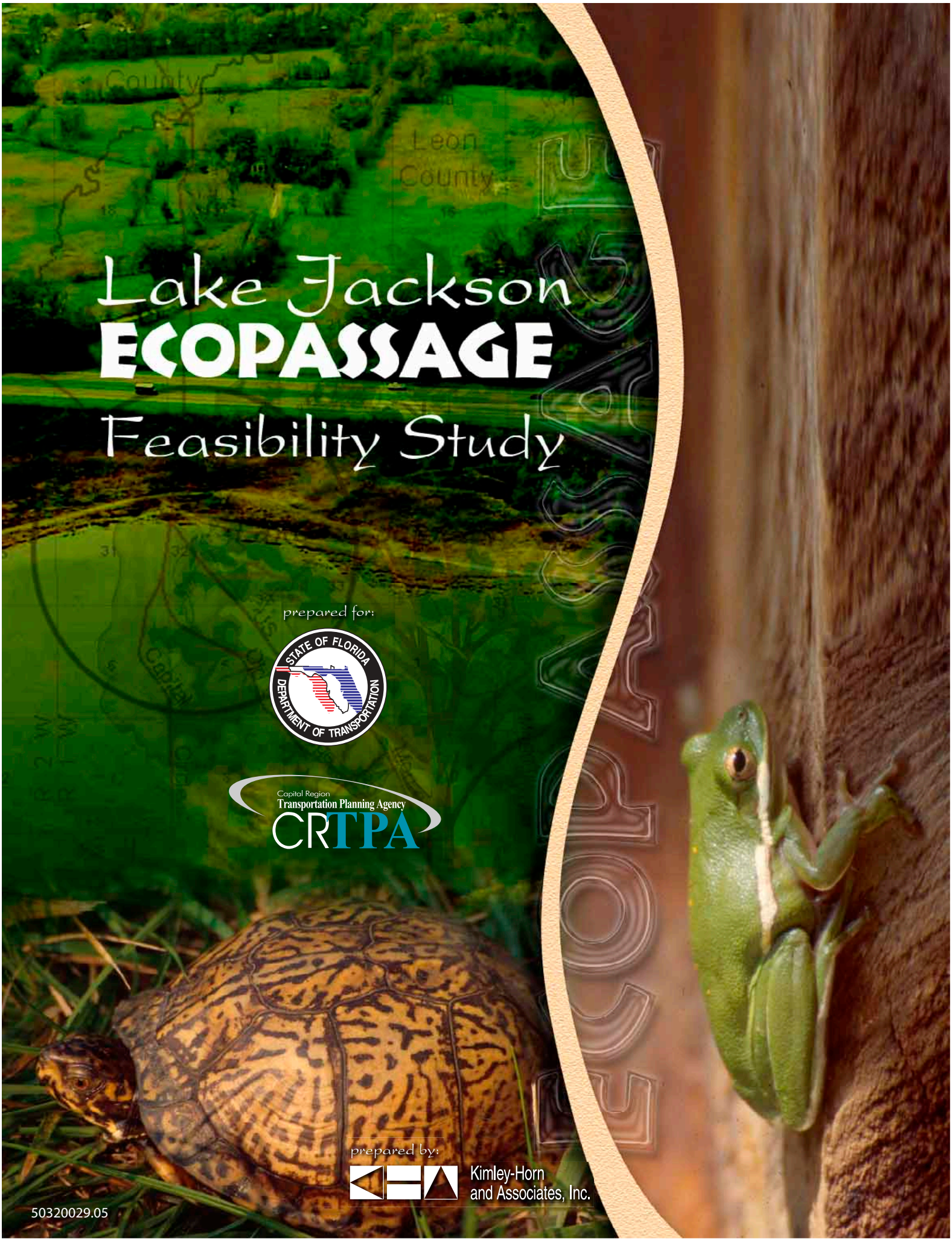

Lake Jackson ECOPASSAGE Feasibility Study

prepared for:

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

Capital Region Transportation Planning Agency CRTPA

prepared by:

Kimley-Horn and Associates, Inc.

50320029.05

Lake Jackson ECOPASSAGE Feasibility Study

Prepared for:

April 2005

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Kimley-Horn and Associates, Inc.

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Lake Jackson
ECOPASSAGE
Feasibility Study

FIGURES

Lake Jackson ECOPASSAGE Feasibility Study

TABLES

APPENDICES

EXECUTIVE SUMMARY

Introduction

Over the last several years, wildlife kills and motorist safety along US 27 (North Monroe Street) between Old Bainbridge Road and Clara Kee Boulevard in Leon County have become of increasing concern to the public. In response to overwhelming citizen support for addressing these issues, Leon County leaders worked with the Florida Department of Transportation (FDOT), which in turn authorized funding for this *Lake Jackson Ecopassage Feasibility Study* (Study) from its Discretionary Environmental Mitigation Fund.

The purpose of the Study was to assess the opportunities that exist within the corridor to provide safe passage for wildlife, while creating a safer environment for the traveling public. The findings of this report are that a feasible preferred alternative, which was subsequently approved by the Capital Region Transportation Planning Agency (CRTPA), was identified. In addition, prior to and during the Study, the community exhibited widespread support and enthusiasm for designing and constructing this alternative. This executive summary highlights the data collection, analysis, and public involvement issues that were involved in the Study.

History

Lake Jackson, with its history of occupation and use dating back thousands of years, is a treasured resource for Leon County and the State of Florida. The Native Americans called this water body “Okeeheepkee” or “disappearing water” because sinkholes under the lakebed would drain the waters of Lake Jackson, making it “disappear” during times of drought. For thousands of years, the lake was home to Native Americans who established communities on the lakefront.

In the 20th century, growth in automobile use and the need for quicker access in and around the South Georgia and North Florida region facilitated the construction of US 27 (North Monroe Street), which bisected Lake Jackson and created Little Lake Jackson. At the time of the road construction, environmental regulations were vastly different than they are today, making bisection of the lake possible. Today’s regulations would likely prohibit such construction.

Animal migrations from Lake Jackson to Little Lake Jackson occur on a daily basis. However, over the years, periodic “drydowns” of the lake have been documented. These drydowns occur during drought periods, when the lake either partially or completely drains into two primary

sinkholes on the lake bottom, and eventually into the Floridian Aquifer. In the following sections of this Study, the regular occurrences of these drydowns are documented. These drydowns are expected to continue in the future, occurring, on average, about every 10 to 15 years, with the most recent cycle occurring in 2000. During a drydown event, Lake Jackson typically empties, and Little Lake Jackson typically does not. When these events occur, several species of wildlife, mostly reptiles and amphibians, migrate in mass quantities from the dry lakebed of Lake Jackson to Little Lake Jackson. Today, with more than 23,000 vehicles traveling this busy corridor each day, hundreds of animals may be killed annually, and thousands of animals may be killed in a period of just days or weeks during drydown events. This situation also creates a hazard for motorists.

Today, the lake continues to be a haven for fishing and wildlife viewing, and it is the only freshwater lake in Florida designated as an aquatic preserve. The positive economic impacts of the lake are well documented due to its abundant natural and recreational features. Its ability to continue to provide these benefits relies on a fragile ecosystem, and it is dependent upon the unique balance between the natural hydrological cycles of the lake and the abundant assemblage of wildlife species that thrive in the lake ecosystem. This study examines these issues in the context of Lake Jackson and Little Lake Jackson in the defined study area.

How the Study Was Conducted

The historic and existing conditions task included collecting data such as topography, hydrology, habitat, animal and plant species identification, wildlife movement, and the use of historical aerial photography. This data laid the foundation for the development of concepts that were considered as part of the alternative selection process. The collected information was also used as part of the Public Involvement Plan (PIP) to gather citizen input.

The PIP included a three-tiered approach to gathering public input and providing information to the public regarding the Study. The first tier included public meetings to inform and educate citizens about the study and to obtain public input on the project alternatives. The culmination of the public meeting phase was an event that occurred at the county boat landing on US 27: more than 100 people participated and provided comment. Concurrently, the second tier of the project included the formation of an Advisory Group. This group consisted of scientists, engineers, and planners who met regularly to the discuss opportunities and constraints of the project. Based on their knowledge and previous experiences, they acted as a guiding force in the development of

alternatives. The third and final tier of the PIP was a panel of scientists that met once to discuss the biological aspects of proposed alternatives. Collectively, the PIP served the project well, and the response to the Study has been very positive, with the public recognizing the need for the Study before any action can take place. Citizens have provided valuable feedback, which has helped guide the direction of the preferred alternative. Lastly, public support for this project came in the form of more than 150 letters of support from four different countries and twenty different states. This type of support had never before occurred for any CRTPA project

Alternatives Evaluation

A number of alternatives were evaluated throughout the study to address the traffic safety and wildlife issues along the Lake Jackson segment of the US 27 corridor. Alternatives were derived based on an inventory of the existing conditions, input from citizens in the community, and the Advisory Group members. Approximately nine alternatives were considered, including a no-build alternative. The alternatives evaluated during the Study included:

No action
Reroute the road
Close the road
Habitat enhancement only
Temporary fence (without monitoring)
Temporary fence (with monitoring)
Use/replace existing culvert and construct wall
Construct additional passageways under highway
Construct bridge

Each alternative was ranked according to selection criteria composed of the issues deemed most important. These included biological effectiveness, motorist safety, maintenance (ease and cost), perceived social costs, and monetary cost of construction. Alternatives were also subjectively ranked through the public involvement process. The preferred alternative was chosen based on the highest ranking obtained through these evaluations.

Preferred Alternative and Recommendations

Based on the evaluation process, the preferred alternative was to replace the existing culvert and construct three additional culverts. Construction of a diversion wall along the length of the

proposed project was also recommended. Specifications for the wall and culvert were also made: ecopassage culverts should be as close to eight feet by eight feet as possible; the wall should be at least five feet high on the lake side; and it should include a six-inch overhanging lip on the lake side of the wall. Enhancement recommendations are summarized below:

Replace existing culvert and provide up to three additional culverts
Construct diversion wall of equal length along the project corridor
Provide and implement a “Monitoring and Maintenance Plan” for the project
Provide and implement a “Habitat Management Plan” (HMP) for the study area
Provide and implement an educational program for the project
Provide interim measures (such as a temporary fence with monitoring) until construction of the preferred alternative
Provide a temporary barrier for those areas where animals may cross and a permanent barrier is not possible

FDOT has indicated that it may not be possible to acquire additional right-of-way for this project. It should be possible to construct the chosen alternative within the existing right-of-way; however, the county may want to consider additional land purchases in order to avoid potential conflicts between the proposed alternative and future development, as well as for habitat preservation. Potential land acquisitions or habitat enhancement areas include:

Acquire one or both of the currently undeveloped commercially-zoned parcels on either side of Cool View Drive
Acquire the three small parcels on the eastern side of US 27, immediately south of the existing county boat ramp property
Acquire the small parcel on Little Lake Jackson side of the road near the northern limits of the project
Move the county boat ramp access to the proposed Jackson View Park, and restore the existing boat ramp property to native habitat
Acquire the existing commercial property (Colonial Liquors and Lounge) at the northern end of the study area for use as an educational center for the project

Permits for the construction of the proposed ecopassage will be required from the U.S. Army Corps of Engineers, the Florida Department of Environmental Protection, The Florida Department of Transportation, and Leon County.

The county has indicated that there are some issues that need to be addressed regarding floodplains, wetlands, and drainage basins. The presence of closed drainage basins and areas of the 100-year floodplain could limit the locations of culverts, specifically the southernmost culvert (Culvert D). If design measures and stormwater modeling are not able to demonstrate compliance with county regulations, this passageway may not be feasible

This Study has made recommendations for the locations and sizes of proposed culverts and walls, however the implementation of these recommendations will be dependent upon existing conditions, including surface elevations and the presence of environmentally sensitive zones such as drainage basins, wetlands, and floodplains.

Passageway sizes were based on available data suggesting that larger culverts will have greater success as functional ecopassages. Based on existing topography, elevation of the existing roadway will likely be necessary to accommodate the larger culverts. Additional data, including topographical survey and geotechnical information, will need to be obtained during the design phase of this project in order to determine the exact locations and sizes of culverts.

1.0 PROBLEM STATEMENT

The stretch of U.S. Highway 27 (US 27) (North Monroe Street) between Old Bainbridge Road and Clara Kee Boulevard in Leon County, Florida, crosses a portion of the large sinkhole lake known as Lake Jackson. The proximity of the highway to the lake, combined with the natural habitat and unique hydrology of the Lake Jackson ecosystem, results in conditions in which there is a high potential for animals, particularly reptiles and amphibians, to cross the highway, at times in large numbers, and come in contact with motor vehicles. This situation puts animal populations at risk as increasing numbers of animals are killed on the road by vehicles, and puts humans at risk by increasing the potential for motor vehicle accidents as motorists stop for, attempt to swerve around, or collide with wildlife.

Concerns regarding wildlife kills and motorist safety along this stretch of US 27 prompted the citizens of Leon County to forward an initiative to Leon County and the Florida Department of Transportation (FDOT). FDOT responded by authorizing funding from its Discretionary Environmental Mitigation Fund to conduct this *Lake Jackson Ecopassage Feasibility Study* (Study) to assess the opportunities that exist within the corridor to supply a safe passage for wildlife while creating a safer environment for the traveling public.

This Study addresses the existing environmental, vegetative habitat, land use, public access, and roadway conditions at the site as well as public involvement, permitting issues, habitat enhancement, habitat protection, and conceptual alternatives to address wildlife mortality, motorist safety, and ecological and hydrological continuity along the corridor. These factors were analyzed to develop a recommendation and implementation strategy for a conceptual design, enhancement, and protection alternative to re-establish an ecological connection between Lake Jackson and Little Lake Jackson, and minimize the effects of the roadway on the ecosystem.

This Study was prepared for the Capital Region Transportation Planning Agency (CRTPA) (formerly the Tallahassee-Leon County Metropolitan Planning Organization/MPO) as part of a Joint Participation Agreement (JPA) between the CRTPA and the FDOT. The county may seek federal funding for the construction and implementation of this project.

2.0 GOALS AND OBJECTIVES

In order to properly address all aspects related to the problem, a set of goals and objectives for the Study were developed. These goals and objectives, developed though input from the Lake Jackson Ecopassage Technical Advisory Group (Advisory Group), the Payne's Prairie Wildlife Coalition, and input from the Lake Jackson Ecopassage Feasibility Study project team, were used as the basis for evaluation and recommendation for alternatives in the Study.

Goals:

1) To minimize effects of the roadway on the ecosystem and re-establish the ecological connection within Lake Jackson for areas bisected by US 27.

2) To improve motorist safety and the aesthetic character of the roadway corridor.

3) To minimize negative human impacts on the aquatic ecosystems and, where possible, recommend appropriate facilities for use as well as provide access to these facilities.

4) To conduct and document the Study in a manner that will facilitate the ability to obtain funding from state and/or federal sources.

Objectives:

1) Reduce automotive crashes and pedestrian incidents and/or avoid accidents as a result of wildlife on roadway.

2) Provide for safe wildlife movement between Lake Jackson and Little Lake Jackson.

3) Minimize wildlife roadkill.

4) Avoid negative effects to current hydrology.

5) Establish a maintenance program for guidewall and passages.

6) Establish a vegetation management regime for the ecopassage.

7) Establish a management plan and make recommendations for a monitoring plan for the ecopassage system.

8) Deter access and use along the roadway corridor to promote safety for humans and wildlife. Divert humans and vehicles to appropriate parking, recreation, and educational areas.

9) Deter littering through an active promotional and educational program that raises awareness of the ecopassage and its purpose.

10) Maximize use of environmentally sensitive materials in the construction of the ecopassage complex, such as low toxicity and/or recycled materials.

3.0 STUDY METHODOLOGY

3.1 Data Collection

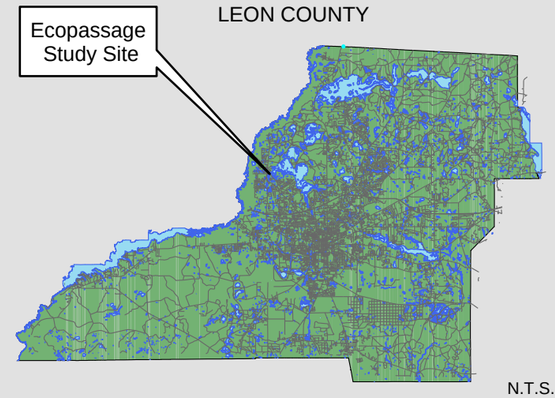
The Project Study Area (Study Area) [*Figure 1*] includes the stretch of US 27 from just south of its intersection with Old Bainbridge Road, south to Clara Kee Boulevard. The Study Area determination was based on existing data showing high animal mortality on this stretch of the highway. It also includes adjacent undeveloped lands identified as potential wildlife habitat. Information on the historical and existing conditions at the Study Area including soils, vegetation, hydrology, topography, wildlife habitat, wildlife movements/migrations, and land use was collected through a review of available natural resource documentation, preliminary coordination of regulatory agencies through the Advisory Group, and field reconnaissance. The existing and historical conditions were documented in the *Existing Conditions Technical Memorandum* prepared for this Study and attached as *Appendix A*.

3.1.1 Natural Resource Documentation

Natural resource documentation reviewed for the Study included U.S. Department of Agriculture/Soil Conservation Service (USDA/SCS) Soil Survey, Geographic Information System (GIS) data layers from Leon County, published and in-press reports on Lake Jackson hydrology and wildlife, existing wildlife data collected from the Study Area, published information on wildlife crossings, North Florida Water Management District (NFWMD) water level data for Lake Jackson, historical aerial photographs of the Study Area, and personal communication with recognized scientific experts. A list of the publications and data reviewed and incorporated into this Study can be found in the *References* section of this report *(Section 10.0)*.

3.1.2 Field Reconnaissance

Field Reconnaissance was conducted at the Study Area in order to document existing vegetative and soil conditions, as well as to observe general conditions at the site. Vegetative transects and quadrant sampling, in conjunction with aerial photograph review, were used to document existing vegetative conditions at the Study Area. Representative soil samples were



PROJECT LOCATION

Legend

- Study Area Limits
- Study Area (Not Accessible)

0 250 500 1,000 Feet

N

NOTES:

1. This map is for informational purposes only.
It was compiled from the most accurate data available
from Tallahassee-Leon County GIS databases.
It is not to be considered a legal document or survey,
and not to be used or presented as such.
2. Aerial from Tallahassee-Leon County, GIS (2000)
3. Project boundaries approximate, based on aerial interpretation

Lake Jackson ECOPASSAGE Feasibility Study

MPO

Kimley-Horn and Associates, Inc.

FIGURE 1 - PROJECT STUDY AREA

also taken and analyzed for pH and mineral content. Results of the field reconnaissance are included in the *Existing Conditions Technical Memorandum* [*Appendix A*].

3.2 Public Involvement

Citizen input is invaluable in the formulation of innovative ideas and techniques to address specific problems, and interested citizens in Leon County played an integral role in the development of alternatives for the Lake Jackson Ecopassage Study. The purpose of the Public Involvement Program (PIP) was to inform and educate citizens and to obtain public input on the development and evaluation of the alternatives.

The Public Involvement Program consisted of a focus workshop, a public meeting, Tallahassee-Leon County Metropolitan Planning Organization (now the CRTPA) and subcommittee presentations, project newsletters, and the formulation of a technical advisory group and specialist panel. The public response to the project has been supportive. The public recognizes the need for the ecopassage study and has provided valuable feedback throughout the process. This feedback was incorporated into the decision-making process and helped guide the direction of the preferred alternatives selection.

