis*), and live oak.

Telegraph Swamp, which occurs in the western half of the property, is the largest wetland/surface water flowway system on the BRP and is oriented and drains from the northwest to the southeast. The majority of the surface runoff on the BRP is diverted by the network of swales, ditches, canals and channelized streams and wetlands into Telegraph Swamp that ultimately discharges southerly into the Caloosahatchee River in Lee County.

Telegraph Swamp can be characterized as an expansive, controlled drainage with slow-moving water that experiences long periods of flooding. It is dominated by pond and bald cypress, but other trees present include South Florida slash pine, swamp tupelo, cabbage palm, laurel oak, red maple, swamp red bay, live oak, dahoon, and Carolina ash. Large

shrubs occurring within Telegraph Swamp include pond apple (*Annona glabra*), buttonbush (*Cephalanthus occidentalis*), wax myrtle (*Myrica cerifera*), hog plum (*Ximenia americana*), Florida bully (*Sideroxylon reclinatum*), myrsine (*Rapanea punctata*), small-leaf viburnum (*Viburnum obovatum*), groundsel tree (*Baccharisi halimifolia*), Peruvian primrosewillow (*Ludwigia peruviana*), Carolina willow (*Salix caroliniana*), and Brazilian pepper.

Portions of Telegraph Swamp were historically harvested for cypress with the most recent harvest occurring just prior to acquisition. The current management plan prohibits the future harvest of cypress on the BRP.

Telegraph Swamp is flat across most of the northern reach. A ditch/canal was cut into the central portion of the northern reach to promote drainage to the southern reach, which consists of a deeper, broader basin. A concrete dam with flashboard risers and an at-grade concrete road was placed across the southern end of the ditch along the Tram Road Grade crossing of the northern reach to regulate flow rates. In the early 1970s, an earthen dam was built across the southerly portion of Telegraph Swamp to hold back the normal runoff at the end of the summer rainy season (part of Hercules Grade). The dam contains water control structures at three separate locations (i.e., concrete weirs with flashboard risers and a concrete at-grade road crossing). The dam can function in the storage of approximately 5 billion gallons of water (Article by Greg Martin, Sun-Herald, April 7, 2003).

Openings in the forest canopy occur throughout Telegraph Swamp. As previously discussed, the canopy openings are mostly due to past timbering activities (i.e., tree clearing/thinning) and other anthropogenic affects. Other aspects contributing to the persistence of such opening may also be related to flooding, senescence, windthrow, soil subsidence, and/or fire. Some of the openings have become infested with exotic vegetation. Of concern is the Old world climbing fern (*Lygodium microphyllum*) which appears to be systematically growing up and over mature cypress trees throughout Telegraph Swamp, but mostly near disturbed openings and edges. This exotic climbing

fern shades out native vegetation and carries fire up into the tree canopy, which can result in the death of the cypress trees. Within clear-cut areas in proximity to pastures, cattle have maintained these openings in an open herbaceous/shrubby condition by grazing or trampling.

Along the dam on Hercules Grade, the cypress swamp has been substantially disturbed due to the presence of the dam. Dead or dying cypress trees were evident as were signs of burning. The extensive presence of dog fennel (*Eupatorium capillifolium*) suggests droughty conditions which have allowed for their establishment. Also noted in this area were Peruvian primrose willow, melaleuca, and Brazilian pepper which have invaded and are growing in dense associations primarily along the south side of the dam. Management should take note of this condition as an intense fire could provide an ideal opportunity for these exotic species to quickly become established.

In comparing the pre-development and existing land covers, it is apparent that the historic areas of hardwood swamp forest have been mostly replaced by cypress swamp on the BRP (i.e., mixed wetland hardwoods cover has decreased from 2,864.6 acres to 29.3 acres and cypress swamp has increased from 7,519.0 acres to 9,528.6 acres). This is most evident in the Telegraph Swamp system. The change in the forest canopy dominant in Telegraph Swamp may be attributed to one or a combination of the following occurrences:

1. The retention of flood waters by the dam and weir structures extended the duration of the normal annual flood regime that resulted in the mortality of wetland hardwoods and eventual replacement by cypress (i.e., wetland hardwoods are less tolerant to flooding than cypress [Hugget, 1998]); and/or

2. During extreme drought periods, fires occurred within the dry swamp system killing the hardwoods and leaving the more fire-tolerant cypress to again eventually fill in the gaps.

Finally, there are two types of pine dominated forested wetlands which occur onsite: Cypress-Pines-Cabbage Palms and Hydric Pine Flatwoods. Hydric pine flatwoods occurs on very poorly drained sites which are shallowly inundated for several months of each year. Hydric flatwoods are open forests with a canopy of South Florida slash pines and an understory of wetland grasses, herbs, forbes, and shrubs. Basically, hydric flatwoods are wet prairies with pine trees. The Cypress-Pines-Cabbage Palms community type is similar to hydric flatwoods, except for the presence of pond cypress and cabbage palms in the canopy and subcanopy layers.

6.2.4 NON-FORESTED WETLANDS

There are two major non-forested wetland types occurring on the BRP, namely 641-Freshwater Marshes (historic Marsh) and 643-Wet Prairies (historic Wet Prairie). The freshwater marshes onsite can be further separated into two distinct types: namely basin and depression marshes. Basin marshes differ from depression marshes by having an irregular shape, larger size, longer hydroperiod, and presence of a deep peat layer. Depression marshes are smaller, circular systems with distinct vegetation zonations and a deeper water center.