3.2.1 Focus Workshop

A focus workshop was held on August 18, 2004 from 6:00 p.m. to 8:00 p.m. at the Fringe Benefits Management Company Building in Leon County. The workshop was offered as a chance to afford area residents the opportunity to understand the Lake Jackson ecosystem and offer comments on potential alternatives to address the problems of habitat fragmentation, wildlife mortality, and motorist safety at the Study Area. The meeting consisted of a 30-minute PowerPoint presentation on the project by Kimley-Horn and Associates, Inc., and a brief overview of the Lake Jackson ecosystem by Ray Ashton (Ashton Ashton & Associates). A question/answer session and an open discussion forum followed the presentations. Exhibits depicting the conditions at the site including aerial photographs, topographic maps, and land use maps were also available to familiarize citizens with the Study Area.

The presentation included a description of the project scope, the project statement, the project goals and objectives, the existing conditions/data collection process, the available alternatives,

permitting and funding issues, the public involvement process, and the schedule. Aerial photographs and charts helped illustrate the current and past conditions of the Lake Jackson ecosystem.

The meeting participants were given the opportunity to rank and comment on possible alternatives to address the conditions at the Study Area. Possible alternatives were complied and presented in an alternatives matrix that was handed out at the workshop. The matrix, which also depicts the pros and cons of the different alternatives, is included as *Appendix B*. The matrix included the following alternatives:

No action
Habitat enhancement only
Temporary fencing only
Temporary fence with monitoring
Use/replace culvert and construct wall
Establish additional passageways under highway (and construct wall)
Construct bridge

Workshop participants were asked to rank the alternatives (with “1” being most preferred) in the “rank” column and to offer comments/suggestions in the “comments” field of the matrix. The “use/replace culvert and construct wall” scenario and the “establish additional passageways under the highway” alternative were ranked the highest at this workshop. Comments received from the workshop indicated that citizens were overwhelmingly against a “no action” option or any option that did not provide additional infrastructure to allow animals to cross the highway, including the temporary fencing option. Citizen comments from the workshop can be found in *Appendix C*.

Approximately 20 participants attended the workshop and provided input on the project alternatives. Typical issues brought up by participants included economic impacts, funding issues, project schedule, and local support for the campaign program. The sign-in sheet and agenda from the workshop are available in *Appendix C*.

3.2.2 Public Meeting

A public meeting for the project was held from 6:00 p.m. to 8:00 p.m. on October 26, 2004 at the Leon County Boat Launch on US 27. The meeting, designed to introduce the preferred alternative to the public and solicit input, attracted approximately 70 citizens and area residents.

Meeting participants were provided a brief introduction to the project and area ecology, and they were given the opportunity to comment on the draft preferred alternative and other identified alternatives associated with the ecopassage. The project concepts were further clarified with a PowerPoint presentation and the use of large graphics presented on posters around the tent. A question/answer session provided participants with the opportunity to ask questions and identify their concerns. Attendees were overwhelmingly in support of the project and the preferred alternative, and most comments related to the project's support. Questions included the anticipated schedule for implementation, funding sources, and if any measures were being taken to accommodate bicycle/pedestrian issues in the ecopassage design. These questions and comments were addressed throughout the evaluation period. Sign-in sheets and the agenda for this public meeting are also provided in *Appendix C*.

3.2.3 MPO (now the CRTPA) and Subcommittee Presentations

A summary of the Lake Jackson Feasibility Study project was presented to the Tallahassee-Leon County MPO (now the CRTPA) and its various subcommittees, including the Transportation Technical Coordinating Committee (TCC), the Bicycle and Pedestrian Advisory Committee (BPAC), and the Citizens Advisory Committee (CAC).

The first presentation, outlining the project scope, schedule, and purpose, was given at the MPO meeting on June 21, 2004. Additionally, the presentation introduced the goals and objectives of the study, the status of the existing environmental conditions data collection, and potential funding strategies for implementing alternatives for the ecopassage.

A second presentation, specifying the work to date and the identification of the draft preferred alternative, was given at the MPO meeting on November 15, 2004.

The MPO's Transportation Technical Coordinating Committee (TCC) reviews items of a technical nature that are submitted to the MPO. The committee is comprised of various City of Tallahassee and Leon County staff members who are established as professionals in the field of transportation. The project presentations that were held at the MPO meetings were first presented to the TCC. The TCC reviewed the presentations at the June 8 and November 15 meetings.

Similarly, the MPO's Bicycle and Pedestrian Advisory Committee (BPAC) observed the presentations on the Lake Jackson Ecopassage Study. This committee is responsible for the review of projects as they relate to the safety of bicyclists and pedestrians along a corridor. Citizens generally comprise the committee and are appointed by the City Commission, the County Commission, and the MPO. A presentation was given to this group on June 8 and November 15 for general input and review.

The MPO's Citizen Advisory Committee (CAC) is an additional board of advisors that review projects in representation of the general public. The primary role of the committee is to provide comments on how the citizens of the Tallahassee-Leon County area will be impacted by the decisions of the MPO and other transportation officials. The CAC also reviewed the project presentations before each MPO meeting. These were held on June 10 and November 17.

3.2.4 Technical Advisory Group

A Technical Advisory Group (Advisory Group) was formed for the Study and met approximately once a month to discuss and provide guidance on the unique ecological, engineering, and permitting issues of the Study. The Advisory Group was composed of 12 members and included engineers and scientists representing the various regulatory and public agencies. A list of the Advisory Group members is provided in *Table 3-1*.

Table 3-1
Technical Advisory Group Members

NAME	ORGANIZATION
Alex Cordero	Florida Department of Environmental Protection – Aquatic Preserves
Clay Carithers	Leon County Growth and Environmental Management Department
Dale Jackson	Herpetologist (Freshwater Turtle Expert) – Florida Natural Areas Inventory
Dave O'Neill	Paynes Prairie Wildlife Coalition
David Cook	Florida Fish and Wildlife Conservation Commission
Howard Lovett	Florida Department of Transportation – District 3
Jack Kostrzewa	Leon County Metropolitan Planning Organization
Jamie Barichivich	United States Geological Survey
Josh Boan	Florida Department of Transportation – Environmental Management Office
Judith Dougherty	Leon County Board of County Commissioners
Karen Kebart	Northwest Florida Water Management District
Matthew Aresco	Florida State University

Meetings were generally held on the third Wednesday of each month. The first meeting occurred on May 19, 2004, and subsequent meetings followed for the purpose of allowing technical assistance to the project team. These meetings included updates on the project status, the study area, the data collection process, and a session for questions and comments. Additional input was obtained from other individuals invited to attend Advisory Group meetings: Steve Hodges, Leon County Environmental Planner, and Jennifer Carver, Leon County Bicycle and Pedestrian Coordinator, as well as Project Team Members.

3.2.5 Specialist Panel Meeting

In addition to the Technical Advisory Group, a panel of scientists was assembled to provide recommendations to the project team. The panel consisted of experts in the fields of biology and ecology from nearby universities and ecological organizations. These experts reviewed the project alternatives from a biological standpoint. The panel was consulted primarily for their technical expertise and professional knowledge, and their assessment of the alternatives was generally absent of other considerations such as costs, public input, etc.

The specialists met on September 23, 2004 at the office of Kimley-Horn and Associates, Inc., (Project Study Team Consultant) in Tallahassee. The objective of the meeting included two main goals: to establish an understanding of the environment and biological system associated with the Lake Jackson area, and to discuss ecopassage alternatives to accommodate animal migration.

As a basis for understanding the Lake Jackson ecosystem, a synopsis of historical facts and statistics was presented, including turtle population trends, historical water level fluctuations in the Lake Jackson watershed, and motorist and vehicular traffic data. Additionally, the panel considered several ecopassage alternatives and evaluated the pros and cons of each scenario and their biological implications. Input provided at the meeting was incorporated into the decision-making process.

3.2.6 Project Newsletters

Two newsletters were included as part of the scope for this project. The newsletters were designed to inform the public about the status, progress, and findings of the Study. The first newsletter included a brief history of the environment associated with Lake Jackson, announcements for upcoming meetings, a description of the project's goals and objectives, status of the data collection process, and examples of feasible alternatives that have been implemented elsewhere (i.e. the Paynes Prairie Ecopassage project on US 441 near Gainesville). The newsletter was delivered to area residents, meeting participants, and interested citizens in the summer of 2004. It was also made available in electronic format for distribution to interested parties. A copy of the first newsletter is included in *Appendix D*.

The second (and final) publication will be distributed upon completion and approval of this Study. This newsletter will inform the public of the findings of the Feasibility Study, including the recommended alternative and the implementation strategy. It will include the executive summary from this Feasibility Report and a data CD containing the contents of the Final Lake Jackson Ecopassage Feasibility Study Report and associated figures and appendices.

4.0 PHYSIOGRAPHIC AND BIOLOGICAL SETTING

4.1 Physiographic and Hydrologic Features

Lake Jackson is an approximately 4,000-acre sinkhole lake located in Northwestern Florida, seven miles north of Tallahassee in the Ochlockonee River Basin. The lake is considered one of Leon County's most treasured natural resources, and it is the only freshwater lake in the state to be designated as an "Aquatic Preserve" by the State of Florida.

Lake Jackson is a closed basin (i.e. not connected to any other lakes, streams, or rivers) and the depth of the water in the lake fluctuates widely [*Figure 2*]. The water level in the lake is controlled naturally by variations in rainfall and by two sinkholes (Porter Hole and Lime Sink) in the lake bottom. During drought conditions, a lowering of the water table causes drainage of lake water into the sinkholes; the lake then dries up, exposing the lake bottom. This has occurred nine times during the last 100 years, with drying events occurring, on average, every 12 years. Following drydowns, major storm events and accumulation of seasonal rainfall serve to restore the lake water levels. The drydowns and periodic refilling affect wildlife movements, as aquatic species attempt to seek habitat in times of drydown, and return to previously dry areas of the lake during refills.

The Study Area [*Figure 1*] includes an approximately ¾-mile stretch of US 27 (North Monroe Street) located between Lake Jackson and Little Lake Jackson in northwest Leon County. The roadway in this area was constructed in the 1920s as a two-lane, concrete roadway. The road construction bisected a portion of Lake Jackson, such that a small arm of the lake and associated wetlands (approximately 50 acres) were isolated on the western side of the roadway. This isolated area of the lake became known as Little Lake Jackson.

Review of historical aerial photography suggests that originally, a small bridge spanned the area between the connection of Lake Jackson and Little Lake Jackson. Around 1964, the roadway was widened to a four-lane divided highway. The bridge between Lake Jackson and Little Lake Jackson was replaced with a 12-foot diameter culvert, which still exists today as the only hydrologic connection between Lake Jackson and Little Lake Jackson. Hydrologic connection of the two areas of the lake is likely to only occur during periods of very high water (around elevation 88-90 $NGVD_{29}$). Based on hydrological data, the last time the lake levels were that

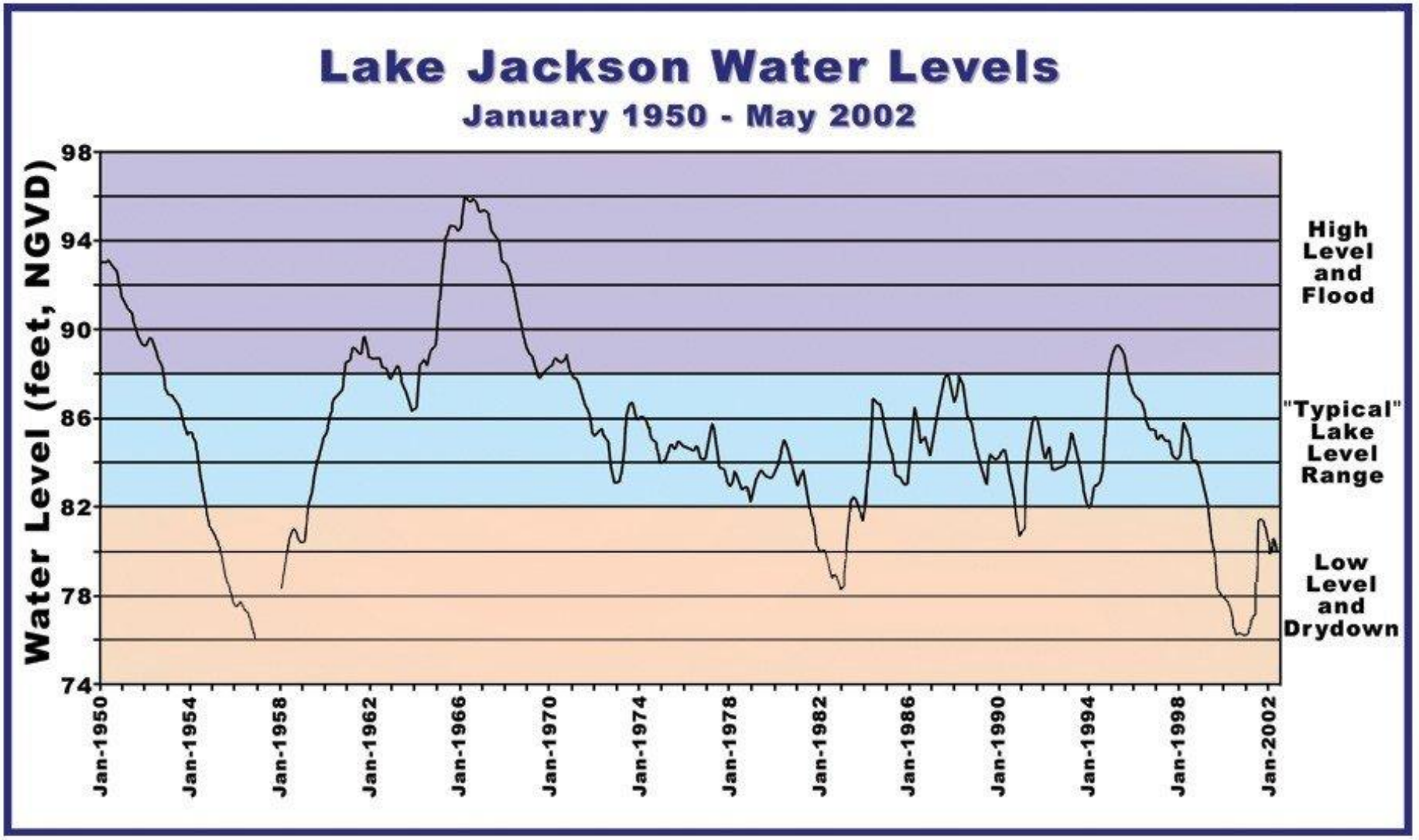

Lake Jackson Water Levels
January 1950 - May 2002
Water Level (feet, NGVD)
98
94
90
86
82
78
74
Jan-1950
Jan-1954
Jan-1958
Jan-1962
Jan-1966
Jan-1970
Jan-1974
Jan-1978
Jan-1982
Jan-1986
Jan-1990
Jan-1994
Jan-1998
Jan-2002
High Level and Flood
"Typical" Lake Level Range
Low Level and Drydown

FIGURE 2

high was around 1996. Though the average depth of both Lake Jackson and Little Lake Jackson is about eight feet, Little Lake Jackson does not dry during severe drought. As such, Little Lake Jackson serves as a refuge to aquatic species during times of drydown.

4.2 Biological Features

The Lake Jackson ecosystem is a valuable biological, aesthetic, and recreational resource of Leon County. This ecosystem was designated as the Lake Jackson Aquatic Preserve in 1974 for the primary purpose of preserving and maintaining the biological resources in their essentially natural condition. The expansive freshwater marshes and native submerged vegetation provide exceptional fish, reptile, amphibian, waterfowl and wading bird habitat.

4.2.1 Vegetation

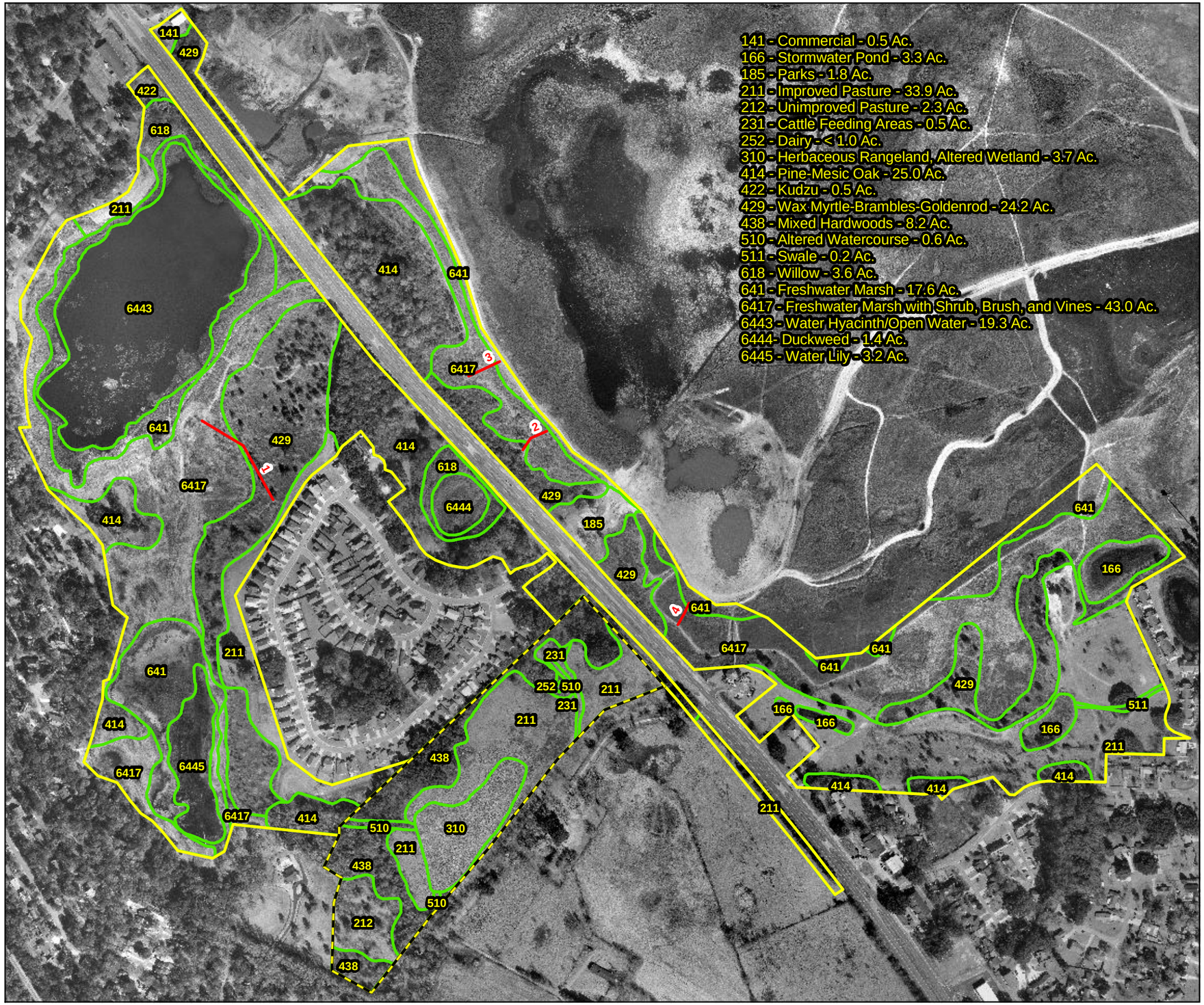
Fourteen distinguishable land use and vegetative communities were documented within the project area. These communities were mapped on 1:300-scale aerial photography and described using the Florida Land Use, Cover, and Forms Classification System (FLUCFCS) (Florida Department of Transportation, 1999). A FLUCFCS map showing the locations of these communities is included as *Figure 3*. A description of each of the existing communities is provided below.

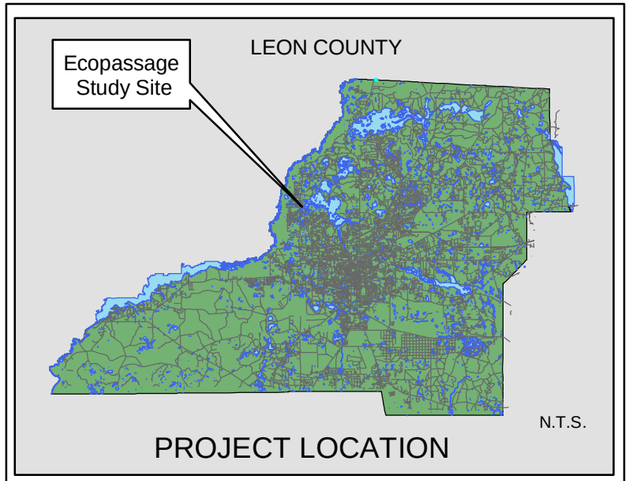
Commercial (FLUCFCS 141, 0.5 Acres)

One commercial area was identified within the study area. This establishment (Colonial Liquors and Lounge) is located north of US 27 on the western portion of the project. There is no vegetation associated with this designation, as it is entirely paved.

Pond (FLUCFCS 166, 3.3 Acres)

Several small stormwater ponds are present in various locations throughout the study area. These ponds are typically excavated from upland soils and retain runoff from surrounding developments. The pond areas vary greatly in vegetative composition. One area adjacent to US 27 is dominated by pickerelweed (*Pontederia cordata*) with subdominants of jointweed (*Polygonum*





Legend

- Study Area Limits (192.7 Ac.)
- Study Area (Not Accessible)*
- FLUCFCS Area Boundary
- Vegetative Transects

* Area was not accessible. Land cover information was obtained from Leon County records (Natural Features Inventory (NFI) submitted by Others).

0 250 500 1,000 Feet

NOTES:

1. This map is for informational purposes only.
2. Land use and cover codes from the Florida Land Use, Cover and Forms Classification System (FLUCFCS), FDOT, 1999.
3. Aerial from Tallahassee-Leon County, GIS (2000)
4. Vegetative Survey and Mapping conducted and compiled by Biological Research Associates, Ltd. July 2004.
5. Project and FLUCFCS boundaries and acreages approximate, based on aerial interpretation.

Lake Jackson ECOPASSAGE Feasibility Study

MPO Tallahassee-Leon County Metropolitan Planning Organization

Kimley-Horn and Associates, Inc.

FIGURE 3 - LAND USE AND VEGETATIVE COVER (FLUCFCS) MAP

hydropiperoides), sawgrass (*Cladium jamaicensis*), Carolina willow (*Salix caroliniana*), and American cupscale (*Sacciolepis striata*). A second area contains low-growing herbaceous vegetation such as jointweed, American cupscale, danglepod (*Sesbania herbacea*), fringe rush (*Fimbristylis* sp.), dog fennel (*Eupatorium capillifolium*), switchgrass (*Dicanthelium* sp.), wispy panicum (*Panicum virgatum*) and black senna (*Senna* sp.).

Park (FLUCFCS 185, 1.8 Acres)

A small community park and boat launch facility is located on the northeastern side of US 27. This park contains a dirt/gravel parking area for approximately 20 to 30 vehicles and a boat ramp. Vegetation within this area includes water oak, bahia grass (*Paspalum notatum*), centipede grass (*Cynodon dactylon*), crape myrtle (*Lagerstroemia indica*), wax myrtle, pecan (*Carya illinoinensis*), Carolina willow, and mixed weedy herbaceous species.

Domestic Grasses-Improved Pasture (FLUCFCS 211, 33.9 Acres)

Two large areas located on well-drained soils contained a predominance of domestic grass. These areas are significantly disturbed and the historical ground cover and canopy have been removed. These areas were most likely historically utilized for either agriculture or cattle grazing. The domestic grass areas are open and are interspersed with young tree species such as live oak, diamond oak, water oak, black cherry (*Prunus serotina*), and loblolly pine (*Pinus taeda*). The ground cover is dominated by bahia grass and contains subdominant species such as ragweed (*Ambrosia artemisiifolia*), fleabane (*Erigeron quercifolius*), white mulberry (*Morus alba*), danglepod, Canada lettuce (*Lactuca canadensis*), dog fennel, Canada goldenrod (*Solidago canadensis*), and pokeweed (*Phytolacca americana*).

Pine-Mesic-Oak (FLUCFCS 414, 25.0 Acres)

Several areas containing a mature canopy of oaks and pines were identified along US 27. Several small areas of this cover were also located adjacent to the limits of the Study Area and offsite residential lots. A closed canopy composed of loblolly pine and oak species (*Quercus* spp.) and an open understory characterize this community. Review of historical aerials shows the majority of

these areas as cleared open land in 1949. These areas have since regenerated and are either secondary or tertiary growth forest. The ground cover contains vines and other weedy herbaceous vegetation. Typical vegetative composition includes water oak, diamond oak, live oak, black cherry, persimmon, elderberry (*Sambucus canadensis*), Chinese privet (*Ligustrum senescence*), winged sumac (*Rhus copallina*), wax myrtle, poison ivy (*Toxicodendron radicans*), Virginia creeper (*Parthenocissus quinquefolia*), muscadine (*Vitis rotundifolia*), and spleenwort (*Asplenium* sp.).

Kudzu (FLUCFCS 422, 0.5 Acres)

One area is dominated by an exotic vine, kudzu (*Pueraria montana*). In this small area, kudzu has smothered the trees and groundcover. Little to no native vegetation exists within this designation.

Wax Myrtle-Brambles-Goldenrod (FLUCCS 429, 24.2 Acres)

This is one of the most dominant upland communities found within the study area. These areas are usually dry; however, they are subjected to a wide range of water level fluctuations and periodically experience prolonged inundation during high water conditions. They contain a mixture of open areas that are composed solely of groundcover species and areas that are dominated by immature trees and shrubs but still maintain groundcover. The vegetation within these areas includes brambles (*Rubus cuneifolius*), Canada goldenrod, dog fennel, wax myrtle, black cherry, loblolly pine, water oak, sassafras (*Sassafras albidum*), and passionflower (*Passiflora incarnata*).

Swale (FLUCFCS 511, 0.2 Acres)

One small swale that connects a residential apartment complex to a pond was identified. This swale is vegetated with domestic grasses and contains species similar to FLUCFCS 211 (Domestic Grasses-Improved Pasture).

Willow (FLUCFCS 618, 3.6 Acres)

Two wetland areas identified are dominated by Carolina willow. These areas are disturbed sites located adjacent to US 27 at the base of the road and along the slopes. One area is adjacent to a small pond that appears to be utilized for

stormwater retention. The pond is covered with duckweed (*Lemna minor*). Subdominant species include water oak, Chinese privet, wax leaf privet, popcorn tree (*Sapium sempervirens*), wax myrtle, Japanese climbing fern (*Lygodium japonicum*), false nettle, red maple (*Acer rubrum*), and pepper vine (*Ampelopsis arborea*).

Freshwater Marsh (FLUCFCS 641, 17.6 Acres)

This designation identifies those areas that are currently at or near water's edge and contain a variety of herbaceous vegetative species. These areas are typically diverse and relatively undisturbed. Vegetation within these areas includes false nettle, saltbush, coinwort (*Centella asiatica*), buttonbush (*Cephalanthus occidentalis*), flatsedge (*Cyperus* spp.), rein orchid (*Habenaria repens*), marsh pennywort (*Hydrocotyle umbellata*), rushes (*Juncus* spp.), anglestem, primrose willow (*Ludwigia leptocarpa*), American lotus (*Nelumbo lutea*), water lily (*Nymphaea odorata*), hairy smart weed (*Polygonum hirsutum*), American cupscale, arrowhead (*Sagittaria latifolia*), and humped bladderwort (*Utricularia gibba*).

Freshwater Marsh, Shrubs, Brush and Vines (FLUCFCS 6417, 43.0 Acres)

These areas experience wide variations in water levels, undergoing several years of inundation followed by several years of drought. Currently, the water levels in the lake are rising; however, the lake remains lower than "normal." Due to the prolonged absence of hydrology, this plant community contains a mixture of wetland, upland, and transitional vegetative species. The ground cover is the most dominant strata within these areas and is composed of herbs, vines, young shrubs and small trees. Dominant plant species include brambles, Canada goldenrod, pinebarren goldenrod (*S. fistulosa*), American cupscale, hairy smartweed, dog fennel, elderberry, wax myrtle, red maple, saltbush, black cherry, and black gum (*Nyssa biflora*).

Water Hyacinth-Open Water (FLUCCS 6443, 19.3 Acres)

This land cover classification is associated with the existing emergent aquatic vegetation and open water areas of Little Lake Jackson. This area is dominated by floating water hyacinth (*Eichhornia crassipes*) and also contains open water.

Rein orchid (*Habenaria repens*) is also common growing within the water hyacinth mats.

Duck Weed (FLUCFCS 6444, 1.4 Acres)

A small pond located between a residential subdivision and US 27 is dominated by duck weed (*Leman minor*) and hydrilla (*Hydrilla verticillata*). This pond is round and contains steep side slopes.

Water Lily (FLUCFCS 6445, 3.2 Acres)

This designation is associated with a small ponded area in the southeastern portion of the project area. This area experiences a wide range of water elevations and contains a variety of emergent and floating vegetative species. This area contains species such as mild water pepper, cattails (*Typha latifolia*), pickerel weed and three species of water lily including American lotus (*Nelumbo lutea*), pond lily (*Nuphar advena*) and fragrant water lily (*Nymphaea odorata*).

Submerged vegetation is abundant throughout the lake because of its general shallowness and relatively good water clarity. Increased nutrients have also produced accelerated growth of vegetation, as evidenced by the rapid expansion of the submerged exotic plant hydrilla (*Hydrilla verticillata*). Major native species occurring throughout the lake include blue hyssop (*Bacopa caroliniana*), coontail (*Ceratophyllum demersum*), green fanwort (*Cabomba caroliniana*), variable-leaf milfoil (*Myriophyllum heterophyllum*), and bladderworts (*Utricularia* spp.) The submerged vegetation provides a base for epiphytic algae and phytophilic invertebrates as well as habitat for small fish. This, in turn, provides forage for many species of game fish and wildlife.

Emergent vegetation covers the broad marsh regions of the lake. These areas range from being totally to periodically inundated, with some species able to tolerate merely damp conditions, and others existing for lengthy periods totally submersed. Major species found in these areas include maidencane (*Panicum hemitomon*), pickerelweed (*Pontederia cordata*), American lotus (*Nelumbo lutea*), and slender spikerush (*Eleocharis baldwinii*). These species stabilize sediments and assimilate nutrients entering the lake from runoff and leachate (septic tanks). The vegetation also contributes detritus and is used as spawning and cover areas for

fish, reptiles, amphibians and some mammals. Birds utilize this habitat for nesting, loafing, and foraging.

Wetland tree and woody plant species also inhabit the drier portions of the transitional marsh in the study area. These include sweetgum (*Liquidambar styraciflua*), oak (*Quercus* spp.), wax myrtle (*Myrica cerifera*), dog fennel (*Eupatorium* spp.), elderberry (*Sambucus canadensis*), blackberry (*Rubus sp*.), smilax (*Smilax sp*.) and grapevine (*Vitis sp*.). These species provide wildlife habitat, filter storm water runoff, and cool near-shore waters.

Algae grow in sediment, drift or float on the water column, or are attached to larger vegetation and structures such as docks. They can become noxious in a lake if they grow to enormous populations, often termed an algal "bloom." Blooms may discolor surface waters, form floating scum, and cause fish kills. Two of the more prevalent macroalgae found in Lake Jackson are musk grass (*Chara* spp.) and stonewort (*Nitella* spp.). Musk grass is found in moderate to sparse growth, primarily in the middle portions of the lake. It is a favorable plant food for waterfowl, and provides good habitat for invertebrates and small fish. Stonewort is moderately established throughout the lake and is also propitious as habitat for invertebrates. A number of filamentous algae also occur in the preserve, including the potentially noxious blue-green species known as *Anabaena* spp. Due to the hypereutrophic conditions in the some portions of the lake, algal blooms have already taken place. These algae possess the ability to fix and store nitrogen for growth, and out-compete other vegetation. Therefore, extensive blooms threaten the viability of the resource as an optimal ecosystem. Other algae present include water-silk or *Spirogyra* spp., *Pithophora* spp., *Hydrodictyon* spp., and many more.

Various species of exotic vegetation have been introduced into the lake area within the last 10 to 20 years. Many of these have become quite abundant in the lake by out-competing native vegetation. This vegetation can be an impediment to boat traffic, and contributes to eutrophication through sedimentation and oxygen depletion. Some of these species grow so rapidly that herbicide and biological control methods have had to be utilized to control them. The three most prevalent exotic plants in the lake area are hydrilla (*Hydrilla verticillata*), water hyacinth (*Eichhornia crassipes*), and alligator weed (*Alternanthera philoxeroides)*. In addition, exotic and nuisance vegetation such as Chinese tallow (*Sapium sebiferum*), blackberry (*Rubus*

sp.), kudzu (*Pueraria Montana*), Chinese privet (*Ligustrum senescence*), and Carolina willow (*Salix caroliniana*) grow in dense thickets along the terrestrial areas of the lake bank.

The fluctuating water levels in Lake Jackson that occur as a result of natural periodic lake drainage and refill have lead to "catastrophic" changes as the lake level drops. Depending on the how high the lake was before the drought conditions and the ultimate draining, as well as the time between the drying event and the refilling of the basin, vegetation from terrestrial plant communities may spread to the former shoreline (i.e. former open water or freshwater marsh areas). As time progresses, the density of vegetation found in these areas along the shoreline may increase, and the composition of vegetation may change. The dense vegetation may impair turtle nesting and animal movements from one area to another.

4.2.2. Wildlife

Studies by Matthew Aresco, a Florida State University Ph.D. candidate, report 22 species of reptiles (snakes, lizards, and crocodilians), 11 species of amphibians (frogs, toads, and salamanders), 23 species of birds, and 17 species of mammals in the Study Area. A list of these species, along with other species known to occur in the area, is included in *Table 4-1*. Federal and State status for each of these species is also included in *Table 4-1*.

Table 4-1
Wildlife Species Occurring in Study Area [1]

Common Name	Scientific Name	Federally Listed	State Listed
Mammals			
Beaver	*Castor Canadensis* *	N	N
Bobcat	*Lynx rufus*	N	N
Cotton Rat	*Sigmodon hispudus*	N	N
Coyote	*Canis latrans*	N	N
Eastern woodrat	*Neotoma floridana* *	N	N
Gray fox	*Urocyon cineroargenteus* *	N	N
Gray squirrel	*Sciurus carolinensis* *	N	N
Marsh rabbit	*Sylvilagus palustris* *	N	N

Marsh rice rat	*Oryzomys palustris* *	N	N
Nine-banded armadillo	*Dasypus novemconctus* *	N	N
Oldfield mouse	*Peromyscus polionotus* *	N	N
Opossum	*Didelphis virginiana* *	N	N
Raccoon	*Procyon lotor* *	N	N
Red fox	*Vulpes vulpes* *	N	N
River otter	*Lutra canadensis* *	N	N
Round-tailed muskrat	*Neofiber alleni*	U/R	N
White tailed deer	*Odocoileus virginianus*	N	N
Wild boar	*Sus scrofa*	N	N
Birds			
American coot *	*Fulica americana*	N	N
Anhinga *	*Anhinga anhinga*	N	N
Bale eagle	*Haliaeetus leucocephalus*	E	T
Brown thrasher *	*Toxostoma rufum*	N	N
Cardinal *	*Cardinalis cardinalis*	N	N
Carolina wren *	*Thryothorus ludovicianus*	N	N
Catbird *	*Dumetella carolinensis*	N	N
Common grackle *	*Quiscalus quiscula*	N	N
Common nighthawk *	*Chordeiles minor*	N	N
Common yellowthroat *	*Geothlypis trichas*	N	N
Eastern kingbird *	*Tyrannus tyrannus*	N	N
Eastern screech owl *	*Otus asio*	N	N
Fish crow *	*Corvis ossifragus*	N	N
Green heron *	*Butorides virescens*	N	N
Least tern	*Sterna antillarum*	N	T
Little blue heron	*Egretta caerulea*	N	SSC
Mourning dove *	*Zenaida aurita*	N	N
Northern mockingbird *	*Mimus polyglottos*	N	N
Purple gallinule *	*Porphyrula martinica*	N	N
Rufous-sided towhee *	*Pipilo erythrophthalmus*	N	N
Snowy egret	*Egretta thula*	N	SSC
Swainsons thrush *	*Catharus ustulatus*	N	N

Swamp sparrow *	*Melospiza georgiana*	N	N
Wood stork	*Mycteria americana*	E	E
Yellow-bellied cuckoo *	*Coccyzus americanus*	N	N
Yellow-rumped warbler *	*Dendroica coronata*	N	N
Reptiles			
Turtles & Tortoises			
Box Turtle *	*Terrapene carolina*	N	N
Chicken turtle *	*Deirochelys reticularia*	N	N
Eastern mud turtle *	*Kinosternon subrubrum*	N	N
Florida cooter *	*Pseudemys floridana*	N	N
Florida softshell *	*Apalone ferox*	N	N
Gopher tortoise *	*Gopherus polyphemus*	N	SSC
Musk turtle *	*Sternotherus odoratus*	N	N
Snapping turtle *	*Chelydra serpentina*	N	N
Suwannee cooter *	*Pseudemys concinna*	N	SSC
Yellow-bellied slider *	*Trachemys scripta*	N	N
Snakes			
Florida green water snake *	*Nerodia floridana*	N	N
Banded water snake *	*Nerodia fasciata*	N	N
Cottonmouth *	*Agkistrodon piscivorus*	N	N
Black racer *	*Coluber constrictor*	N	N
Corn snake *	*Elaphe guttata*	N	N
Ribbon snake	*Thamnophis sirtalis*	N	N
Eastern king snake *	*Lampropeltis getulus*	N	N
Black swamp snake *	*Seminatrix pygaea*	N	N
Mud snake *	*Farancia abacura*	N	N
Red bellied snake	*Storeria occipitomaculata*	N	N
Gray rat snake *	*Elaphe obsoleta spiloides*	N	N
Rough green snake	*Opheodrys aestivus*	N	N
Scarlet snake *	*Cemophora coccinea copei*	N	N
Lizards			
Eastern glass lizard	*Ophisaurus ventralis*	N	N
Green anole *	*Anolis carolinensis*	N	N

Five-lined skink	*Eumeces fasciatus*	N	N
Ground skink	*Scincella lateralis*	N	N
Broad-headed skink	*Eumeces laticeps*	N	N
Six-lined racerunner *	*Cnemidophorus sexlineatus*	N	N
Crocodilian			
American alligator *	*Alligator mississippiensis*	T/A [2]	SSC
Amphibians			
Salamanders			
Two-toed amphiuma	Amphiuma means	N	N
Central newt	Notophthalmus viridescens	N	N
Frogs & Toads			
Pig frog *	*Rana grylio*	N	N
Bullfrog *	*Rana catesbeiana*	N	N
Leopard frog *	*Rana sphenocephala*	N	N
Green tree frog *	*Hyla cinerea*	N	N
Squirrel tree frog	*Hyla squirella*	N	N
Florida cricket frog *	*Acris gryllus*	N	N
Southern toad *	*Bufo terrestris*	N	N
Narrowmouthed toad *	*Gastrophryne carolinensis*	N	N
Eastern spadefoot toad *	*Scaphiopus holbrooki*	N	N

* Found dead on road in project area (data collected by Matt Aresco)

N = Not Listed SSC = Species of Special Concern (State) T = Threatened E = Endangered U/R = Under Review

[1] Not a comprehensive list of all species known to occur in the Lake Jackson Area. Species listed are based on data collected by Matt Aresco, information from the Florida Department of Environmental Protection, and on observations by Project Study team.