Marshes on the BRP are vegetated by a variety of wetland emergents. Generally, within the deeper water zones the marshes are vegetated by maidencane (*Panicum hemitomon*), pickerelweed (*Pontederia cordata*), bulltongue arrowhead (*Sagittaria lancifolia*), and sawgrass (*Cladium jaimaicense*), while the shallower transitional zones support St. Johns-wort (*Hypericum fasciculatum*), blue maidencane (*Amphicarpum muhlenbergianum*), myrtleleaf St. Johns-wort (*Hypericum myrtifolium*), southern umbrellasedge (*Fuirena scirpoidea*), erectleaf witchgrass (*Dichanthelium erectifolium*), falsefennel (*Eupatorium leptophyllum*), Elliott's yellow-eyed grass (*Xyris elliottii*), rosey camphorweed (*Pluchea rosea*), Tracy's beaksedge (*Rhynchospora tracyi*), low pinebarren milkwort (*Polygala ramosa*), bluejoint panicum (*Panicum tenerum*), yellow hatpins (*Syngonanthus flavidulus*), and longleaf threeawn (*Aristida palustris*).

Wet prairie are nearly treeless, poorly drained flat land with scattered shrubs and dominated by a mixture of transitional grasses, forbes, and herbs. The plants that typically occur in the shallower reaches of marsh also occur throughout the wet prairie. Other typical plants found within the wet prairies onsite include Queensdelight (*Stillingia sylvatica*), alligatorlily (*Hymenocallis palmeri*), tenangle pipewort (*Eriocaulon decangulare*), pineland heliotrope (*Heliotropium polyphyllum*), Leavenworth's tickseed (*Coreopsis leavenworthii*), pineywoods dropseed (*Sporobolus junceus*), slenderfruit nutrush (*Scleria georgiana*), piedmont marshelder (*Iva microcephala*), clustered bushmint (*Hyptis alata*), gaping panicum (*Panicum hians*), and sand cordgrass (*Spartina bakeri*).

Wet prairies differ from hydric flatwoods by having less pines and a longer hydroperiod. Wet prairies are different from marshes by having a shorter hydroperiod, shorter herbage, more grasses/forbes, and a sandy substrate. Wet prairies are also more shallowly inundated than marshes during the wet season. Wet prairie occurs along the shallower edges of marshes and in association with mesic and hydric flatwoods.

In the absence of fire, woody shrubs tend to invade herbaceous wetlands with wax myrtle dominating in wet prairies and Carolina willow in marshes. Eventually trees will colonize these shrubby sites, with pine forest dominating in drier areas and cypress and/or mixed hardwood swamp in wetter areas. Almost all of the marshes/wet prairies located within pine flatwoods at the BRP do not have a shrubby overstory indicating that the fire management program has been instrumental at maintaining an open, herbaceous character. Even with the advent of fire, the shallow edges of marshes and wet prairies have pines encroaching from adjacent flatwoods, which appears to be a consequence of shortened hydroperiods associated with ditching and/or the prolonged drought conditions.

Over time, the open expanses of wet prairies, which were much more prominent historically, will be replaced with hydric flatwoods. Approximately 345.8 acres of marsh and 4,387.5 acres of wet prairie historically occurred on the BRP. Currently, there are 4,310.7 acres and 1,735.5 acres of marsh and wet prairie, respectively (i.e., an increase of

3,964.9 acres of marsh and a decrease of 2,652.0 acres of wet prairie). The increase in marsh acreage could be attributed to a mapping error (i.e., the differences in marshes versus wet prairies on aerial photography may not be readily apparent) and/or the removal of pines in hydric flatwoods, which creates an open herbaceous wetland condition (i.e., the acreage of hydric flatwoods has decreased from 10,592.4 acres to 5,153.1 acres).

Another non-forested wetland type occurs on the BRP albeit in much smaller acreage than either marsh or wet prairie, namely 644-Emergent Aquatic Vegetation. This category of wetland includes both floating-leaved plants such as yellow pond lily (*Nuphar advena*) or fragrant white water lily (*Nymphaea aquatica*) and free floating vegetation such as water hyacinth (*Eichhornia crassipes*) or duck weed (*Lemna* spp.). These wetlands are actually deep water areas that are inundated for most of the year, which typically occur as openings within larger systems such as cypress strands.

6.2.5 AGRICULTURE/SILVICULTURE

Historically, portions of the native habitats on the BRP were partly or completely converted to agriculture (i.e., row crops, sod and other field crops, citrus groves, cattle pasture/rangeland, etc.) or harvested for timber. Controlled burns were used to keep underbrush down for timber harvesting. In addition, the ranch has and continues to eradicate noxious vegetation such as water hyacinth, old world climbing fern, melaleuca, and Brazilian pepper and destructive wildlife species such as wild pigs.

By the late 1930s, all of the pine and most of the cypress had been logged off the site. From 1962 to the 1990s, some tracts have been harvested up to three times. In recent years from 1998 to 2006 approximately 1,200 acres of cypress have been harvested from the BRP.

The existing vegetative cover map identifies agricultural (200 series) and rangeland (300 series) FLUCFCS land use categories on the site (see Map 16). The agricultural and rangeland land uses on the BRP consist of 211-Improved Pasture, 212-Unimproved

Pasture, 213-Woodland Pasture, 214-Row Crops, 215-Field Crops, 221-Citrus Groves, 260-Other Open Lands, 320-Shrub and Brushland, 321-Palmetto Prairies, and 330-Mixed Rangeland.

Based on the review of aerial photographs, there does not appear to have been any drastic changes in the extent of agriculture or type of agricultural use on the property from 2004 to 2008. However, it should be noted that crop and pasture lands are rotated and what may be row crops one year might be pasture the next. There are three primary types of pasture on the BRP: improved, unimproved and woodland. Improved pasture is open land dominated by pasture grasses such as bahia grass (*Paspalum notatum*) and Bermuda grass (*Cynodon dactylon*). The improved pasture on the BRP consists of converted natural communities or row crops/sod fields. Improved pasture occurs throughout the BRP, including along the floodplain edges of the Telegraph Swamp system.