[2] Listed Threatened due to similarity in appearance to the American crocodile, a federally listed endangered species

4.2.2.1 Listed Species

Suwannee cooters (a state-listed species of special concern) were recorded killed on the highway as they crossed US 27 during the last drydown in 1999/2000. Eastern indigo snakes (a state- and federally-listed threatened species) and Florida pine snakes (a state-listed species of special concern), while not directly observed in the project area, may occur in the faunal basin

and are vulnerable to being killed on roads in their habitat. In addition, alligators (a state-listed species of special concern and a federally-listed threatened species due to the similarity in appearance to the American crocodile) have been found dead on the road at US 27 and Lake Jackson. Juvenile alligators are especially vulnerable, likely as a result of trying to cross the road as they disperse from nests noted around Little Lake Jackson. Gopher tortoises (a state-listed species of special concern) have also been identified in the area and have been found dead on the road in the project area. *Appendix E* includes maps showing locations where gopher tortoises and alligators have been found near the temporary fence or dead on the road along the project study area.

5.0 OPPORTUNITIES AND CONSTRAINTS

5.1 Physical, Social and Economic Conditions

Lake Jackson is a closed-basin sinkhole lake that undergoes wide fluctuations in water levels. During periods of extreme drought, the lake can dry completely, resulting in mass-migrations of reptiles and amphibians to available open-water habitat, including Little Lake Jackson, on the western side of US 27.

As animals migrate to Little Lake Jackson during droughts, they are presented with the obstacle of crossing US 27. In studies conducted by Matthew Aresco at the project site, it was determined that there is a 98% probability of a turtle being killed in one attempted crossing of US 27. He notes that, according to a model developed for the study, the probability of a turtle successfully crossing US 27 decreased from 32% in 1977 to only 2% in 2001.

This data suggests that the location of US 27, in conjunction with the high traffic volume (estimated by FDOT as 23,000 vehicles per day), results in high mortality for turtles and other wildlife in the area during migrations precipitated by lake drydowns. Animals that were successful crossing the roadway during the initial migration when Lake Jackson dried may not be able to successfully cross the roadway a second time, when they migrate back across the road to Lake Jackson when the water levels rise.

Wildlife road crossings (and mortality) are greatest during drydown (and, to a lesser extent, refill) migration events. Though road mortality of species is only likely to be biologically

significant (i.e. likely to cause measurable adverse effects to populations) during event years, the roadway still presents a problem to wildlife during non-event years. Migrations of various species may occur seasonally in response to mating, nesting, foraging activity, as well as when animals move from one part of their home range to another or establish a new home range. Animals most vulnerable to being killed on roadways include animals with large home ranges (usually larger mammals, but also large snakes such as the Eastern indigo snake), and small, slow-moving animals such as turtles and salamanders.

It has been noted that the demographics of a population may be affected in areas near roadways, with sex ratios becoming biased toward one sex. Aresco studied Florida cooter, yellow-bellied slider, and common musk turtle populations near the project study area and found that in all species, populations had significant male-biased sex ratios. A probable reason for this is that "despite male-biased population sex ratios, under normal (non-drought) conditions, a significantly greater proportion of adult females than males were found on land along the highway, and thus have a greater annual probability of being killed by vehicles." (Aresco, in press). Since turtles generally prefer an open habitat for nesting, it is possible that the disturbed, open habitat along the roadside is attractive to females for nesting habitat, especially when other areas are unavailable (as a result of development or overgrown vegetation). Accordingly, females are more vulnerable to being killed on roadsides. Additionally, hatchlings in roadside nests are more vulnerable to being killed on roads, and nests in these areas may be more susceptible to predation. Some scientists believe that populations may not be able to overcome the sex discrepancy, as numbers begin to decline over time, as less and less females are available to nest, and more nests fail or are impacted by predation. Also, populations may become more susceptible to disease as a result of reduced genetic diversity. Eventually, over time, local populations could disappear.

Arguments for the protection of biodiversity usually arise from feelings of human obligation, not only because of the intrinsic value of each individual species, but also because the elimination of some or all of native species in an area could result in serious ill effects to an ecosystem on which humans rely for economic and social (recreational) reasons.

The Lake Jackson ecosystem is an important part of the local economy. It is has a long-standing reputation as a world class sport-fishing resource, and the area is also used by many individuals for active and passive recreational activities such as swimming, picnicking, bird

watching, waterskiing, and boating. An economic report prepared in 1994 (McGinnis et. al., 1994) indicated that in 1993, 53,441 people were reported visiting Lake Jackson. Visitors to Lake Jackson, (both from Leon County and from out of the area), contributed an estimated $10.6 million to the Leon County economy in 1993 in lake-related goods, services, and purchases. The study showed that the majority of the users of Lake Jackson generally had a favorable impression of the lake water quality; ranking it a 3 or above on a scale of 1 to 5 (1 being not usable and 5 being drinkable). The study also indicated that most users were willing to pay to improve the water quality at the lake (e.g. moving water quality from a 3 to a rank of 4). The study attempts to quantify the value that lake users place on this resource. Based on the study results, it is clear that individuals consider the lake an important resource, worthy of protection. The State of Florida, through the Northwest Florida Water Management District (NWFWMD) and affiliated programs, has invested several million dollars over the last ten years in restoration and management programs for Lake Jackson.

The lake ecosystem is complex, and features of the lake help keep the system in balance. Natural fluctuations in the lake level are considered beneficial for fisheries habitat and health, as they help minimize exotic vegetation and help to improve overall water quality (NWFWMD, 2002). Additionally, turtles and other wildlife species are considered an important part of the lake's overall health. For example, turtles eat large amounts of algae and other plant material, including the exotic aquatic plant *Hydrilla*. Turtles also eat dead material, and are an important part of the lake food web as both scavengers and as a food source for larger predators such as alligators. Reduction in the turtle populations (or, similarly, other wildlife populations) could adversely affect the overall health and balance of the lake, from the water quality to available food in the food web. Diminished health of the lake could degrade fisheries, as well as other wildlife populations, which in turn would affect recreational opportunities and tourism dollars spent in the area.

In addition to the ecological and economic reasons, there are also human safety reasons to take measures to reduce wildlife roadkills at US 27 and Lake Jackson. Wildlife attempting to cross the highway is a threat to motorist safety. The Wildlife Society estimates that more than 200 motorists are killed and thousands more are injured in animal-vehicle related collisions yearly in the United States. (USDOT/FHWA, 2000). On US 27, near misses between vehicles have occurred when vehicles have stopped to help animals cross the road, or have swerved sharply in an attempt to avoid hitting animals (Aresco, personal comment). Many adult turtles weigh at

least five to ten pounds, and can become projectiles when hit, flying at a height and speed fast enough to crash through a windshield. Peak migration days can result in hundreds of animals crossing the highway, causing concern for motorist safety.

5.2 Environmental Resources

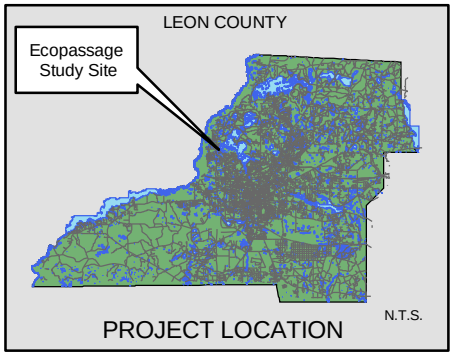
The Lake Jackson ecosystem is a valuable biological, aesthetic, and recreational resource of Leon County. This ecosystem was designated as the Lake Jackson Aquatic Preserve in 1974 for the primary purpose of preserving and maintaining the biological resources in their essentially natural condition. The expansive freshwater marshes and native submerged vegetation provide exceptional fish, reptile, amphibian, waterfowl, and wading bird habitat.

Possible environmentally sensitive areas within the project study areas include potential turtle nesting areas [*Figure 4*] located along the shores of Lake Jackson and Little Lake Jackson, as well as in the eastern portion of the Sellers Parcel area, the 107-acre parcel of land located on the western side of the study corridor. A portion of the Sellers Parcel (±24 acres) adjacent to the Lakeside subdivision was included in the Study Area.

Much of the land immediately adjacent to the lake, including most of the areas of potential turtle nesting habitat, are under public ownership (i.e. county or state). Additionally, a portion of the land around Little Lake Jackson, adjacent to the Lakeside subdivision, was placed under conservation easement as part of the development agreement for that development. The Sellers Parcel is privately owned, and is likely to be developed.

Undeveloped areas in and around the lake are also used by other wildlife species, including birds, reptiles, and amphibians. Data from Aresco (2000-2004) indicates that approximately 82 species of animals (amphibians, reptiles, birds, and mammals) have been found along the highway in the subject site area.

Fragmentation of wildlife habitat has occurred in the project area as a result of development around the lake. In the project study area, US 27, the county boat ramp, and the Lakeside subdivision are the prominent development features that may have an impact on wildlife corridors and habitat.



Legend

- Potential Turtle Nesting Areas
- Study Area (Not Accessible)
- Study Area Limits

0 200 400 800 Feet

N

NOTES:

1. This map is for informational purposes only. It was compiled from the most accurate data available. It is not to be considered a legal document or survey, and not to be used or presented as such.
2. Aerial from Tallahassee-Leon County, GIS (2000)
3. Project boundaries approximate, based on aerial interpretation.
4. Nesting areas approximate, based on aerial interpretation.
5. Nesting area data courtesy of Matt Aresco.

Lake Jackson ECOPASSAGE Feasibility Study

MPO Metropolitan Planning Organization

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FIGURE 4 - POTENTIAL TURTLE NESTING AREAS

US 27 created a barrier for movement of animals from Lake Jackson to Little Lake Jackson, especially in times of low water or drought. Additionally, the placement of fill and general disturbance from the construction of the roadway has resulted in hydrological impacts that have, over time, changed the composition of vegetative communities in the area. The transition of open littoral and lakeshore areas to dense thickets of brambles and vines has impacted wildlife habitat, as turtles are less likely to nest in densely vegetated areas, and overgrown vegetation and vegetative monocultures may impede wildlife movements and reduce available forage for certain types of wildlife.

Though the ±125-unit Lakeside residential subdivision resulted in direct impact to wildlife habitat, the development also included the preservation of approximately 33 acres adjacent to Little Lake Jackson. However, there is no ongoing habitat management plan associated with this preservation area.

Access to an unimproved driveway used as construction access for the Lakeside subdivision was restricted by FDOT in July 2004. FDOT maintenance crews installed fencing and “No Trespassing” signs to prohibit entry to the dirt road that was intended as a temporary drive for the Lakeside subdivision construction, but was being used as an alternate access to the residential development as well as access to Little Lake Jackson. The roadway was located through the existing Lakeside conservation easement, which contained turtle nesting habitat. Impacts to turtle nests and other wildlife from motor vehicle traffic on this road were reported (Aresco, personal comment). The driveway should have been abandoned following construction of the Lakeside subdivision, and its use was not in compliance with FDOT regulations. The Lakeside Homeowners Association was contacted prior to the closing and concurred with the decision to block the access. The closing of this access will protect fragile turtle nesting habitat and wildlife from the impacts from motor vehicle traffic.

The county boat ramp consists of an approximately 16-acre parcel, most of which is composed of the undeveloped wooded and littoral areas of the lakeside. An approximately 2.5-acre area is currently used as a public boat ramp. This area has served as a public boat ramp since the early 1960s (based on historic aerial photograph review). The boat ramp includes an unimproved drive to the lake edge, as well as unimproved parking areas, and picnic tables. The park is primarily used by fishermen as a boat launch. The boat ramp and parking areas are unpaved, which reduces stormwater runoff into the lake; however, the area is impacted by

erosion and tire rutting. The rutting increases the likelihood of vehicles getting stuck, which, in turn, can worsen erosion. Erosion impacts water quality through the runoff of sediments into the lake. The boat ramp also serves as access to unofficial dirt roads located in fragile habitat on the lakeshore and lake bottom. Though the access to these roads has been temporarily restricted with fencing, maintenance of this fencing will be necessary to prohibit motor vehicle access to these fragile areas, which are used by wildlife as foraging and nesting habitat.

5.3 Topography, Drainage, and Floodplains

5.3.1 Topography

Topography in the project area is steep to gently sloping, with elevations ranging from approximately 80 feet to 100 feet ($NGVD_{29}$). Elevations of the highway in the project study area are approximately 96 to 100 feet, approximately 80 feet at the edge of Lake Jackson, and 84 feet at the edges of Little Lake Jackson and the Lakeside stormwater pond. Elevations drop off steeply or gradually from the roadway toward the water bodies (i.e. Lake Jackson, Little Lake Jackson, and Lakeside stormwater pond). The topographical changes, in particular the steep slopes, will present design challenges when discussing the preferred alternative at the project site, and may affect the type and location of any proposed improvements at the site.

Additional survey will be required prior to the design of any proposed improvements in the area. Sizes of culverts may need to be limited, though the largest size culvert possible, given the existing elevations, should be used. Vegetation clearing and appropriate grading will be necessary to accommodate any proposed walls along steep slopes.

5.3.2 Drainage

Leon County has designated the area around Lake Jackson as an environmentally sensitive zone, and, as such, it is subject to the special development standards as outlined in the Leon County Land Development Code (Section 10-192). Protections in place for the area around the lake (“Lake Protection Zone”) include limitations on development and specific requirements for stormwater treatment. Sites within the Lake Protection Zone that are located within areas that have been demonstrated to be closed basins that do not naturally or artificially discharge into Lake Jackson are not subject to the same treatment standards as areas within the Lake

Protection Zone that are open to Lake Jackson. The Lakeside residential subdivision is one such closed-basin development. The stormwater system is entirely closed (i.e. it does not discharge) to Lake Jackson. As a result, the county has indicated that installing a wildlife crossing/culvert in an area that would connect the Lakeside closed basin (or any other closed basins along the project corridor) to Lake Jackson may not be permittable. Additional information on Leon County permitting requirements can be found in *Section 8.3.*

5.3.3 Floodplains

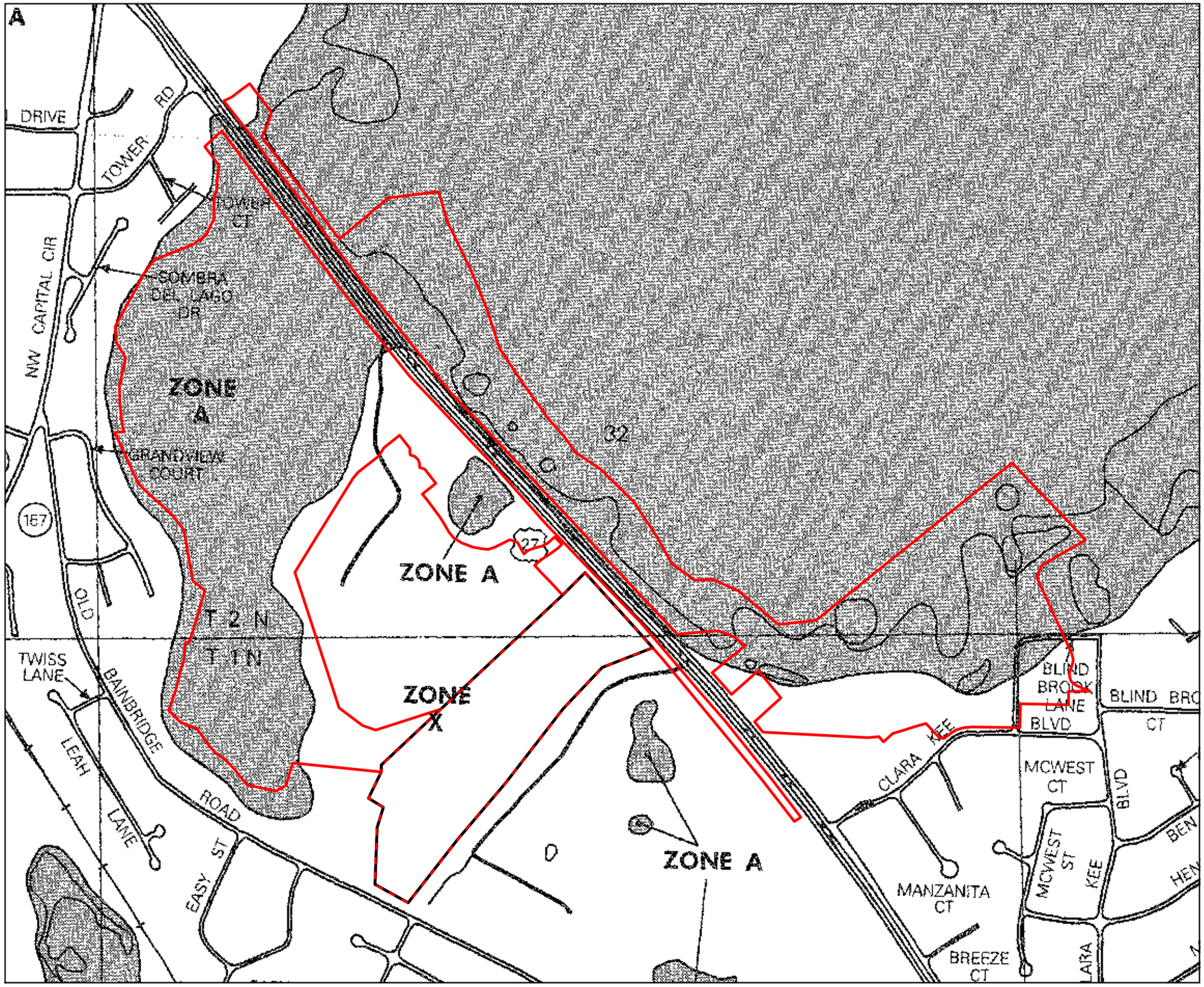
Portions of the project area are located within the 100-year floodplain as designated by the Federal Emergency Management Agency (FEMA) and incorporated by Leon County [*Figure 5*]. The floodplain elevation around the lake area is 86 feet ($NGVD_{29}$). Areas of the 100-year floodplain will limit some alternatives, including locations of any proposed culverts/wildlife passages. Leon County has indicated that it will be difficult or impossible to permit any culverts (i.e. wildlife crossings) in areas where there is a 100-year floodplain on one side of the road, but not on the other side of the road. The reason for this is that regulations do not allow connecting areas that are not part of the 100-year floodplain to the floodplain, as this could affect off-site property owners by creating floodplain in areas where floodplain did not previously exist. Due to the presence of floodplains and existing elevations, wildlife crossings (i.e. culverts) may not be permittable in some areas along the project corridor. Additional information on Leon County permitting requirements can be found in *Section 8.3*.

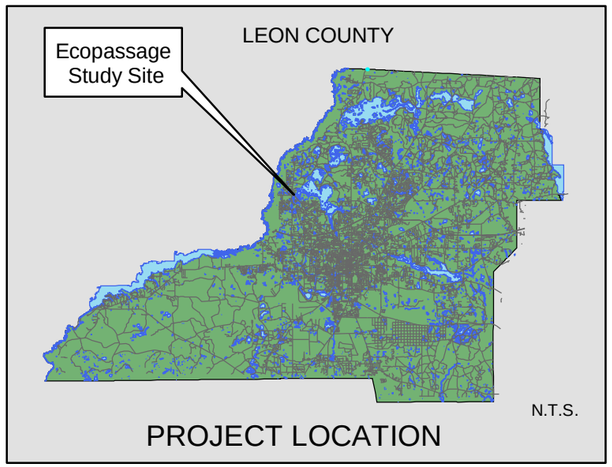
5.4 Land Use and Public Access

Land use and public access along the corridor were considered as a part of this Study. Right-of-way, available lands, and land use, as well as proposed county greenways and bicycle/pedestrian plans were reviewed for the project. These areas and their potential opportunities and/or constraints are described below.

5.4.1 Right-of-Way

Right-of-way along the project study area varies from 160 feet in width in the southern $\pm$3,500 feet of the corridor, to 200 feet in the northern $\pm$1,200 feet of the corridor. The paved roadway averages about 85 feet in width, with a 4-foot to 5-foot paved shoulder in most areas.





Legend

- Study Area Limits
- Study Area (Not Accessible)*
- 100 Year Flood Areas

Zone A - Base Flood Elevations Determined

0 300 600 1,200 Feet

NOTES:

1. This map is for informational purposes only.
2. Map information from the Federal Emergency Managment Agenct (FEMA) Flood Rate Insurance Map (FIRM) Panel No. 12073C0115D, dated November 19, 1997
3. Project boundaries approximate, based on aerial interpretation.

Lake Jackson ECOPASSAGE Feasibility Study

TALLAHASSEE-LEON COUNTY MPO Metropolitan Planning Organization

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FIGURE 5 - FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) FLOOD INSURANCE RATE MAP (FIRM)

Undeveloped area along the right-of-way ranges from 25 feet to 40 feet in width on either side of the road in most areas along the right-of-way.

FDOT has stated that it will not acquire additional right-of-way for this project. Thus, the chosen alternative will have to be accomplished within the existing FDOT right-of-way. The width and configuration of the right-of-way will play a large part in the design of the chosen alternative. Parts of the undeveloped right-of-way are vegetated, and, in some areas, topography is very steep as the terrain slopes from the roadway toward the water bodies. As such, clearing of vegetation and grading will likely be necessary for construction of the preferred alternative. In addition, utilities are located within the road right-of-way along the project corridor. According to a survey prepared for FDOT as part of a roadway resurfacing project planned along the project corridor (not part of this study), utilities located in the right-of-way along the project corridor include overhead power and telephone lines, as well as buried water lines. Design of the preferred alternative will need to take measures to avoid impacts to these utilities, and additional survey will be necessary prior to the design of the preferred alternative.

5.4.2 Development and Property Ownership

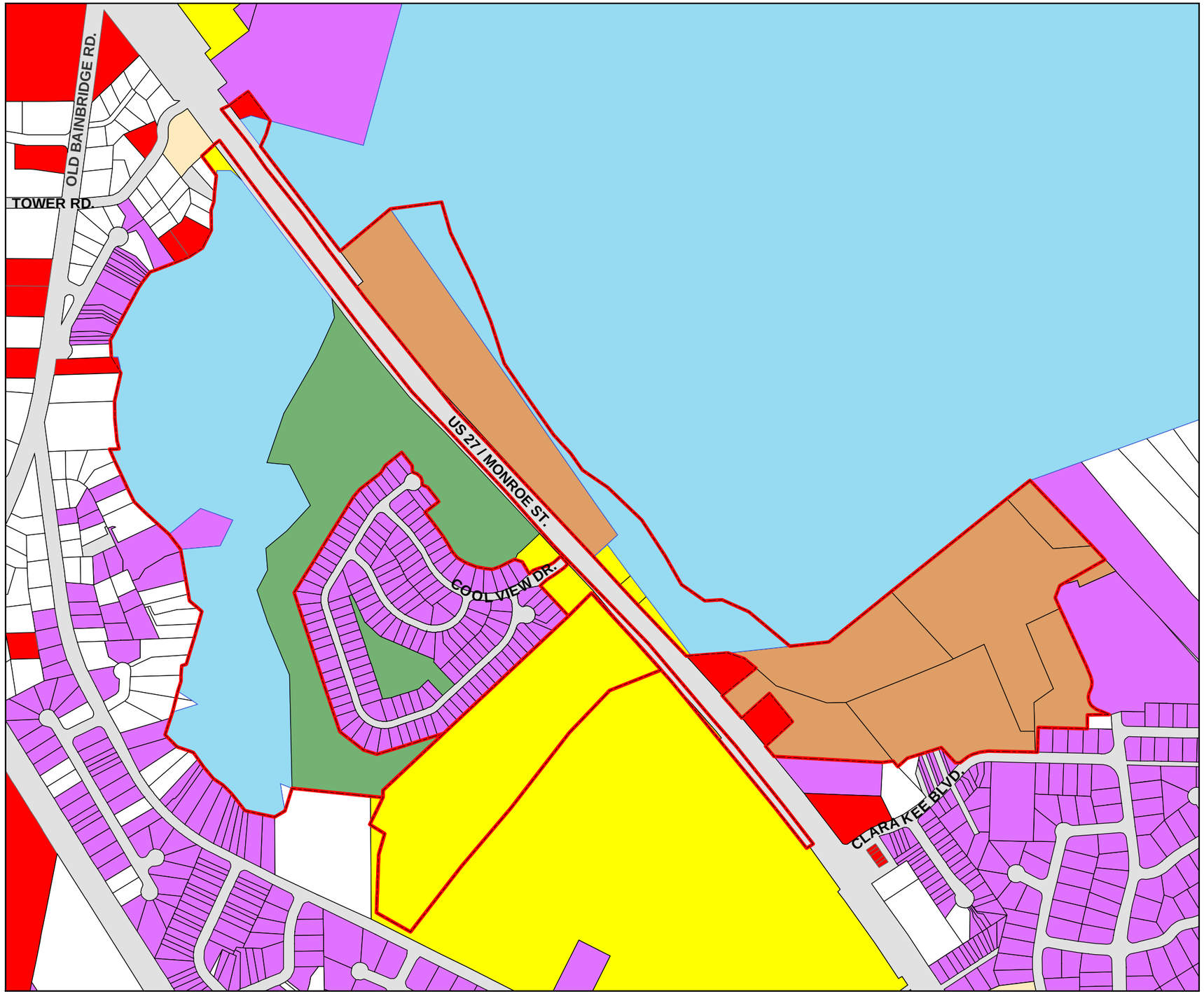
Development near the project study area is limited, and includes two small professional office buildings (<4,000 square feet) on the eastern side of US 27 at the southern end of the corridor, the county boat ramp, the Lakeside residential subdivision, and an existing liquor store and lodge/meeting hall, on the eastern and western sides of US 27 respectively, at the northern project limits. The remainder of the land along the project corridor is largely undeveloped. Much of the undeveloped land along the project study area is owned by either the county, (i.e. the boat ramp property and the proposed Jackson View Park Property) or the State of Florida (i.e. the submerged lands of Lake Jackson). A large tract of undeveloped land ($\pm$33 acres) on the western side of the roadway, adjacent to Little Lake Jackson, is owned by the Lakeside subdivision; however, it was placed under conservation easement and granted to Leon County as part of the development agreement for the subdivision. An amendment to the conservation easement would be required to allow construction of enhancements (i.e. diversion walls or culverts) on the Lakeside conservation area property.

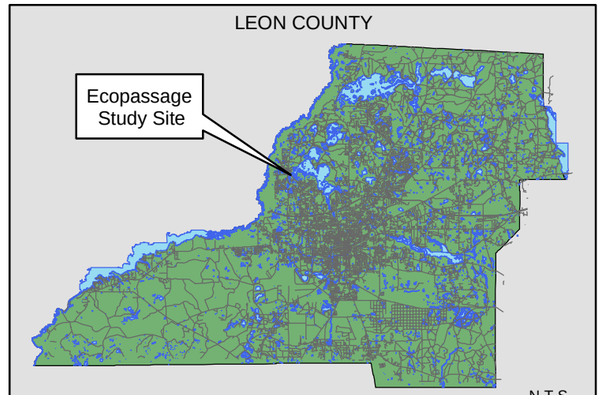
Based on review of Leon County land use data, there are several parcels of undeveloped privately owned land not under conservation easement and located within the project study

area. These areas include the approximately 24-acre tract that is part of the107-acre Sellers Parcel, two parcels located on the western side of US 27, which include an approximately 1-acre parcel located south of Cool View Drive and a 0.7-acre parcel located north of Cool View Drive, three small parcels (between 0.5 and 0.25 acre) located on the eastern side of US 27 immediately south of the county boat ramp property, and an approximately 0.34-acre parcel located on the western side of US 27 at the northern terminus of the Study Area [*Figure 6*].

The 107-acre Sellers Parcel, a former agricultural property that is primarily undeveloped, is proposed for development with a Planned Unit Development (PUD) project, including multifamily residential and mixed commercial uses. Leon County approved the development plan, with restrictions, in September 2004. The developer is required to provide greenspace as part of the proposed project. Based on available data (i.e. wildlife crossing data and potential turtle nesting areas), preserving the area along the northern boundary (i.e. area adjacent to the Lakeside subdivision within project Study Area) could provide the greatest overall benefit for wildlife in the area. Providing an approximately 500-foot-wide corridor along the northern boundary would provide a continuous wildlife corridor from Little Lake Jackson to possible nesting habitat located in this area as well as preserve wetlands in this area. Though preservation of this area is recommended based on the information gathered during this study, the locations of any preservation areas for this development will need to be determined by the developer and Leon County in order to best serve the development and county requirements.

The two undeveloped parcels on either side of Cool View Drive are commercially zoned lots that are currently for sale. Based on discussions with Leon County, it is likely that proposed driveway access for future development on these parcels will be required to connect to Cool View Drive rather than US 27 due to Leon County and Florida Department of Transportation (FDOT) regulations. As such, it may be possible to construct a diversion wall within the right-of-way along the US 27 frontage of these properties without interfering with the driveway access. However, acquisition of one (i.e. on the north side of Cool View Drive) or both of these parcels by the county for preservation would help to further protect the study area from development that would increase traffic in the area; it would also provide additional land for the design of a proposed wall. Since these parcels are in an area near the likely terminus of a wall, additional land to accommodate a wall that could curve back 50 to 100 feet (to minimize animals getting around the end of the wall) would be beneficial. Likewise, acquisition of the small (0.34-acre) undeveloped parcel near the northern terminus of the Study Area could also serve to





Legend

- Study Area Limits
- State of FL (Lake Jackson)
- Developed-Residential
- County Lands
- Undeveloped-Private
- Conservation Easement
- Developed-Commercial/Office
- Vacant
- Developed-Religious

0 300 600 1,200 Feet

NOTES:

1. This map is for informational purposes only.
It was compiled from the most accurate data available
from Tallahassee-Leon County GIS databases.
It is not to be considered a legal document or survey,
and not to be used or presented as such.
2. Parcel, ownership and Land Use Data from Tallahassee-Leon County
3. Project boundaries approximate, based on aerial interpretation

Lake Jackson ECOPASSAGE Feasibility Study

TALLAHASSEE-LEON COUNTY MPO Metropolitan Planning Organization

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FIGURE 6 - LAND USE / OWNERSHIP WITHIN STUDY AREA

accommodate a curved-back wall terminus, which is recommended in order to minimize the likelihood that animals will make their way around the wall and onto the highway.

The three small parcels immediately south of the boat ramp on the eastern side of US 27 could pose problems for a proposed diversion wall, as the construction of a wall could interfere with future access from these parcels to US 27 (the only available roadway access). If a proposed wall were to extend from the right-of-way onto the county-owned Jackson View Park Property, (as it likely would) it would have to cross over the southernmost of these three privately owned parcels, and an easement over this property would be necessary. Leon County has indicated that it would be very difficult to get development permits for these three parcels (due to lake protection regulations and adjacent wetland areas). The county could consider purchasing these parcels in order to protect the area from development (which results in more traffic and potential adverse effects to the sensitive area around the lake) as well as to eliminate potential conflicts with driveway access, avoiding the need to obtain easements to accommodate wall design.

5.4.3 Public Access

Along the project study area, public access to Lake Jackson is available at the US 27 boat ramp, which is located near the center of the Study Area. It will also be available from the proposed Jackson View Park, which will have an access from US 27 between the two existing office buildings near the southern limits of the Study Area. Additionally, Leon County is proposing to purchase an approximately 14-acre parcel just north of the Study Area known as the “Red and Sam’s Property.” Another public access point to the lake, the county-owned Sunset Landing, is located just north of the Red and Sam’s Property, approximately 1,800 feet northeast of the Study Area.

Public access to Little Lake Jackson is more restricted as there are no official public access points or public lands located around the lake. The area is surrounded by a conservation easement along the south-southeastern shore, and most of the properties located along the northern and western shores are privately owned. An unimproved road created through the conservation easement as a construction access for the Lakeside Subdivision was unofficially used by some individuals as access to Little Lake Jackson. However, this access was closed because it was a non-permitted, temporary construction access, and it was not consistent with the conservation easement. There is potential for access to Little Lake Jackson from US 27;

however, there are safety concerns regarding the lack of parking and the steep terrain between the roadway and the lake.

There is no existing public access, and currently there are no plans to provide public access to Little Lake Jackson. Many species of wildlife, including nesting turtles and alligators, use Little Lake Jackson as a refuge. The restricted access to this area is beneficial to wildlife as it reduces the likelihood of human disruption. The implementation of enhancements such as a guide wall to divert wildlife to culvert crossings will not affect access to Little Lake Jackson.

Existing public access to Lake Jackson is provided by the county boat ramp. Implementation of enhancements such as a guide wall to divert wildlife to culvert crossings may impact access at the boat ramp. Measures will need to be taken to ensure that boat access to the lake is maintained, while still providing adequate protections for wildlife. Discontinuing the wall at the boat ramp driveway would allow wildlife to enter the road from the boat ramp driveway. Stopgap measures such as a cattle-grate could be installed along the driveway at this location. The grate would leave the driveway accessible to cars, while keeping smaller animals from entering the roadway. The grate would be designed to allow animals to escape to safer areas behind the wall, which would eventually lead to culvert crossings. But the grate may not be effective for larger animals, and animals could be come trapped in the area below the grate.

Another option would be to relocate the boat ramp to the proposed Jackson View County Park. This would allow a wall to continue along the right-of-way in front of the boat ramp, and public access to the lake would still be available. The existing boat ramp property, which is unimproved and impacted by erosion, could be restored to provide native habitat for nesting turtles and other wildlife. This would create a continuous wildlife corridor along the eastern side of US 27 within the Study Area. The area would be managed and maintained by Leon County.

The proposed Jackson View Park will have more amenities including paved parking, restrooms, walking trails, and passive use areas that are not offered at the current facility. Picnic facilities, which are located at the current boat ramp, will also be available at the proposed park. Plans for the proposed Jackson View County Park are still under review by Leon County. Preliminary plans include an area for canoe access, but do not include a boat ramp. The plans would need to be revised and approved by the county to include a boat access similar to the area provided at the existing boat launch. Construction of a boat launch and proposed project enhancements

(i.e. diversion wall) would also need to be coordinated to ensure that public access to a boat launch is maintained. Alternate existing boat launch sites in the area include Sunset Landing, located less than one-half mile north of the US 27 boat ramp site. The county has also discussed purchasing the Red and Sam's Property (located approximately 3,000 feet north of the existing boat ramp), which could also potentially accommodate a public boat ramp.

5.4.3.1 Greenways

The Tallahassee-Leon County Planning Department released the Tallahassee-Leon County Greenways Master Plan in July 2004. The general purpose of this Master Plan is to provide a long-term vision for the local greenways system, incorporating a trail network designed to link greenways, parks, and other public-access conservation areas. The plan includes recommendations for land acquisitions and describes management principles, practices and guidelines for addressing natural resource protection, public access, recreation, education, and economic development. It also identifies funding sources for acquisition, management, and other greenway objectives.

The Greenways Master Plan identifies a proposed greenway corridor in the vicinity of the Study Area. The Lake Jackson South Greenway is proposed from Lakeshore Drive north to Jackson View Park. A portion of the Lake Jackson South Greenway would connect Jackson View Park with J. Lee Vause Park (formerly Old Bainbridge Park) to the north. Lee Vause Park connects to another proposed greenway, the Lake Jackson North Greenway, which would extend along the northern shore of Lake Jackson, east to Meridian Road. The Greenways Master Plan provides this description of the proposed Lake Jackson South Greenway:

> "The Lake Jackson South Greenway would include lake protection enhancements and extensions of the regional greenway system. The project would include passive recreation (bicycle/pedestrian) connections, where feasible, between existing state and county parks and boat landings, as well as conservation easements and stormwater facilities owned and operated by the NWFWMD. The greenway corridor will also incorporate lands exposed during the recent Lake Jackson drawdown. At high water, this corridor could function as a canoe or kayak trail. Although this greenway will incorporate passive recreational elements, it will enhance the lake's economic and recreational value."

The segment of the Lake Jackson South Greenway connecting Jackson View Park to Lee Vause Park is located within the Study Area, and could be affected by enhancements proposed as part of the Lake Jackson Ecopassage Feasibility Study. Leon County has indicated that the proposed shared-use path connecting the two parks would need to be located within existing right-of-way along the eastern side of US 27. Proposed enhancements for the ecopassage project (i.e. culverts and diversion wall) would also need to be located within the existing right-of-way.

The Greenways Master Plan has assigned a priority rank to 17 distinct greenways projects identified within it. Priority rank was based on available funding sources, and included as top priority those projects ranked on the A list of Blueprint 2000 projects within the Urban Services Area; projects that were consistent with the Florida Community Trust program criteria; projects for which funding from state or local government was available; and projects associated with certain proposed private developments. The projects were ranked 1 (highest priority) through 4. Nine projects, including the Lake Jackson South Greenway project, received a priority rank of 2. The Lake Jackson North Greenway received a priority rank of 3. Of those projects that received a priority rank of 2, the Lake Jackson South Greenway received a score of 9 (tied with one other greenway project), which was the lowest score given to a project with a ranking of 2. Scores ranged from 19 (highest) to 2 (lowest). Public preference was also scored, with the Lake Jackson South project receiving a public preference score of 8. Six projects had lower public preference scores, two other projects had the same public preference score, and nine projects had higher public preference scores.

Based on the priority ranking, it is unlikely that the Lake Jackson South Greenway will be implemented prior to proposed ecopassage enhancements at the Study Area. It is recommended, however, that consideration be taken with the design of the proposed enhancements to accommodate the future shared-use path at the site. Through appropriate grading, it may be possible to include a shared-use path along the top of a proposed diversion wall. Measures such as fences along proposed diversion walls may be necessary to avoid negative interaction between bicyclists/pedestrians and wildlife. Such measures may be undertaken at the time of the proposed enhancements or at the time of the implementation of the greenway project.

5.5 Enhancement Opportunities

During the drought of 1999-2000 in North Florida, Lake Jackson dried, causing a mass migration of thousands of animals attempting to move across US 27 to Little Lake Jackson, which did not dry in the drought. Since February 2000, a total of 10,229 reptiles and amphibians of 44 species, and more than 9,200 vertebrate animals have been found dead on the road or attempting to cross the 0.75-mile section of US 27 at Lake Jackson (Aresco, 2004).