Some of these improved pasture areas are still wet, even with ditching, and support the growth of wetland plants. These wet pastures are mostly mapped as having either depressional soils or other sandy soils that mostly exhibit a hydric condition. The wet pastures were vegetated by torpedograss (*Panicum repens*), West Indian marsh grass (*Hymenachne amplexicaulis*), prairie iris (*Iris hexagona*), turkey tangle fogfruit (*Phyla nodiflora*), Virginia buttonweed (*Diodia virginiana*), Bermuda grass, bahia grass, pickerelweed, bulltongue arrowhead, manyflower marshpennywort (*Hydrocotyle umbellata)*, false hop sedge (*Carex lupuliformis*), Nuttall's thistle (*Cirsium nuttallii*), winged loosestrife (*Lythrum alatum*), wax myrtle, and red maple. Some remnant and naturally recruited cypress was evident along improved pastures where areas of flatwoods and cypress domes were previously converted. However, no natural recruitment of cypress was observed within the wet pastures along Telegraph Swamp.

Unimproved or woodland pastures are lands that have been partially modified for livestock grazing, but retain some characteristics of the original plant community. Typically, the unimproved pastures consist of a patchy mixture of pasture grasses and mesic flatwoods vegetation, while the wooded pastures tend to have an understory of

pasture grasses with an open or sometimes closed canopy of trees such as South Florida slash pine and live oak.

The row crops on the BRP include but are not limited to tomatoes, bell peppers, yellow squash, and watermelon (FLUCFCS 214). Typically, watermelon or some other vegetable is planted and harvested in the spring, the fields are then disked and re-planted with bahia grass seed to convert the fields into pasture, cattle graze on the pasture for up to five years at different frequencies and then the low grade or field sod is finally harvested (i.e., a vegetable-pasture-bahia grass sod rotation cycle). In addition, approximately 350 acres of sod farms produce high end turf grass (St. Augustine, Bermuda grass and Zoysia grass) on the BRP (the FLUCFCS category of 215-Field Crop is used for sod farms and hay fields, because without field checks it is difficult to ascertain production using aerial photography alone.). Three separate areas of citrus grove are located on the southeastern end of the property (FLUCFCS 221). When ranch/farm related structures are evident on the aerial photography such as pens and barns, but the structures and/or intent for use is not known, the FLUCFCS 260 classification was utilized. Finally, portions of the natural upland flatwoods on the site have either been utilized as rangeland for cattle and/or altered through timber harvesting activities to create open rangeland dominated by a mixture of shrubs (FLUCFCS 320) or saw palmetto (FLUCFCS 321). When more than one-third intermixture of either grassland or shrub and brushland range species occurs the specific classification is changed to mixed rangeland (FLUCFCS 330).

6.2.6 SURFACE WATER FEATURES

The surface waters on the BRP consist of natural features such as open water areas in cypress strands (some of these areas were mapped as FLUCFCS 520-Lakes on the current conditions map and as 560-Slough Waters [historic Water] on the pre-development map); the deep water centers of depression marshes and cypress domes; and creeks and man-made features such as canals/ditches, cattle ponds, and borrow ponds.

Ditches and ponds are classified as 510-Streams and Waterways and 530-Reservoirs or Cattle Ponds, respectively. Most of the ponds on site are small and used to water livestock (i.e., 530-Reservoirs or Cattle Ponds). Some of the ponds were created through the excavation of road fill and then abandoned (i.e., 160-Extractive or Borrow Ponds). Some wetland areas on the BRP were bermed and/or given names that indicate the depressions/basins fill up with water during the rainy seasons to give the temporary appearance of a lake or pond, but are in actuality shallow water wetlands for most of the year (e.g., Boyd Bay, Long Pond, Duck Pond, Possum Pond, Ocean Pond, Curry Lake, etc.).

The ditches are of various sizes, but mostly narrow and shallow, except for the major named canals such as South Lightered, Sugar Hill, Clay Gully, Big Island, etc. Only some of the larger ditch systems, which were easily discernable on the aerial photographs, were included on the current conditions vegetation map. The deepest/widest ditch/canal appears to be the system cut through the center of Telegraph Swamp in the northern reach. The ditches were all dug to facilitate drainage of agricultural sites.

Natural creeks also occur on site such as Telegraph Creek, Clay Gully, etc. The pre-development map had a small acreage of open water mapped for Telegraph Creek. However, some of the stream channels were not readily identified from aerial photography and therefore were not mapped on the existing map. Telegraph Creek is the southern outfall for Telegraph Swamp. Clay Gully is a partially channelized creek system which drains areas in the northeast to the central part of Telegraph Swamp.

6.2.7 URBAN AND BUILT UP LAND USES

Currently, the BRP also contains buildings/structures associated with ranch operations, barns, cattle pens, sheds, storage buildings, eco-tourism business facilities, old/abandoned hunting camps, an institutional facility, and active residences. Since the urban and built up components of the property are not significant in terms of acreage/percentage, these land use types will not be discussed. However, these developments are depicted on the

existing map, where identified (i.e., 100-Urban and Built-Up, 110-Low Density Residential [includes single-family residences and hunting camps], 130-High Density Residential, 140-Commercial and Services, 145-Tourist Services, 170-Institutional, and 189-Other Recreational).

6.3 HISTORIC & CURRENT FLOWWAY MAPPING

Map 8, Historic Flowways, was prepared by ECT using information for the USDA Soil Survey for Charlotte and Lee Counties using ESRI ArcEditor software. ECT in cooperation with the local office of the USDA, complied a database of all existing soil types within the BRP and reclassified them as a function of their respective water table depth and duration. This effort was limited to six (6) categories which were Open Water, 100% Wetlands, 75–95% Wetlands, 20-40% Wetlands, < 20% Wetlands and Uplands. Base maps of the BRP were prepared using this methodology and overlaid on the historic aerial map set. The polygons were edited and adjusted to correct any inconsistencies and to address minor mapping errors. ECT then added in the incised portions of the natural creeks flowing from the BRP. Typically incised streams and creeks occur irrespective of soil type and frequently occur in and through upland soils.

The Historic Flowways map provides a clear perspective on the nature and extent of the naturally occurring historic flow regime at the BRP. This information in conjunction with the provided topographic information well illustrates the areal extent of the historic flowways at the BRP. As has been discussed herein, the natural historic condition allowed flow to begin as sheetflow in many areas ponding in the various marsh areas prior to staging up and continuing to flow towards the broader flowways and thence on to the various incised channels which occur closer to the Caloosahatchee River.

Utilizing GIS, these shapefiles can be overlain onto the historic and or current ditch shapefiles to illustrate areas where ditches could be potentially remediated to restore a more historic flow regime. Further, the user can include the facilities inventory shapefiles to determine areas where culvert size and distribution could be altered to provide a broader section of flow under the various farm roads located throughout the

site. Similarly, the user can combine the Crescent B Ranch map (#14) with the Historic Flowways map to determine what if any alterations might be considered to the current flow conditions in and around the rotating and permanent agricultural operations. It is noted that prior to initiation of any significant alteration near the perimeter of the BRP which could potentially affect off-site or downstream landowners, a proper assessment and design effort should be undertaken.

SECTION 7.0

SUMMARY REPORT AND RECOMMENDATIONS

7.0 SUMMARY REPORT & RECOMMENDATIONS

Project Task Summary

Pursuant to ECT's engagement document with the Division of Forestry, seven (7) specific tasks were assigned under the terms of our agreement. Each of the seven tasks provided for specific deliverables and actions. This section will address those requirements and conclusions associated there with.

Task I – Existing Document Review and Analysis

ECT's efforts in this regard were intended to provide a general assessment of the extent and to a lesser degree specific content of archival information available in the public domain. To that end, ECT reviewed numerous reports and documents as previously discussed Section 2 of this report. The summation of this assessment is that there is a fairly extensive library of available GIS data available concerning the BRP. A substantial portion of that information that is related to the hydrologic condition of the BRP has been included in Appendix I of this report.

ECT conducted a comparative analysis of historically progressive aerials beginning with circa 1940's. The analysis of which indicated that the oldest (1944/1946) and the most recent (2004, 2007 & 2008) provided the most distinctive and relevant information. Although it was interesting to visualize the progression of change over time while reviewing the progressive aerials, in the final analysis their inclusion with this report was unessential.

ECT also developed comparative topographical mappings based on the most recent USGS Quadrangle maps for the BRP (Current Conditions) and the 1929 ACOE survey (historic). These maps were invaluable in assessing the differences between the historic and current conditions as it relates to surface water flows and the alterations thereto that have occurred during the intervening period between the two.

During the agency permit review process, ECT identified fifty nine (59) relevant Management and Storage of Surface Waters permits (MSSW), Environmental Resource Permit (ERP) permits and applications that were related to the BRP or lands adjacent to or downstream of the BRP. Copies of these permits and applications have been included in Appendix II along with, available copies of relevant surface water studies, hydrological data and associated design reports.

Further, ECT reviewed the current Consumptive Water Use permit (CUP) for the BRP and have included a copy of the CUP and associated Staff Report in Appendix II. We have also included a copy of the current application made by Charlotte County for municipal withdrawals from the BRP property. It is noted that during our review, ECT discussed the pending application with SFWMD Staff. The essence of this discussion focused on the proposed source aquifer for the proposed withdrawal. According to SFWMD Staff, Charlotte County is proposing to permit a municipal back-up withdrawal from the Floridan aquifer which underlies Southwest Florida. Given the depth of the proposed withdrawal, it is ECT opinion that this withdrawal would have an insignificant if any affect on the ground and surface water resources of the BRP.

A thorough review of publically available flow, stage and rainfall data was conducted and yielded limited information. With the exception of historic rainfall data for the area surrounding the BRP, little other information is available. ECT reviewed records from Lee County, Charlotte County, United States Geological Survey (USGS), South Florida Water Management District (SFWMD) and the University of Florida Institute of Food and Agricultural Science (IFAS). Copies of rainfall data from the sources and locations identified in Section 2 have been included in Appendix II. It is noted that additional data may be gleaned from the Regulatory Files of the SFWMD as frequently specific hydrological information is requested by the agency during review of permit applications. As such it is suggested that a data mining effort be considered to determine what useful information may be available.

Task II – Field Assessment

Utilizing information gathered in Task I - Existing Document Review and Analysis, ECT initiated field data collection efforts on the 73,229.8 acres of the BRP. Of primary interest was the development of a comprehensive inventory of existing hydraulic facilities and structures. ECT staff collected information on 392 specific locations including significant wetlands, water bodies, flow-ways, drainage swales and ditches, and control structures. ECT provided qualitative information, photographs and coordinates for each identified site. Information related to this aspect of the report is contained in both Appendix I and II.

Information collected during this task was done so for the primary purpose of establishing a basis for assessing the affects of the existing infrastructure on the natural flow regime and to provide a basis for assessing the extent of any adverse impacts that exist. ECT did not conduct or develop any hydrologic or hydraulic models of this information.