In order to prevent massive road mortality of migrating animals, Matthew Aresco erected a temporary fence using woven fabric filter cloth (i.e. silt fencing) along much of the project Study Area. The fence, which was constructed to prevent animals from crossing the road, was also oriented to direct animals to a large (12-foot diameter), existing culvert that joins Lake Jackson to Little Lake Jackson under US 27. A 3,000-foot fence along US 27 North was completed in April 2000. A second fence, 2,000 feet in length, was constructed along US 27 South to intercept animals attempting to migrate back across the road when Lake Jackson refilled in 2001. Both fences have been monitored by Aresco two to four times each day since construction. During monitoring, animals found moving along fences were hand-collected, documented, hand-carried across the highway, and released into the water. In 33 months, more than 8,000 reptiles and amphibians trying to cross the highway were safely removed from potential impacts due to collisions with automobiles; but more than 600 reptiles and amphibians were killed as the result of collisions with automobiles during this period. While the use of the silt fencing has been demonstrated to be an effective temporary means of reducing wildlife mortality, this option requires intensive (i.e. daily) monitoring and maintenance. Animals are still able to climb over the temporary fence or are able to enter the road through holes or breaches in the fabric. While no alternative is likely to be completely effective in preventing wildlife road mortality, more efficient, long-term options should be explored. Ideally, ecopassages should be designed to mitigate the effects of road mortality and habitat fragmentation for all species affected by a particular highway, including reptiles and amphibians, with the primary goal being a multi-species approach that seeks to restore the ecological connectivity of fragmented areas (Aresco, 2004).

Opportunities for enhancement at the Study Area include measures to mitigate the fragmentation of habitat that has occurred as a result of the construction of US 27. An example of such measures includes the wall and culvert system (ecopassage) constructed by the Florida

Department of Transportation along a 1.7-mile stretch of US 441 at the Paynes Prairie State Preserve south of Gainesville, Florida. The design includes an approximately 3-foot-high concrete guide wall with an overhanging lip (to prevent animals climbing over the wall) and a series of culvert underpasses. Reports indicate that it has been effective in diverting wildlife from the highway, reducing mortality, and facilitating under-highway movements (Dodd et al, 2002).

Enhancement opportunities should include the following considerations:

Measures to minimize wildlife roadkill by restoring a connection between Lake Jackson and Little Lake Jackson

Measures to improve human safety by minimizing wildlife on the roadway

Measures to preserve existing habitat

Measures to restore habitat that has been degraded

Maintenance, monitoring, and management of the area/enhancements

Enhancement opportunities could also consider the following land acquisitions or enhancement projects:

Undeveloped parcels on either side of Cool View Drive

The two undeveloped parcels on either side of Cool View Drive are commercially zoned lots that are currently for sale. The parcel to the north of Cool View Drive is approximately 0.7 acre in size, and the parcel to the south of Cool View Drive is approximately one acre. Acquisition of one or both of these parcels by the county for preservation would further protect the Study Area from development that would increase traffic in the area. It would also provide additional habitat. It may be necessary to acquire the parcel on the north side of Cool View Drive for the design of a proposed wall. Since this parcel is in an area near the likely terminus of a wall, acquisition of all or part of this parcel could help to accommodate a wall that could curve back 50 to 100 feet. This would help minimize animals getting around the end of the wall.

Three undeveloped parcels south of the county boat ramp

There are three small, undeveloped parcels located on the eastern side of US 27, immediately south of the boat ramp. Though Leon County has indicated that it would be very difficult to obtain development permits for these sites (due to lake-protection regulations and adjacent wetland areas), the county could consider purchasing these parcels in order to protect the area from development, to eliminate potential conflicts with the preferred alternative, and to avoid the need to obtain easements.

Small undeveloped parcel at northern terminus of the Study Area

The 0.34-acre parcel on the western side of US 27 at the northern limits of the Study Area is currently overgrown with kudzu vine. Acquisition of this parcel by the county for preservation could help to further protect the study area from development that would increase traffic in the area. Habitat enhancements, which might include removal of the invasive kudzu vine and possible replanting, could provide additional habitat along the corridor. It may be necessary to acquire this parcel to accommodate the design of a proposed wall. Since this parcel is in an area near the likely terminus of a wall, acquisition of this parcel could help to accommodate a wall that could curve back 50 to 100 feet. This would help minimize animals getting around the end of the wall.

Move county boat ramp to proposed Jackson View Park

The existing county boat ramp property, which is unimproved and impacted by erosion, could be restored to provide native habitat for nesting turtles and other wildlife. This would create a continuous wildlife corridor along the eastern side of US 27 within the Study Area. The area would be managed and maintained by the County. The boat ramp access could be moved to the proposed Jackson View Park, which will have more amenities than the current facility (paved parking, restrooms, walking trails, and passive use areas). Alternate existing boat launch sites in the area include Sunset Landing, located less than 0.5 mile north of the US 27 boat ramp site. The County has also discussed purchasing the approximately 14-acre Red and Sam's Property. Located approximately 3,000 feet north of the existing boat ramp, it could also potentially accommodate a boat ramp.

Acquisition of property for an educational center

It is likely that an ecopassage project, if visible from the highway, will generate some public interest. As such, it is recommended that some type of educational program be implemented as part of the project. The educational program should be located near the project. One possible location is the existing commercial facility (Colonial Liquors and Lounge) located on the eastern side of US 27 at the northern project limits. This area is close to the project, and has adequate, safe parking for visitors. Acquisition of this property by the county would be necessary. Other possible locations for an educational program include the existing boat ramp and the proposed Jackson View Park.

6.0 ALTERNATIVES

6.1 Selection Process and Evaluation Criteria for Preferred Alternative

The evaluation criteria for the preferred alternative of the Lake Jackson Ecopassage Feasibility Study was based primarily on the set of goals and objectives developed by the Project Team and the Advisory Group at the beginning of the Study (*Section 2.0*) and included factors such as biological effectiveness, motorist safety, monetary cost, and maintenance requirements. Selection of the preferred alternative included input from several different groups, including the Advisory Group, the public, and a panel of experts assembled to evaluate data and alternatives at the project site. A summary of these groups and their roles in the selection of the preferred alternative is included in this section.

6.2 Identification of the Enhancement Alternatives

There are several potential enhancement options that exist as a means to address the traffic safety and wildlife issues along the Lake Jackson segment of the US 27 corridor. Based on the inventory of the existing conditions and input from citizens in the community, nine alternatives were derived, including a no-build alternative. Some alternatives considered a combination of one or more of the alternatives. The alternatives evaluated during the Study included:

No action
Reroute the road
Close the road
Habitat enhancement only
Temporary fence without monitoring
Temporary fence with monitoring
Use/replace existing culvert and construct wall
Construct additional passageways under highway
Construct a bridge

A description of each alternative, as well as a summary of the advantages and disadvantages associated with each, is detailed in the following sections. The alternatives were evaluated based on their performance in key areas such as impacts of the enhancement on the project's goals and objectives, costs, and social impacts. A matrix reflecting the performance of each alternative as it relates to the criteria is depicted in *Table 6-2*.

6.2.1 The "No Action" (No-Build) Alternative

The "No Action" alternative is a no-build option that would include no new construction or enhancement programs in the Lake Jackson area. This alternative does not relieve the problems that have been identified along the corridor. If the existing conditions persist, there is the potential for a steady decline in the turtle population, which could lead to the elimination of one or more species from the area over time. Currently, there are no measures to assist animals in crossing the highway to the Little Lake Jackson basin.[1] The "No Action" alternative does not address motorist safety as conflicts occur between animals and vehicles traveling the highway. The potential for accidents from vehicles swerving to avoid animals on the road, vehicles stopping in the middle of the highway to assist animals trying to cross, and turtles colliding with traffic as they become projectiles on the road would continue.

The number of wildlife road kill incidents is another concern that is not addressed in the "No Action" alternative. Animals will continue to migrate as Lake Jackson's drydown periods occur,

[1] This excludes the temporary fence installed and monitored by Matt Aresco since 2001-2002. The fence was installed by Aresco in response to massive road mortality at the site during the last drydown in 2000, and has since served to mitigate some of the effects of the highway on wildlife. The "No Action" alternative assumes that no such temporary measures would be implemented or maintained.

searching for remaining pools for food and shelter. With an average of 23,000 vehicles a day on this segment of US 27, many animals that attempt to cross the highway are killed. With the "No Action" alternative, no solutions will exist to minimize wildlife road kills or provide for safe movement of wildlife across the highway.

Additionally, the Lake Jackson basin is impacted by stormwater runoff, littering, and other human activity that results from increased urban and suburban expansion. Degradation of the lake basin will continue to occur if measures are not taken to prevent further harm and divert human activities to more appropriate venues. The "No Action" alternative does nothing to facilitate these needs or promote public awareness of the ecosystem and its value.

While the "No Action" alternative does not require any monetary costs (including construction, right-of-way, and maintenance costs), there are economic disadvantages involved. If the Study is revisited in the future, the costs to implement new alternatives could be much higher due to the effects of inflation, higher material costs, and higher labor costs. Additionally, there could be potential economic backlash from current ecopassage supporters (conservation groups, tourists, local citizens, and regional stakeholders) if the "No Action" alternative is pursued.

6.2.2 The "Reroute the Road" Alternative

The "Reroute the Road" alternative proposes to divert the stretch of existing highway in the Study Area around the Lake Jackson basin so that it does not create habitat fragmentation in this area. This alternative is considered an extreme scenario, which is unlikely to engender public support. Rerouting the road would require significant time, effort, and expense to implement. Additionally, there is a lack of available land for the realignment of the highway. Therefore, right-of-way costs would be high as land acquisition and property relocations would be necessary for the project. Also, though habitat fragmentation could be eliminated in the Study Area, fragmentation could occur in another area where an alternate route would be proposed.

6.2.3 The "Close the Road, or Close the Road at Key Times" Alternative

A temporal alternative would involve closing US 27 at Lake Jackson during key hydrological cycles. The road closure would occur during the drydown periods, when animal migration is at

its peak. The road could remain open during normal lake level periods. This option is politically and economically infeasible due to the high volumes of traffic that travel the route daily. The logistics of a road closure might also be difficult to enforce and manage. Additionally, this alternative does not address migrations that occur outside of drydown cycles.

Associated with the ”Close the Road at Key Times” alternative is the “Close the Road” option, which suggests permanently blocking off traffic on the segment of US 27 that adjoins Lake Jackson. This option is considered an extreme alternative to building an ecopassage, and it is deemed economically and politically infeasible. The route carries significant traffic volumes and has limited parallel facilities that can accommodate alternative routes for northwest travel.

6.2.4 The “Habitat Enhancement Only” Alternative

The “Habitat Enhancement Only” alternative includes implementing a “Maintenance, Monitoring, and Management Plan” for the lake edge and adjacent areas that have been secondarily impacted from hydrologic alteration caused by the road, resulting in exotic infestation or a shift of appropriate representative vegetation. The plan would include the maintenance and upkeep of overgrown vegetation that abuts the lake edge and its adjacent areas. Upkeep would include regular removal of invasive and exotic species that are not native to the habitat. Implementation of this alternative would likely occur as part of a Maintenance, Monitoring, and Management Plan for the chosen alternative.

The three most prevalent exotic plants in the lake are hydrilla (*Hydrilla verticillata*), water hyacinth (*Eichhornia crassipes*), and alligator weed (*Alternanthera philoxeroides)*. These species can be an impediment to boat traffic and contribute to eutrophication of the lake through sedimentation and oxygen depletion. Ongoing management measures to control or reduce these species in the lake have been undertaken by the State of Florida (i.e. NWFWMD and affiliated organizations).

In addition, exotic and/or nuisance vegetation such as Chinese tallow (*Sapium sebiferum*), blackberry (*Rubus sp*.), kudzu (*Pueraria Montana*), Chinese privet (*Ligustrum senescence*), and Carolina willow (*Salix caroliniana*) grow in dense thickets along the terrestrial areas of the lake bank. Thinning or removal of these species would be beneficial, as it would create the open areas that are more preferable to nesting turtles. Habitat enhancement could also involve

restoring the hydrology to previously impacted wetland areas through re-grading. Hydrological enhancement can be focused on restoring specific hydrologic regimes and hydroperiod requirements for both targeted wildlife and vegetation.

There are additional advantages to consider when evaluating this alternative. It is an economical means to potentially reduce animal migration since there is only low maintenance costs associated with the management program. Currently, several parcels of county-owned and conservation lands exist to the east and west of the highway, serving as potential areas for habitat enhancement and management programs. Therefore, right-of-way acquisition is not likely to be necessary for this option, which minimizes costs and prevents displacement of adjacent property owners. The program also encourages a more diverse ecosystem of native vegetation as opposed to the monoculture that exists in many areas.

The management of the vegetation would help open up the habitat, enabling wildlife movement in a native upland ecosystem. Vegetation management could also discourage concentrated nesting sites, enabling animals to spread out nesting sites over a greater area, which could help to minimize nest predation. The enhancement option could potentially result in fewer animals trying to cross the highway in search of additional habitat since existing sites would become more suitable. Theoretically, this would reduce the number of potential auto and pedestrian collisions with animals and would potentially reduce the number of animals being killed on the highway. But this option only addresses potential migration for nesting and is not likely to reduce the numbers of animals crossing the highway in drydown years. Additionally, this plan would not provide safe access across the highway for the animals that do continue to pursue other habitats. Removal of vegetation can also disrupt the natural filtration of stormwater runoff and flooding, heightening the problem rather than providing relief to the Lake Jackson basin.

Additionally, the alternative could result in increased human traffic once the vegetation is removed and the area becomes more open and accessible. This could have a negative impact on the existing habitats if humans disrupt nesting sites and generate noise, litter, and harmful pollutants. While the clearing may increase public activity on the site, it does not provide an education program or lead to public awareness of the importance of the Lake Jackson ecosystem. It also does not meet the general expectations and support of the public to install or enhance an ecopassage to protect and preserve animal migrations.

While not likely to be an effective alternative on its own, implementation of a habitat enhancement plan could be very effective when combined with other alternatives that might more directly address wildlife mortality during drydowns. Habitat enhancement will likely occur as part of a Maintenance, Monitoring, and Management Plan for the chosen alternative.

6.2.4.1 Management Plans

Several options exist for implementation of a management plan, though the logistics of any plan will require further review. Some potential opportunities include a county-owned lands management program, a homeowners association education program, and a bureaucratic regulation program. These options are discussed below.

County-Owned Lands Management Program

Some county-owned lands are identified near the site. These could be managed by the county for the purposes of protecting existing nesting grounds and for the general upkeep of the vegetation. Methods of controlling the brush will be selected and employed for clearing out land to assist in animal movements. These methods could include hand removal, mechanical removal, chemical treatment with an approved herbicide, felling, mowing, controlled burning, or other shearing techniques. It is crucial that any mowing or other mechanical clearing activities occur during non-nesting seasons. This option does not address habitat sites located on privately owned lands or on the fringes of privately owned lands.

Homeowners Association Education Program

In order to address lands not currently owned by the county, a homeowners association education program is a viable option. This program could establish a system for instructing the neighboring residents how to maintain their lawns and how to periodically burn brush. The program has the potential to work for those residents and associations who are willing to participate in the program. However, it is not known how effective this option would be without official regulation and incentives.

Bureaucratic Regulation Program

The "Bureaucratic Regulation Program" would establish an official policy through the cooperation of various county and/or state agencies on the regulation of vegetative management in the Lake Jackson area. The use of herbicides and cutting/clearing practices would be overseen by selected regulatory entities, enforcing the mandatory upkeep of private properties. It is not known how cooperative these property owners and public officials would be in implementing this program. Cooperation of these entities would be essential for this type of program to succeed.

6.2.5 The "Temporary Fence" Alternatives

6.2.5.1 Temporary Fence Only

The "Temporary Fence Only" alternative proposes the installation of a temporary fence along the roadway to encourage crossing through the existing culvert. The fence would remain through the drydown periods and would be removed following the refill of the lake and the end of the mass migration period. It should be a minimum of four feet in height to prevent snakes and turtles from climbing over it and to offer multi-species protection. Additionally, the decision would have to be made as to when the fence would be installed so that there is no lag between migration and installation.

This alternative offers relief on a temporary basis, only addressing concerns during the most extreme migration periods. During these drydown stages, the fence would provide for safer movement of wildlife by restricting their access to the highway and encouraging them to use the existing culvert. As a result, fewer vehicle/animal collisions would occur, leading to fewer road kill incidents. Additionally, a temporary fence would restrict human access to animal habitats during the drydown periods.

There are disadvantages associated with the installation of a temporary fence. For example, there would be no measures in place to protect wildlife during the lake's normal cycles. The fence also does not address the stormwater problems that are present due to the urban activities surrounding the site. Though the fence does not disrupt the native landscape, it could be perceived as an "eyesore" to area residents and visitors.

This solution is likely the least expensive method for minimizing road kills during the mass migration period. Construction costs, right-of-way costs, and maintenance costs are all anticipated to be very low with the installation of temporary fencing. Private property owners are more likely to cooperate with a temporary fence on the frontage of their property. Therefore, it is not anticipated that any property relocations or right-of-way expenses would be incurred. Maintenance of the fence would cost very little, as it would be removed following the drydown period. Without regular maintenance during drydown periods, however, the temporary fence could quickly become ineffective. Temporary fences are subject to holes and breeches after short periods of being exposed to the elements.

6.2.5.2 Temporary Fence with Monitoring

The use of a temporary fence with a monitoring program was also considered. This option provides a supplemental monitoring program that accompanies the installation of a temporary fence. The program would include paid staff and volunteers contracted to provide routine maintenance of the fence (particularly after rainstorms and mowing) and to oversee the transition of animals attempting to cross the highway over to the existing culvert. Staff would visit the site twice a day during the drydown periods. The fence and monitoring program would then be removed once the lake levels refill.

Opportunities exist for funding the project, including the establishment of a trust fund. Donations and grants could act as the principal money in the fund. The interest accumulated from this principal could then be used to support the daily maintenance and monitoring of the site. The principal would remain intact through the next cycle, available for the subsequent drydown periods. Additionally, the Florida Department of Transportation has discussed the possibility of providing prison crews for maintenance of the temporary fence.[2] Potential additional financial support is available from the Leon County Commission. Low construction and maintenance costs are anticipated with the implementation of this alternative. Right-of-way costs are also assumed to be low, since private property owners are more likely to cooperate with temporary enhancement measures that would not permanently affect their property. Therefore, the relocation of property owners or acquisition of additional right-of-way would not likely be necessary.

[2] Prison crews have been used previously for maintenance of the existing temporary fence erected by Aresco in 2001.

This option could also provide a potential educational and ecotourism opportunity that would generate income for the area. A group such as Earthwatch or International Expeditions could be charged with organizing and overseeing volunteers. Volunteers would sign up and pay a fee to participate as a "research assistant" for the monitoring program. The county or a trust fund set up for the ecopassage would receive a percentage of the volunteer fee. Based on other monitoring-type programs, approximately three to five volunteers per week could be expected. Participants typically pay for their own transportation and would also pay for lodging and meals in the area. Income could be generated through the fees that volunteers pay to participate. Similar such programs have been successful. The disadvantages would be that since the drydown events occur sporadically, the ecotourism opportunities would be hard to predict. Also, due to the time lags between events, it might be difficult to generate interest in the destination.