Task III – Historic Surface Water Conditions

Utilizing information gathered in the previous Task, ECT obtained and analyzed historic aerial photographs and topographic information of the BRP and surrounding area and, in our opinion, established a reasonable representation of the historic surface water conditions of the site. This information is provided graphically in the report in the form of various GIS graphics and as data files in the included Appendix. Specifically, ECT performed a planning-level GIS analysis and associated narrative which is provided in Section 4 of this report. In essence, up until the mid-1940's the site was for the most part in its historic natural condition from a surface water perspective. Beginning in the mid-1940's progressively more intense drainage improvements were developed to provide greater productivity and greater access to the land. These early alteration began the progression of transfer of runoff between historic watersheds and initiated the subsequent alterations and impacts downstream of the respective improvements. The most notable alterations from this era are the Big Island Canal, the Clay Gully Canal and the South

Lightered Canal. Each of these systems radically altered the natural drainage condition in their respective portions of the watershed.

The alteration of the surface water condition from the natural condition to the improved condition initiated transitions of pre-development wetland systems by altering the hydroperiods of the natural systems. In some cases hydroperiods were shortened by the activity and is others the hydroperiods were extended as a result. In either event, these alterations led to shifts from the historic condition and are discussed in detail in Section 6 of the report.

As with other aspects of this report, historic and current land use conditions were mapped. The historic condition was based on work done by Michael Duever and known as the Pre-Development Map of Southwest Florida. For the purposes his work, Dr. Duever defined historic as being representative of conditions of the landscape prior to the arrival of Europeans in southwest Florida in an era where hydrology and fire regimes were the primary determinants of plant community distribution.

ECT contrasted the Duever map with work developed by the SFWMD as the 2004 Land Use/Cover map. Analysis of the land use cover data from both maps provided the basis for the assessment discussed in Section 6. Table 4 provides a summary of historic and current land uses/covers by acreages for each category found at the BRP. Although not done as a part of this report, the user could overlay the historic and current land use shapefiles with the historic flowways shapefile and produce an "area of interest" map for further field recognizance to determine the extent of transition in the current day and to determine areas of over drainage and areas of over inundation.

Task IV – Surface Water Current Conditions

The efforts of the previous tasks were primarily conducted to bring the transitions of the past into focus in the present for the purpose of establishing a current surface water conditions for the BRP. By comparing geo-referenced historic information such as

aerials and topography, a basis for assessment was developed to identify areas of concern and establish restoration priority areas.

On the basis of the information compiled by this report, the current surface water condition is substantially different from the historic condition primarily on the basis of quantity and distribution. In the historic condition, the primary conveyance condition was overland flow from the higher elevations in the northeast via sheetflow to the southwest. Flow between intermittent depressional areas created a natural cascading affect across the landscape. Where flow concentrated and elevation differential allowed, incised channels formed until land surface elevations flattened, typically resulting in slough flow to the points of outfall. This natural flow regiment would have resulted in slower moving runoff which would result in lower peak discharge rates and stages at the various outfall creeks as identified in the report. This aspect of the natural condition is significant to the development of any future restoration plan. Of critical importance is the development of a restoration plan that restores the timing of flow for the restored system. As noted in the report, a key hydrologic component is the time of concentration (Tc) of a system. The time of concentration for a watershed is the time required for water to travel from the most remote point in the watershed to a defined outlet once the soil has become saturated and depressional areas filled. Watersheds the size of those related to the BRP under natural conditions would typically have a time of concentration measured in days.

Given the current conditions, since the development of the Big Island, Clay Gully and South Lightered Canals, the time of concentration for these watersheds can more appropriately be measured in hours rather than in the historic interval of days. This significantly affects the peak discharge rates and peak stages in the areas downstream of these canals. Careful consideration should be given to any proposed alterations to these systems to in order to limit potential adverse impacts associated with the improvements.

In order to accurately assess the effects and impacts of any proposed alterations to the existing system, it will be key to develop an accurate data base of several basic hydrologic parameters such as flow, stage and rainfall. As noted in the report, there is a

deficiency of data related to flow and stage for all outfall points from the BRP, no data with respect to inflow points and no publically available data related to on-site rainfall, flow and stages. As such it is suggested that a detailed monitoring plan be developed for the BRP.

As noted in the report, the BRC has an ongoing data collection program that includes some elements that covers portions of the BRP. As such, it is recommended that BRI coordinate with BRC to expand this program to include hydrologic monitoring of several sites. Figure 1, Water Quality Sampling Locations 2008, Babcock Ranch Community, illustrates two sites located on the Big Island Canal (17-WCFB & 22-WCFB), one site on Telegraph Creek (31-WCFB), one site on Cypress Creek (36-WCFB) and one site in the Curry Lake Canal (15-WCFB). These sites appear to be sufficiently far enough up the landscape as to preclude tidal influences; however, this should be confirmed as it could affect the quality of the collected data. An internal site (05-WCFB) is located at the Tram Grade crossing of Telegraph Swamp and should also be part of the data collection effort.

ECT would recommend several additional sites as follows:

Outflow –

1) Fichter Creek
2) Hercules Grade Weirs
3) Jack's Branch (BRC Water Quality Site - 10-WCB)

Inflow –

1) Jack's Branch (BRC Water Quality Site – 04-WCB)
2) Upper Reach of Buck Gully (BRC Water Quality Site – 03-WCB)

Other/Internal -

1) All Culverts along SR 31, SR 74 and Farm Grade – To determine flow direction.
2) South Lightered Canal x 2: One to be located south of inflow from Telegraph Swamp, one to be located near BRI proposed site 16-WCFB. The location of the latter site should be reviewed for adequacy with respect to capturing all flows from agricultural development in the area.

3) South East Corner – A minimum of three surface water flow sites should be established in this area to determine direction and magnitude of flow in the area of the south and east property boundaries.

4) Rain Gauges – Three internal rain gauges should be established to adequately compile rainfall intensity and distribution information for the BRP site. These sites should generally be located in open areas free of vegetated canopy and should be distributed north to south with consideration give to the proximity of the previously mentioned installations so as to maximize the areal distribution of data gathered.

Data from these stations should be collected for a period sufficient to provide for the development of acceptable rating curves at the respective sites and for a long enough period to cover a representative distribution of storm events up to and including the 100 year event. While this does not suggest that data should be collected for the next 100 years to insure the 100 year event is included, it is counting on the statistical probability that that event will happen sooner rather than later. It is however important to gauge these stations under extreme conditions such as the 100 year event. Data collection for such events will allow for more accurate modeling of the dynamics of storm water run off both on the BRP and downstream thereof. This is significant given the history of flooding concerns in the downstream areas, particularly those associated with Cypress and the remnant Spanish Creek watersheds. This assessment perceives that a key component in addressing the hydrologic restoration of the BRP will be to finally address these off-site flooding impacts. Flow data associated with larger events will be essential to adequately addressing those issues.

Additional to the monitoring of the surface water stage and flow data, consideration should be given to the installation of groundwater monitoring data points at the site. Review of Figure 2, Babcock Ranch Installed Piezometers as of 9/23/08, BRC has established a rather extensive network of monitoring stations. BRI should coordinate with BRC to acquire copies of their monitoring protocol to review the adequacy of their program relative to the needs of the BRP and request copies of all data associated with these sites. Given the expansive circumstance of the BRP and the nature of the existing

groundwater monitoring network, ECT has not endeavored to prescribe specific locations for additional facilities, but rather recommends that as restoration projects begin, consideration be given to a more project specific intensity to establish baseline data for the proposed project as a method of establishing success criteria for the project.

Task V – Historic & Current Wetland & Flowway Mapping Analysis

As discussed in the report and evidenced by the data comparison in Table 4, Pre and Post Development Land Use/Cover Types, there appears to have been a fairly significant transition of land cover from the "pre-European" to the modern era. As noted in the report, these variations could be discounted as simply the result of inaccurate mapping or related to the inherent difficulties associated with accurately projecting land uses backwards in time. However, the underlying basis by which the Duever mapping was done is sound and to an extent somewhat irrefutable. The pre-European mapping done by Duever is in essence based upon soils, from which certain vegetative communities can be predicted with reasonable certainty. That is to say that a soil with hydric or upland classification today would predictably support the same range of vegetative communities even in the historic condition.

As noted previously, certain classifications have expanded while some have contracted significantly between the two era's. While some variation may be attributable to the level of accuracy related to predicting the past, indications of anthropogenic alterations are quite evident. Substantial increases in categories reflecting human alteration such as pasture and agricultural production presently represent just over 20% of the BRP land area, where certainly in "pre-European" time that percentage would have been 0%. Perhaps the most significant variation is that in the category of Mixed Wetland Hardwoods (FLUCFCS 617) which went from 2,864.6 acres to 29.3 acres, a one hundred fold decrease over time. This area formerly occupied primarily the central core of the Telegraph Swamp and as such provided significant habitat diversity in that setting. Alterations in the systems hydroperiod likely related to the manipulation of water levels

at Hercules Grade have apparently, over time, resulted in a transition of this area to a cypress swamp system.

Given the extent of changes to the hydrologic conditions of the BRP as identified herein and the quantifiable shifts in land cover over time, it is confirmed that the current condition is substantially different than the historical. Evidence of vegetative community conversion in association with quantifiable variations in surface hydrology is indicative of altered conditions. It is suggested that a vegetative community restoration plan be developed for the BRP which would incorporate hydrologic restoration as a key element in restoring the natural successional progression to areas of the preserve. This plan would be designed to be implemented over the course of many years as opportunities and funding becomes available and should focus on the relationship between land cover and hydrology.

Task VI – Summary Report Recommendations

The following is a summary list of suggestions and recommendations as contained within the text of the report and is inclusive of recommendations and suggestions developed based upon information contained within the report.

1) Initiate an effort to conduct a detailed regulatory file research for the purposes of establishing a base data set of permitted parameters. This would provide the BRI with a concise composite of permit authorizations for lands both on and adjacent to the BRP property. Further this data set would include relevant information from studies, hydrologic modeling efforts and other related documents utilized in acquisition of regulatory approvals.

2) Conduct a transition assessment to establish the relative positioning in the projects landscape of major and minor land use changes for the purpose of establishing potential restoration target areas based on hydrologic alteration over time. This assessment would potentially assist in the prioritization of

probable restoration activities by defining a level of difficulty associated with restoring appropriate ground water regimes to a particular area.

3) Coordinate with the BRC to expand the ongoing and proposed surface and groundwater monitoring program to be inclusive of the needs of the BRP. Develop a plan that expands on the proposed BRC program to include points of significance to the BRP as discussed herein. In as much as the design and cost specifics for a long term monitoring plan are unable to be developed based on the level of detail contained herein, it is noted that ECT's experience with similar programs on similarly sized parcels suggest that appropriate data collection units could be placed in the field for approximately $500.00 per station not inclusive of installation cost. A device such as Insitu, Inc.'s LevelTOLL 100 would be capable of recording approximately 1,100 individual data points per day over a 5 year life cycle. It is likely that a 5 year life cycle would be adequate to meet the data collection requirements as identified herein.