The monitoring program would afford area residents the opportunity to volunteer and contribute to the project, promoting public awareness and involvement. Additionally, the option provides a low-cost way to reduce animal conflicts on the highway. However, once again, this alternative does not address the migration and stormwater issues during normal lake level periods.

6.2.6 The "Use/Replace Existing Culvert and Construct Wall" Alternative

This alternative involves replacing the existing culvert and constructing varying degrees of diversion walls on either side of the highway. The walls would serve to divert animals from crossing the highway and would encourage them to travel through the culvert. This alternative provides a more permanent means for safer animal migration, reduced road kill incidents, and reduced animal/vehicle conflicts on the highway. However, some species may succumb to exhaustion or predation as they travel too far away from the culvert and get trapped along the retaining wall. Decisions would need to be made regarding how far to extend the walls, the type of materials used in the walls, and the type of materials to use in the subsurface at the base of the walls. Replacement of the current culvert should be done with the understanding that it is an existing operational passage under the road. It is recommended that the height and width of the new culvert be duplicated, as these factors are likely the attributes leading to its success.

Reduced human access would also result from the implementation of retaining walls, encouraging the diversion of disruptive activities to more appropriate areas. The ecopassage may require security to protect migration routes and nesting areas.

At the same time, the walls would stand out to passing traffic, calling attention to the project and promoting public awareness of the Lake Jackson ecosystem. The tremendous public support for this type of alternative was revealed in comments obtained through the Lake Jackson Ecopassage Feasibility Study public meetings and workshops.

While the retaining walls provide an effective and more permanent solution to animal safety, the costs associated with them are higher than in the previous alternatives. For example, potential land acquisition costs might be necessary, since private property owners may be less willing to allow permanent structures on their frontage. Currently, three private parcels exist on the east side of the highway and two on the west side that could impede the ability to install retaining walls. Therefore, acquisition of these parcels may be necessary before the walls can be built. Construction costs for the walls would also be high. However, regardless of the project, the existing culvert will need to be replaced eventually and will incur costs regardless of the implementation of retaining walls. The walls will most likely require maintenance to avoid and repair cracks, to mow and hedge vegetation along the wall, and to monitor animal migration activities near the site. Wall junctions, corners, and other seams may require sealing on a regular basis. Therefore, maintenance costs are also anticipated to be higher.

6.2.6.1 Wingwalls and Kick-Back Walls

The implementation of “wingwalls” is a potential retaining wall design. These walls would extend out a few hundred feet from either side of the culvert entrance as a channel to help direct animals through the culvert. However the species crossing the highway outside of the perimeters of the wingwalls would not be protected.

The use of “kick-back” walls is another potential retaining wall design. Kick-back walls are short walls, approximately 20 feet long and 24 inches high, that branch off the main wall. Kick-back walls are a potential solution to address observations by biologists and herpetologists indicating the tendency for turtles to move back and forth in front of a fence or wall that is blocking their forward movement. It has been observed that turtles will move in a space of approximately 50 feet and will continue to move back and forth until they die (from exhaustion or predation). The idea of the kickback wall is to move the turtles and other wildlife away from the straight-line wall back toward the lakeside. The walls should interrupt the pacing and cause the animal to move back toward the lake and/or cause it to continue to move along the wall until it reaches an

ecopassage. These walls should extend back at least 20 feet, perpendicular to the main wall, and be placed in 50-foot to100-foot increments along the main wall. The junction of these walls should be curved, so that the animals flow along it and don't get "stuck" in a corner. The use of these walls has not been tested in a setting like the proposed project site, thus their effectiveness is unknown. Right-of-way limitations exist, and the numerous small walls could present a maintenance problem (providing many areas for debris to become trapped) for a proposed ecopassage.

Another potential retaining wall design is the use of flarebacks and curves along the ends of the walls. By creating a wall that curves back on itself (120 degrees or more) at the ends, the potential that animals will make their way around the end of the wall and onto the highway is minimized.

6.2.6.2 Wayside or Visitor Center

Along with the installation of retaining walls, a wayside kiosk or visitor center could be placed along the roadside. The information center could present information on the Lake Jackson area and serve to educate and inform citizens of the ecosystem and its benefits. The location of the wayside kiosk or visitor center would need to take into consideration proximity to the ecopassage project and available parking. Parking along the right-of-way could be dangerous, so an area with safe parking would need to be considered.

One potential location for a visitor center is a commercial property (existing liquor store) located at the northern limits of the property, on the eastern side of US 27. This property is in close proximity to the proposed ecopassage project, and has safe, adequate parking. The county would need to acquire this property. Other possible locations for an educational kiosk or visitor center include the proposed Jackson View Park or the existing county boat ramp.

6.2.7 The "Establish Additional Passageways" Alternative

This alternative would replace the existing culvert and include up to three additional culverts/passageways along the corridor in high potential crossing areas. The locations of the new passages would most likely occur south of the existing culvert. This option could still

include the full diversion wall option or the “wingwall” concept (see descriptions in *Section 6.2.6*).

The locations of the culverts would be based on species occurrence, availability of public lands, existing site conditions, and impacts on the surrounding floodplain and stormwater systems. Positioning of the additional ecopassages would be established using current data from migrations during and after drydown events on Lake Jackson.

The public involvement effort for the Lake Jackson project revealed that there is significant public support for this alternative with the full diversion wall option. The addition of culverts would expand the opportunity for animals crossing the highway safely, therefore reducing the number of road kill incidents and animal/vehicle conflicts on the road. Public education and awareness would also increase as motorists and passengers along US 27 observe the new passages and their accompanying walls. Including the concept of a roadside kiosk or visitor center would also call attention to the project. Additionally, the retaining walls could serve to restrict human access to the site, potentially protecting and shielding species from human disruptions. Project costs associated with this alternative would be lower than the bridge alternative but higher than a ”No Action” or “Temporary Fence” option.

Permitting of proposed structures for this alternative is the primary concern associated with this option. Floodplain and hydrological impacts associated with this option will need to be addressed during county permitting, and detailed drainage analysis for proposed culverts will likely be required. Culverts may be prohibited in some areas based on existing floodplain and/or drainage conditions. Based on existing data, it was determined that the culverts should be spaced no further than 400 feet to 500 feet apart, and a box culvert (or equivalent) of at least eight by eight feet should be used. The existing topography and the presence of 100-year floodplain areas and closed drainage basins may limit the size and/or locations of proposed culvert crossings. It is recommended that the largest sized culvert that can be accommodated by the existing elevations be used.

6.2.8 The “Bridge” Alternative

This alternative proposes the replacement of the section of US 27 between Lake Jackson and Little Lake Jackson with a bridge. This would theoretically restore the hydrological system to

pre-highway conditions and open up more opportunities for animals to cross freely between the two water bodies. The construction of a bridge would prove most effective in minimizing collisions between wildlife and motorists while also reducing the number of road kill events. Additionally, the magnitude of the project would certainly increase public awareness of the site and expand educational opportunities. The more “visible” the ecopassage is, the more likely the project will be in attracting tourists and naturalists to the area. A wayside kiosk or visitor center should also be explored as an option for reaching this goal.

While the bridge is beneficial from an ecological standpoint, it is the most costly alternative. Construction costs would be higher as would the anticipated right-of-way costs and maintenance of traffic costs associated with constructing a bridge. Federal programs may be available to assist in retrofitting a bridge. Maintenance of the bridge itself would likely incur high costs, however only minimal supervision over migration activities and vegetative management would be necessary. The schedule for construction of the bridge would also be long term, leaving a gap in addressing immediate issues.

6.3 Preferred Alternative Selection Process

The process for selecting the preferred alternative included collecting input from a variety of sources, developing evaluation criteria that were applied to each alternative, and evaluating each process to determine which alternative would best meet the goals and objectives of the feasibility study. A summary of the input and processes used in the selection of the preferred alternative and a discussion of the preferred alternative follows.

6.3.1 Advisory Group

The Lake Jackson Ecopassage Advisory Group is composed of approximately 12 members representing various community, regulatory, and state and local government organizations. Members were selected for their expertise in areas such as biology/herpetology, ecology, permitting issues, wildlife crossings, and roadway planning. The group met at regular times throughout the project to discuss progress and to offer suggestions on how to address the problem of wildlife mortality at the Study Area. The Advisory Group developed a set of goals and objectives to be used to evaluate alternatives, and its input was considered when evaluating the alternatives and choosing the preferred alternative.

6.3.2 Public Input

A public workshop was held on August 18, 2004 to inform the public about the Ecopassage Feasibility Study and to present possible alternatives to address the problem of wildlife mortality at the Study Area. Meeting attendees were presented with information about the Study Area and provided a list of possible alternatives to address the issues at the site. The alternatives list included pros, cons, and general costs for each alternative. Attendees were asked to rank the alternatives in order of preference/effectiveness, with their first choice being the alternative they felt would best address the issues of wildlife mortality and human safety. Attendees were also asked to offer comments on the alternatives and to suggest additional alternatives that had not been considered.

Public comments indicated that options that did not include some type of permanent infrastructure (i.e. culverts or a bridge) were generally “not acceptable” to address the problem. Most people advocated constructing a wall to keep wildlife off the road, while using/replacing the existing culvert and adding some additional crossings/culverts to allow wildlife passage across the road. Several people felt that a bridge, while a good solution, might be too costly and would only address the area between Lake Jackson and Little Lake Jackson, not the rest of the corridor. Based on public comment, the preferred alternative was to construct a permanent wall to keep wildlife from entering the roadway and use the existing culvert, as well as additional culvert crossings, to allow wildlife to safely pass to the other side of the road.

6.3.3 Specialist Panel

A group of scientists, considered experts in the fields of biology/herpetology, ecology, and conservation, was called upon to comment on the project alternatives. A meeting between the scientists, project team members, and regulatory personnel was held on September 23, 2004 to discuss the biological and social implications of the situation at the project study area. A list of the panel members and meeting attendees is included in *Table 6-1*.

Site conditions, including the periodic drydowns and mass migrations, were discussed as well as road mortality during “normal” (i.e. non-drydown) years. The relative importance of turtles and other fauna in the area was also discussed. Based on these discussions, it was determined that

> Turtles and other fauna are important to the overall lake ecosystem.
> Road mortality of turtles and other wildlife is not just a problem in drydown years.
> Mitigative measures are warranted at the site in order to reduce wildlife mortality.

Social issues were also discussed, and it was concluded that

> Measures to reduce the numbers of wildlife on the road are called for in order to address safety concerns.

Since the area has a high incidence of wildlife on the road, it could be assumed that traffic accidents as a result of wildlife collision (or attempting to avoid wildlife collision) would be more likely to occur in the area. By reducing the numbers of wildlife on the road, there could, in turn, be a reduction in the potential for traffic accidents as a result of wildlife collision.

Alternatives to address the wildlife mortality at the site were discussed. Most agreed that something needed to be done to minimize road mortality; therefore, the “no action” alternative was not acceptable. Some additional alternatives were discussed, including closing the road during mass migrations, re-routing the road, and building a road tunnel so that wildlife could cross over the road. After discussion, these alternatives were considered impractical for several reasons, including the very high costs that would be associated with them. It was determined that the “Temporary Fence Only” option was not a good solution, as the cost and need for maintenance, the quality of the installation, and the reliability of those installing and monitoring the fence would be highly variable, resulting in an ineffective product. While most agreed that some type of habitat enhancement was necessary at the project site, habitat enhancement only was not considered an effective solution, as habitat enhancement alone is not likely to keep animals off of the road. The idea of a bridge was well received; however, some participants expressed a concern that the bridge would only address the 700 feet (approximately) of roadway between Lake Jackson and Little Lake Jackson. It was determined that a very large bridge (spanning most of the project corridor) was not likely to be feasible, due to the costs, the level of environmental documentation required for permitting, and the timeframe for design and construction.

The alternative that was best received by members of the panel was some type of wall and culvert system. A retaining wall to keep animals off the road, directing them instead to culverts where they could cross under the road, while not a perfect solution, was determined to be the most feasible way (from a biological, design, construction, and cost standpoint) to minimize wildlife mortality and increase human safety (by minimizing wildlife collisions) in the project study area.

Table 6-1
Specialist Panel Attendees

NAME	ORGANIZATION / AFFILIATION
Ray Ashton	Biologist/Ecologist with Ashton Ashton & Associates / Project Team Member
Dr. Whit Gibbons	Senior Professor of Ecology at the University of Georgia's Savannah River Ecology Laboratory
Dr. Bruce Means	Research Ecologist, Director, Coastal Plains Institute
Matt Aresco	Ecologist, Research Fellow, Ph.D. candidate at Florida State University
Jack Kostrezwa	Tallahassee-Leon County MPO, Acting Executive Director
Clay Carithers	Leon County Growth and Environmental Management - Permitting
Allison Connell	Kimley-Horn and Associates, Project Team Member
Jon Sewell	Kimley-Horn and Associates, Project Manager
Syd Hockett	Kimley-Horn and Associates, Administrative Assistant

6.4 Alternative Selection

Each alternative was ranked according to selection criteria based on issues deemed most important. These included biological effectiveness, motorist safety, maintenance (ease and cost), perceived social costs, and monetary cost of construction. Each criterion was ranked from 1 (least effective or desirable) to 5 (most effective or desirable). Monetary cost was scored based on a higher value using the range from 1 (least effective or desirable) to 10 (most effective or desirable). A summary of the selection ranking is included in *Table 6-2.*

Table 6-2
Alternative Selection Criteria
Lake Jackson Ecopassage Feasibility Study

Alternative	Biological Effectiveness	Motorist Safety	Maintenance	Perceived Social Costs*	Monetary Cost **	Total Score	Overall Rank (Based on Score)
No Action	1	1	5	2	10	19	6
Re-Route Road	5	5	5	2	1	18	7
Close Road During Migrations	3	4	4	1	3	15	8
Habitat Enhancement Only	2	1	4	4	9	20	5
Temporary Fencing w/ Monitoring	4	4	1	4	8	21	4
Existing Culvert and Construct Wall	4	5	3	6	7	25	2
Additional Passageways w/ Wall	7	6	3	6	6	28	1
Bridge	6	5	4	5	2	22	3

* Perceived social costs, while difficult to quantify, are important to consider for each ranking. For example, the monetary cost of construction for the no action alternative may be low, however, social costs may be high, due to increased chance of traffic accidents, and the public's perception of local and state governments, who were aware that a problem exists in the area but did nothing about it. Social costs could also include residents who would be displaced by the construction of a new road or motorists who would be inconvenienced by a road closing.

** Monetary cost assumed that lowest cost would get highest ranking

Table 6-3 illustrates the rank for each group (rank of 1 being most preferred), as well as the overall rank. Based on these evaluations, the overall ranking resulted in the "Additional Passageways Under the Highway" alternative being ranked the highest by all processes.

Table 6-3
Summary of Preferred Alternative Selection Process and Final Ranking
Lake Jackson Ecopassage Feasibility Study

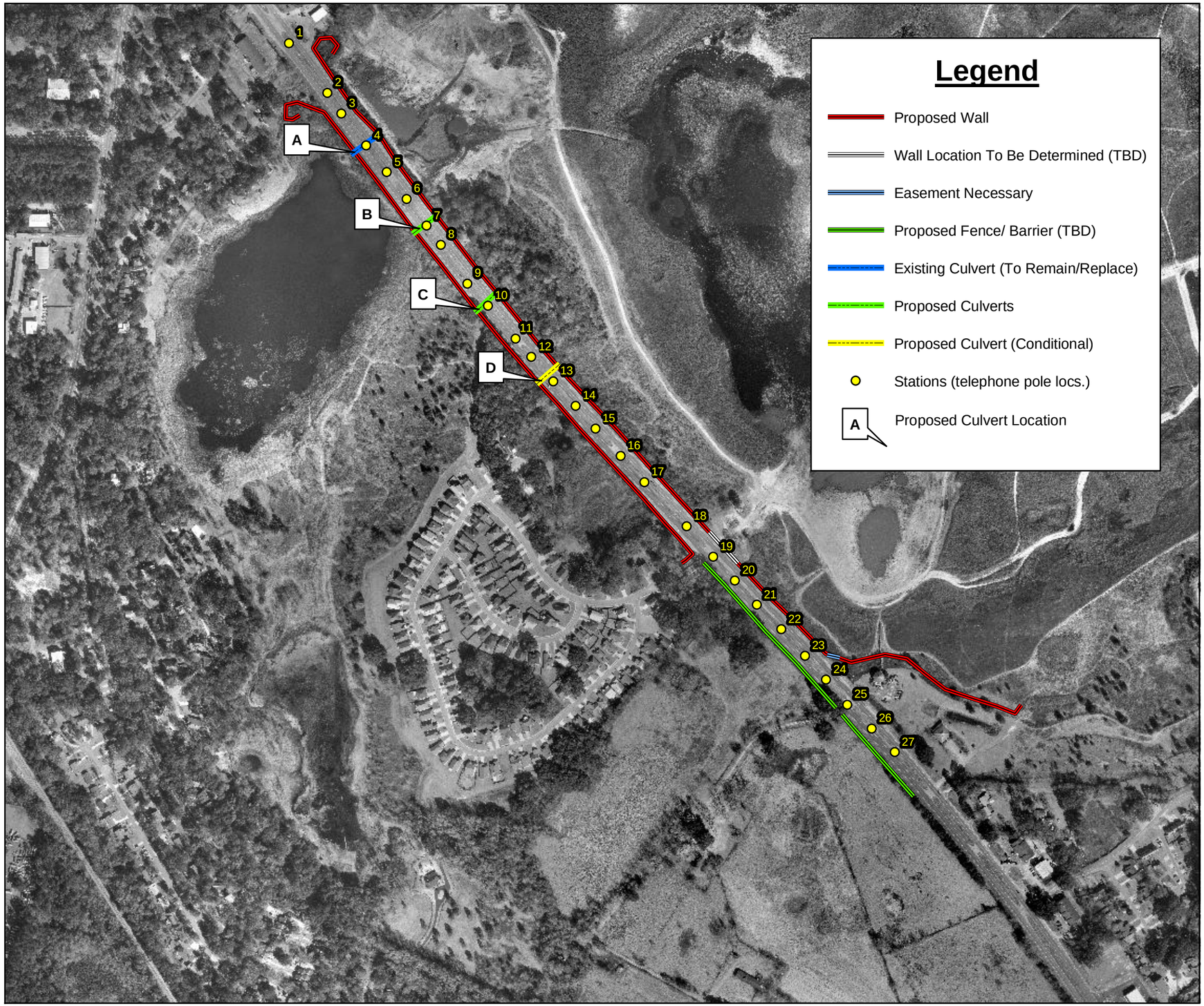
Alternative	Advisory Group/Consultant Team Rank	Public Meeting Rank	Specialist Panel Rank	Evaluation Criteria Rank	Overall Rank
No Action	6	*	7	6	6
Re-Route Road	7	**	6	7	7
Close Road During Migrations	8	**	5	8	8
Habitat Enhancement Only	5	*	4	5	5
Temporary Fencing w/ Monitoring	4	*	5	4	4
Existing Culvert and Construct Wall	3	3	3	2	3
Additional Passageways w/ Wall	1	1	1	1	1
Bridge	2	2	2	3	2

* Denotes options public meeting attendees discarded as "unacceptable" and did not bother to rank.