4) Develop a comprehensive restoration planning document early in the process to establish priority areas for restoration. The document would focus on two distinct yet integral components, vegetation restoration and hydrologic restoration. The document would have to be developed in concert with restoration activities associated with the CLECP program and the BRC restoration plan as approved by ARC.

Although not completely discussed in the report text, the Coastal and Estuarine Land Conservation Program (CELCP) grant funding provides specific guidelines in the form of restrictive covenants. A copy of these covenants has been included in Appendix II. Review of this document does not reveal any significantly stringent requirements, conditions or action items other than the need to restore and preserve and is lacking in any particular specificity regarding how this is to be accomplished. As such, it appears that

the integration of this area into the overall restoration plan should not be overly encumbered terms of the grant funding.

As to the BRC restoration plan, a copy of which is also included in Appendix II, additional discussion and recommendations are contained herein.

In general, the development of a long term vegetative and hydrologic restoration plan should include the development of enhanced habitat benefits, provide for the establishment of system buffer areas, improved water quality and sustainable flow regime to list a few. By developing this planning document early in the process and including enough specificity in the plan, DOF will be able to respond quickly to funding opportunities as they come available on short notice for "off-the-shelf" turn dirt type projects.

5) ECT has reviewed the BRI restoration plan as approved by the ARC and currently under review by the SFWMD. ECT concurs with the recommendation therein to construct groundwater protection weirs in the Big Island, South Lightered and Curry Lake canals. ECT is concerned that the proposed control levels of one foot above or below the "permitted" control elevation may not be sufficient to achieve an adequate level of restoration in some areas. Further, ECT is concerned that in the Curry Lake area, the plan recommends ditch plugs rather than ditch restoration. It is suggested that this issue be reconsidered with the preference towards complete restoration of this area by removing and restoring exiting ditches and drainage ways.

ECT has not had the opportunity to fully review the modeling that the pending SFWMD ERP, which includes the BRC restoration plan, is based upon. It is suggested that prior to the granting of an authorization to construct these facilities, a thorough review of the presumptions and anticipated results be conducted on behalf of the BRP.

6) In association with the recommendations above, it is recommended that a hydrologic base model be developed for the existing and historic condition of the BRP. The "existing" model should be calibrated utilizing data gathered in the cooperative monitoring program with BRC and would be utilized to evaluate the affects of proposed restoration activities. The development of the "historic" model would be useful in assessing levels of success of various restoration projects relative to the natural condition.

It is suggested that the development of these models be conducted earlier in the restoration planning schedule so as to afford the DOF reasonable assurances that hydrologic restoration activities will achieve the desired results.

7) Given the discussion herein with respect to the alteration of historic land uses to improved conditions, it is suggested that BRP work with BRI to develop a prioritization list of the existing farm fields. It is established that as the BRP goes forward, it will be self sustaining financially. Maintenance and preservation of the ongoing agricultural operations will be critical to achieving that objective. That said some adjustment to the current operations can be anticipated as a part of a comprehensive BRP restoration plan.

At present, there are certain farm fields that are placed into production every year. These fields are primarily located in the southeasterly portion of the site. Other fields scattered throughout the site, are placed into production on a rotating basis. Typically, after a single growing season (typically a spring crop), these fields are leveled and seeded with Bahia grass and used as improved pasture. After a grow-in period, they are used for sod production. This pattern of rotation is very beneficial in the control of nuisance pest by allowing the land to "rest" for a period between farming cycles.

It is suggested that these rotating fields be prioritized and the less desirable or productive fields be considered for restoration, particularly those that present

significant benefit to the overall restoration scheme. Several elements will need to be considered prior to initiating restoration activities, primarily potential habitat and hydrologic benefits. Fields appropriately situated in the landscape to provide significant benefit should be considered priority candidates for restoration.

To mitigate for the loss of production lands, BRP should evaluate the potential to consolidate farm production operations so as to limit the areal extent of their footprint on the BRP, as such areas in and around the exiting operations could be evaluated for conversion to off-set production acreage lost to restoration. It is noted that some lands are better suited than others for agricultural production; therefore, close coordination with Ranch Management would be appropriate before moving forward on this issue. The goal of this effort would be to remove fields that have resulted in significant alterations in natural hydrology and to better plan and lay out the fields so that the natural systems would be least affected.

8) In conjunction with Item 7 above, consideration should be given to an overall evaluation of the ongoing agricultural operations within the BRP and cumulative impact on the environmental and water resources. As noted in the report, many of the permanent fields, primarily in the southeasterly portion of the BRP, have been permitted by the SFWMD and include above ground impoundments (AGI) for the treatment and attenuation of excess runoff from the farming operations. Given that many of the AGI's were designed and permitted under the older MSSW permitting criteria (prior to the implementation of ERP regulations) which tended to be less sensitive to cumulative and secondary environmental impacts. Further, these systems were designed using peak discharge rate criteria. Without going into excessive detail, this criterion tends to allows substantially greater volumes of water to be discharged from an area than would naturally occur. As such, consideration should be given to re-designing these systems using a Total

Volume approach, which would result in these systems discharging at a more natural rate and overall quantity. An assessment should be conducted to establish what if any alterations to the existing systems would be required to meet this condition.

9) For the most part, the AGI's typically impound an area proportionate to the needs of the field being drained and typically are permitted to encompass agency jurisdictional areas such as cypress domes/sloughs or prairie/marsh wetland areas. Given that the historic drainage condition was overland and sheetflow between these wetlands systems prior to being impounded, the development of the impoundments has altered the natural condition. As noted above, any restoration plan should consider the current appropriateness of the locations and extents of these existing AGI's and set about to provide a less impactive plan for going forward.

In as much as it appears that some of the impoundments have altered the historic drainage patterns and are redirecting flows, the assessment of this impact should be conducted in conjunction with the initial modeling effort so as to fully assess the impacts of the existing farming operations and AGI's, roads, trails, pumps and discharges associated therewith. It is noted that for the most part, this report did not define any major adverse impacts associated with the existing farming operations excepting their generally site wide alteration of drainage patterns. That said the development of a site wide agricultural development plan for the BRP becomes critical in the preservation of agriculture going forward at the BRP.

10) Given that the long term farming operations in the southeasterly portion of the BRP are primarily located within South Lightered canal (SLC) basin, it is suggested that an assessment be directed at the complete restoration of this canal. The SLC was initially constructed in the 1940's prior to the inclusion of the above ground impoundments for the farm fields. Historically, prior to

the addition of the AGI's now associated with these fields, excess storm water would have either gravity flowed from the fields or would have been pumped onto adjacent lands. Given the relatively flat land surface slopes in this area, the storm water would have tended to stage up in the vicinity of the fields making it difficult to control the groundwater table for crop protection. In as much as these fields now have storage and treatment areas adjacent to the fields, they are less dependent on the overall area drainage for protection. As such there appears to be a significant potential to conduct a major restoration project within the SLC basin. Such a plan could include aggregate treatment facilities developed in conjunction with existing or restored flowways that would provide a more natural flow regime in the area.

11) As discussed in the text of the report, the Big Island canal (BIC) diverts significant flows from the Telegraph Swamp through upland areas into the lower portion of Telegraph Creek. This diversion effectively depletes base flow from the upper portion of Telegraph Creek and bypasses completely the historic high water flows to Fichter and Cypress Creek's. It is noted that the pending BRI restoration plan, currently under review by the SFWMD, calls for the construction of two water control structures in the Big Island canal. While such structures will no doubt be an improvement over the current condition by conserving groundwater levels and limiting discharge to the Creek, ECT is concerned, as noted previously, with respects to the proposed control levels. This issue should be fully evaluated prior to construction authorization.

It is noted that the current points of control and as proposed are located on BRC property. It is recommended that the BRP seek and acquire an interest in the control of these facilities.

Restoration activities associated with the BIC should include an assessment of the potential for restoring the noted historic baseflows to the entirety of

Telegraph Creek and provide allowances for high water flows to reenter the adjoining sub-basins of Fichter and Cypress Creek. This effort should be fully evaluated to insure minimization and limitations of off site and downstream impacts. It is likely that at the conclusion of this evaluation, the BIC will have to remain as an emergency outfall to provide an acceptable level of flood protection for off site and downstream developments that have occurred since the "historic" condition.

12) Similar to the SLC and BIC, the Clay Gully Canal (CGC) system should also be evaluated. As illustrated in the report, the easterly extent of the CGC has been expanded to near the eastern property limit. This extension has effectively intercepted sheetflow from the north and diverted it westerly into the Telegraph Swamp thus substantially altering the historic drainage divides. Historically this flow would have continued southerly over the lands now utilized for the long term farming area and on to either Cypress Creek, or prior to the development of the County Line Grove system on to Spanish Creek.

Restoration of natural flow conditions in the CGC would not be recommended until such time that the site wide agricultural plan had been completed and flowways through the farming area had been established. The interactions of these two elements would be evaluated during the hydrologic modeling effort as suggested herein.

13) In keeping with the previously noted areas of opportunity, ECT identified that the northeastern portion of the site (FWC hunting area) contained very few elevated grades and a limited number of culverts. In an effort to maximize the area affected by a restoration project, it is suggested that this area could be an excellent opportunity to effectively restore historic conditions with a relatively limited amount of effort and funds. By reestablishing the natural flow regime by removing obstructions to flow a significant portion of the BRP could be effectively restored. By opening flowways, filling swales and ditches,

creating stabilized wet weather crossing of larger flowways, the natural condition could be rather effectively restored and at relatively little cost.

14) In summary, several rather detailed assessments will be required prior to initiating full scale restoration activities. In keeping with the concept of a planning level effort, ECT has endeavored to identify all of these elements in sufficient detail so as to assist the DOF in taking the restoration program to the next level.

Initial efforts to establish an adequate library of base line hydrologic parameters will be essential. This library can be augmented by mining data from applicable regulatory files and through cooperation with the BRC monitoring efforts already under way on the BRC.

As this library is being populated, efforts should begin with respect to the development of a hydrologic model of the BRP. Depending on funding availability, the areal extent of the initial model limits can be defined. There is any number of numerical models available on the market that would be suitable for use at the BRP; however the model should be a dynamic model allowing for assessment of various climatic conditions over significant periods of time. Further the selected model should have a groundwater component so as to be able to assess the affects of proposed restoration efforts on the ambient water table and therefore the hydroperiod of wetland systems within the area of study. It is suggested that as a general rule, the simplest model capable of assessing the situation is the most appropriate model. Given the size and complexity of the hydrologic conditions of the BRP, it would not be recommended that an overly complex model be chosen due to the cost associated with acquiring the data sets required to accurately populate the model input database.

Additional survey field work will also need to be conducted. It is suggested that funding be sought to acquire LiDAR data for the entire BRP. Although

this data will not supplant the need to field survey inverts for culverts or cross sections of ditches, it would provide the ability to develop a DEM for the expanse of the BRP and would greatly reduce the cost of developing the digital elevation model.

In conclusion, there are a multitude of opportunities and challenges ahead with respects to the hydrologic restoration of the BRP; however the potential rewards of a successful effort will prove equally significant to future generations of Floridians and their guest. ECT appreciates that it has had an opportunity to participate in this effort.

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SECTION 8.0

LITERATURE CITED

8.0 LITERATURE CITED

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