** Denotes not presented at the public workshop.

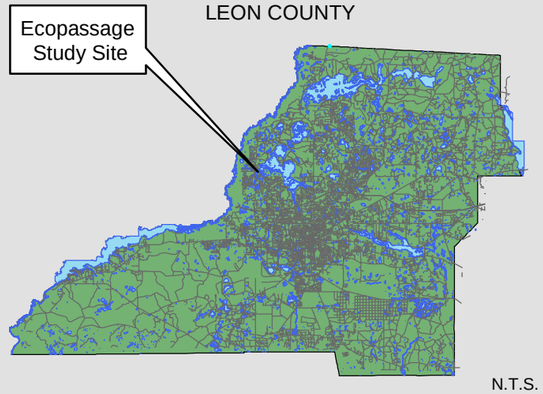
6.5 Preferred Alternative

Based on the various selection processes used in this study, the preferred alternative is to replace the existing culvert and insert up to three additional culverts/passageways in high potential crossing areas, as well as construct a diversion wall along the project corridor [*Figure 7]*.



Legend

- Proposed Wall
- Wall Location To Be Determined (TBD)
- Easement Necessary
- Proposed Fence/ Barrier (TBD)
- Existing Culvert (To Remain/Replace)
- Proposed Culverts
- Proposed Culvert (Conditional)
- Stations (telephone pole locs.)
- A — Proposed Culvert Location



PROJECT LOCATION

0 250 500 1,000 Feet

N

NOTES:

1. This map is for informational purposes only. It is not to be considered a legal document or survey, and not to be used or presented as such.
2. Aerial from Tallahassee-Leon County, GIS (2000)
3. Minimum Wall Height proposed (from ground elevation) is 5 feet.
4. Wall to be angled and/or have an overhanging "lip" to prevent animals from climbing over wall.
5. Proposed culvert crossing size is 12' width/height, though final size will depend on existing topography. Greatest height allowable for existing topography will be used.
6. Proposed wall location TBD area dependent on moving boat ramp access to proposed Jackson View Park. Existing Boat ramp location will be closed and habitat restored.
7. Proposed culvert location (conditional) dependent on floodplain and drainage issues. Note that a culvert in this location may not be possible. If a culvert is not possible in this location, the alternative will only include 3 culverts (A,B,C) including replacement of the existing culvert.
8. A modified barrier wall, such as a fence, or guardrail, is proposed in the area south of Coolview Drive, in lieu of the more costly, and permanent concrete wall. A Permanent wall is recommended if construction of a stormwater pond is proposed in currently vacant property on the west side of US 27. Developer could be responsible for wall.
9. An easement may be needed to construct permanent wall from ROW to County Park property, as it will likely cross private property.
10. This Drawing is Conceptual and subject to change.
11. Ecopassage at location A may consist of more than one side-by-side culvert.

TALLAHASSEE-LEON COUNTY MPO Metropolitan Planning Organization

Kimley-Horn and Associates, Inc.

FIGURE 7 - PREFERRED ALTERNATIVE LOCATION MAP

7.0 ENHANCEMENT PROJECTS

Based on the data gathered during the course of the Study, which took into account existing conditions at the site, wildlife movements, public input, and similar projects, the preferred alternative is to replace the existing culvert and insert up to three additional culverts or passageways in high potential crossing areas, as well as construct a diversion wall along the project corridor [*Figure 7*]. Typical conceptual cross-sections of the proposed ecopassage were created as part of this study and are included in *Appendix F*.

Culvert size and location recommendations were based on available existing data. It should be noted that additional data, including topographical survey and geotechnical information, will need to be obtained prior to the design phase of this project, and locations and sizes of proposed culverts may need to be adjusted based on this information.

A monitoring and maintenance program is also suggested as a component of the project, as is an educational program to be implemented in conjunction with the ecopassage project.

7.1 Enhancement Construction Recommendations Based on Biological Parameters

Ecopassage complexes (i.e. wall and culvert system) have been shown to be relatively successful in curtailing wildlife loss and potential hazards to traffic by providing an impassable barrier to many species of wildlife including most snakes, turtles and tortoises, and most species of salamanders. They are less successful in containing birds, lizards, frogs, and some species of mammals (i.e. deer and bats). Trying to curtail animals that can fly, jump to substantial heights, or are adapted for climbing on surfaces like walls, is simply too expensive or impractical. The plan recommended here has taken into account the data on the species that make up roughly 90 percent of the wildlife fatalities recorded on US 27 within the Study Area.

The project recommendations take into account the behavior of the animals listed as fatalities on US 27 during and after the last natural drydown (1999-2000). The published data and the

observations of herpetologists and other biologists on the behavior of animals that are confronted with a barrier while attempting to migrate from one point to another, either for nesting or escaping a negative environmental situation, have been evaluated and taken into consideration for the recommendations. These recommendations should be addressed and implemented in the design of the proposed enhancements. Failure to address these recommendations could jeopardize the success of the project.

7.1.1 Diversion Walls

The following recommendations are made for the proposed diversion walls:

The proposed wall should be placed as close to the highway as possible (though outside of FDOT clear-zones). Locating the wall as close to the highway as possible may help to ensure that the structure avoids impacts to wetlands and to the lake floodplain. In addition, the distance traveled by wildlife under the highway should be the shortest possible, designed to maximize the ability of animals to see light (polarized and normal sun) and the horizon, parameters understood to be factors in the success of ecopassages. Locating the walls as close to the highway as possible would also serve to minimize additional habitat fragmentation.

The walls along either side of the highway should be the same length (i.e. there should not be a wall on one side and not the other). If walls are not consistent on both sides, it is possible that animals not impeded by a wall on one side will get caught on the roadside by the wall extending further on the opposite side. This scenario could increase the likelihood that the animal would be killed on the road. If walls cannot be made to be the same length on both sides, design considerations should be made to minimize the likelihood that animals will get caught in front of a wall.

If a water retention facility or artificial pond is built within the study area, then walls on either side of the road should be extended to ensure that animals attracted to this new water source are prevented from crossing the road.

The walls should be flush to the ecopassages (i.e. no drop-offs or gaps) so that the animals move along the same plane as they move from the wall into the opening of the passageway.

The walls should be no less than five feet high, measuring from the lakeside of the wall, from the ground surface to the lip of the wall. A wall of this height will curtail deer, especially fawns, yearlings, and does, from jumping over the wall. Combined with a large enough ecopassage, they will be more likely to avoid jumping over the walls. In addition, this is ample height to keep most snakes and other non-winged vertebrates behind the wall. Also, a five-foot drop will serve to deter humans from jumping down from the top of the wall to the base to collect or observe animals walking along the base of the wall or to take the route as a short-cut to one of the lakes.

The wall should have a lip which overhangs four to six inches on the top on the lakeside of the wall. The lip overhang, if manufactured separately from the wall unit, should be installed in a way that the joints of the lip are not in line with the wall joints. The overhanging lip will prevent larger snakes from being able to climb over the top of the wall from vegetation that has taken root near the wall base. Offsetting the lip joints from the wall joints makes a more efficient barrier to snakes and other animals attempting to climb the wall at the joints.

The base of the wall (on the lakeside) should be non-vegetated, and a barrier to prevent plant growth (such as filter cloth, sand, small gravel, or other method) should be installed in this area. Herbicides should be avoided, due to unknown effects on wildlife and the ecosystem. Methods used also should not be a barrier to wildlife (e.g. large rocks that would be difficult for small animals to negotiate). These measures will curtail the weed growth that might reach the height of the wall in just a few weeks. Weed growth can facilitate animals climbing the wall. Taking such measures can also reduce the need to mow along the wall, saving maintenance costs, as well as reducing the likelihood of damage to the wall by flexible arm mowers trying to cut at its base.

The wall joints should be no more that 1/8 inch wide or they should be permanently sealed (with a high-quality silicone concrete sealant, or similar product) to be flush with the wall. The surface of the wall should be smooth to help prevent animals from climbing the wall; snakes can get into the joints, and by pushing on each side, gain the leverage they need to propel themselves upward.

There should be no breaks in the wall. Where there are vehicle passageways, measures should be taken to prevent animals from getting around the wall to the road. Without a continuous barrier, wildlife will be able to enter the highway at the road crossings. A possible alternative could include using an open-topped box culvert with a cattle-guard crossing. The entrance to the concrete box would be slopped from the wall to the culvert, which should be a minimum of four feet down and at least six feet wide. The top of the culvert, where cars cross over, could be made up of smooth galvanized pipe or similar material. The width of the opening is to discourage deer and other mammals from attempting to cross; however, animals like otter may be able to figure out a way to get through.

The wall-terminus should be carefully considered. Instead of ending abruptly, the straight wall should curl back in a 120-degree curve. The wall should extend back toward the lakeside for no less than 20 feet, if possible. If a straight wall ends abruptly, the wildlife that come to the wall near that end (and move toward the end) could move around the wall and go onto the highway.

7.1.2 Ecopassages

Creating passages under highways that various animals will use has been only moderately successful to date. It is a difficult task, because most of the animals expected to use the ecopassage do not use burrows, and many appear to have instincts that rely on the horizon and polarized light for navigation. They are not accustomed to entering the cave- or burrow-like conditions of ecopassage culverts.

The existing culvert under US 27 that connects Little Lake Jackson with Lake Jackson has been demonstrated to be used by nearly all of the wildlife that are of concern in the area (Aresco 2004). Observations of tracks made in the substrate on the bottom of the culvert include snakes, turtles, alligators, and otters. Based on these observations, it is clear that this culvert is successful as an ecopassage.

Based on the success of the existing passage, the goal in the development of additional ecopassages along the Study Area is to use the existing culvert as a model. One of the main reasons why this passage is so successful is that it lies between the two lake bottoms. The height and width of the passage are also likely key factors in its success.

The following recommendations are made for the proposed ecopassages:

The existing ecopassage is approximately 12 feet in diameter (though it has been somewhat compressed and includes several feet of natural substrate on the bottom). It is recommended that the dimensions of this culvert be maintained for additional ecopassages (a concrete box culvert or equivalent could be used). The reason for this recommendation is that scientists believe that it is necessary for animals to have a view of the horizon in order to encourage successful use of a passage. It is also important that tree canopy and brush not obscure the horizon at either end. In addition, adequate light is important throughout the tunnel. The height of the passage opening will help maximize the amount of ambient light. It may also be advisable to put in a “skylight” (i.e. open grate) in the highway median in order to provide additional light in the passage. The larger width of the culvert may also encourage animals to enter, since they will be able to clearly see the entrance and exit, and may perceive that they have space to escape danger.

The bottoms of the ecopassages should be covered with natural substrate. The substrate should be sandy soil, taken from a nearby area. The reason for this recommendation is that there may be some species that would avoid a bare concrete floor. Additionally, the natural substrate would be more conducive to amphibian

movements. Amphibians are likely move during the rains, and rains could make the natural substrate wet to damp during amphibian movement conditions.

Ecopassage locations are recommended based on the available data suggesting the most likely locations for animals to attempt to cross the highway [*Appendix G*]. It is suggested that the maximum number of ecopassages possible be provided in order to increase the likelihood that an animal traveling along a wall will be able to encounter a passage, minimizing the distance necessary to travel along the wall to get to a passage. Based on input from biologists and herpetologists familiar with turtle movements, passages ideally should be located no more that 500 feet apart. Increasing the frequency of passages will also minimize the amount of time spent along the wall, as animals traveling along the wall could become more susceptible to predation. The existing culvert, which is currently being used as an ecopassage, is the top priority for the location of an ecopassage (location A). Additional proposed locations are listed below, in order of priority (see *Figure 7* for locations).

1. Proposed ecopassage at location B
2. Proposed ecopassage at location C
3. Proposed ecopassage at location D

Based on existing conditions, it has been shown that the maximum size culvert that can be accommodated by the study area is eight feet (i.e. a box culvert that is eight feet high and eight feet wide). The highest elevations are located in the area of the existing culvert. This is also an area where data suggests a high rate of potential animal crossings. It is suggested that the culvert in this area be replaced with a wider culvert if possible. This could be done through the installation of two to three culverts side-by-side in this area [*Appendix F*]. It should be noted that additional survey and geotechnical investigation will be necessary prior to the design phase of the project. Locations and sizes of proposed culverts will need to be determined based on the results of this information. Culvert sizes may need to be adjusted based on the existing elevations; however, it is recommended that the largest-sized culvert possible, given the existing elevations, be used.

7.2 Monitoring and Maintenance

To be effective, wildlife management projects should have a plan to monitor the management efforts to determine if the recommended management is working. Likewise, management projects should be properly maintained to ensure that enhancements are working optimally.

Development of a full Monitoring and Maintenance Plan is outside the scope of this document, however, development of such a plan should be undertaken in order to define the entity (or entities) responsible for monitoring and maintenance, as well as to define parameters of monitoring, including data collection methods, data storage procedures, and reporting formats. Recommendations for developing a Monitoring and Maintenance Plan are included in the following *Sections 7.2.1* and *7.2.2*.

7.2.1 Monitoring Program

Monitoring is important to determine if implemented enhancements are working, as well as to determine if the ecosystem is being subjected to conditions other than those imposed by the recommended enhancements. Pollution, climate change, use of the resources, or changes in the Lake Jackson drainage area may have an effect on the vertebrate fauna of this system. A detailed Monitoring and Maintenance Plan identifying the entities responsible for monitoring and maintenance, and parameters and standards for data collection and storage, should be developed.

Considerable data has been collected on the conditions of the Lake Jackson aquatic complex, in particular those species that have been targeted in the planning of the ecopassage effort. This data, including published and unpublished data, should be stored and made available by the organizations overseeing management of both the Lake Jackson Aquatic Preserve (i.e. the FDEP) and the proposed ecopassage complex (i.e. Leon County). Data storage should be done in a manner that allows data collected in future monitoring efforts to be compared with past data in a way that allows managers to determine if the ecopassage is working and to identify its effect on the vertebrate fauna of the preserve.

Data on the general conditions of the lake ecosystem should be obtained and analyzed as part of a monitoring program. Surveys of populations of various species of reptiles and amphibians within the lake should be monitored to determine status and changes. To date, general monitoring of water quality, biodiversity, and basically accepted standard aquatic system monitoring at the Lake Jackson Aquatic Preserve has been available from the state (i.e. FDEP, NWFWMD) and community organizations (i.e. Friends of Lake Jackson). Additional data collection on general conditions (if necessary) should use these existing data methods and locations.

A specific monitoring program should be established to measure the effects of the ecopassage complex. The program should include measurements of key elements of the project, including the following:

The success of the wall to keep animals off the highway.

Surveys should be undertaken during peaks of annual activity by turtles and other fauna groups to determine if the wall is successful in keeping wildlife from being killed on the highway. These surveys should be done when a natural drydown takes place on Lake Jackson in order to compare road kill rates with those of previous events. This monitoring should also include areas where there are no walls along US 27.

The use of passageways by wildlife to freely move back and forth

A potential problem associated with ecopassage projects is they may be effective in keeping wildlife off the highways, but they are not successful in encouraging the natural flow of wildlife from one side of the highway to the other. This establishes the highway (and the wall) as a biological barrier. Along with reducing wildlife causalities on the highway, another main goal of the ecopassage is to avoid isolating populations.

During active periods (including the next drydown event), monitoring of passageways using photo and track monitoring should be conducted. The data should then be compared with that previously collected and stored to determine the success of the passageways.

The monitoring data can be used to measure species diversity and the relative abundance of each species in the area. It can also be used to determine if there are changes that need to be made to the ecopassage complex. It should be noted that no thorough studies exist on measuring the size and shape of passageways that are most effective in encouraging regular use by species present in the study area, or whether or not kickback walls will work to stop stranding along the walls. The study team has examined available literature, visited existing ecopassages, and made observations on various species and how they behave along barriers and during their attempts to use passageways. Data from the monitoring of these passageways should be analyzed and used to update knowledge on design and effectiveness of ecopassages.

A well-planned monitoring program can be done as part of a graduate student research project, volunteer program, or an ecotourism project as long as training and guidelines were designed to insure that the data collected would be comparable. Provisions will also need to be made for effective data storage.

It should be noted that, based on the data from the last natural drydown event, establishing a volunteer/tourism project through a reputable nature tour operator (under the guidance of a field herpetologist) could provide maintenance, wildlife assistance, and collecting of appropriate monitoring data. This effort would not only reduce costs, but also provide some economic input and good public relations for the project.

7.2.2 Maintenance Program

Monitoring of the ecopassage maintenance needs should also be included in the monitoring program. The effectiveness of ecopassage projects depends a great deal on maintenance. The

following are key points regarding the need for maintenance to keep the walls and passageways functioning properly:

Maintenance on the walls should be done at least four times per year, once in the early spring (February-March), two times in the summer (May and July), and in September to coincide with nesting season activity and seasonal plant growth.

Periodic efforts will be required to keep weeds and debris from falling onto and over the wall, and to keep the area clear of shrubs and trees that may overhang the wall. Such build-up of debris or overhanging vegetation can provide snakes with an easy route over the wall and may even allow some turtles to climb over the wall.

Joints between wall sections should be sealed to prevent impressed areas that allow snakes to get leverage and scale the wall. This may require periodic sealing if the width of the joints is not taken into consideration when designing the wall, or if finishing of the wall is not completed in such a way as to ensure that there are no joints present.

The ecopassages must be kept clear of debris and the passages periodically inspected to be sure they are not washed out or blocked. The openings on either side need to be kept clear of vegetation so that light can enter and a clear horizon is visible to the animals using the ecopassages (lack of a clear horizon and low light are believed to be primary reasons why turtles may not enter ecopassages).

Regular monitoring of wildlife along the walls and ecopassages should be conducted. Monitoring during the first-year breeding cycle will provide information on the success of keeping wildlife off the roads and the success of the ecopassages to allow free passage under the highway. Monitoring may be very important during a natural drydown because of the massive number of turtles and other animals that migrate during this time. If turtles or other species are piling up along the route or getting over the barrier because there is debris on the walls, or if the animals are moving over the road where there are no wall barriers, then further management actions would be indicated. It may require the moving of animals, actions to keep debris cleared, or the installation of temporary barriers.

7.3 Additional Habitat Enhancement and Management

The need for additional habitat enhancement in the Study Area was recognized during the Study and is recommended as a component of ecopassage enhancements. Habitat enhancements should include the removal of nuisance and exotic vegetative species and the clearing of overgrown brush and vines in county-owned lands and conservation areas. Select clearing can serve to open up overgrown areas and make them more suitable for nesting turtles. Management techniques should take a multi-species approach, and should consider the native landscape and wildlife in the area. Opportunities for habitat enhancement exist within the project Study Area and were discussed in *Section 6.2.4*. Likewise, possible management scenarios for surrounding habitats were suggested in *Section 6.2.4.1*.

Development of a full Habitat Enhancement and Management Plan is outside the scope of this document; however, development of such a plan should be undertaken in order to more fully explore and document specific target areas, methods, frequency, maintenance, and monitoring parameters for habitat enhancement of county-owned and conservation lands in the Study Area. Recommendations for developing a Habitat Management Plan (HMP) are included in the following *Section 7.3.1*.

7.3.1 Establishing a Habitat Management Plan (HMP)

There is currently no Habitat Management Plan for the Study Area. A management plan for Lake Jackson was developed by the NWFWMD and the Lake Jackson Action Team under the auspices of the Surface Water Improvement and Management (SWIM) Program in 1990 and was updated in 1994 and 1997, and an Aquatic Preserve Management Plan was developed by FDEP and adopted in 1991. Neither of these plans includes specifications for the management of lands within the project Study Area, though the preservation initiative of the 1994 management plan identified the need for long-term monitoring of habitat along Lake Jackson. Leon County was identified as the lead agency for this project, with the City of Tallahassee, NWFWMD, FDEP and FWC as participants.

Leon County, along with FDEP and other stakeholders, should establish a HMP along with a monitoring program to measure the HMP's success in meeting the set goals. The HMP should

establish clear methods to sustain the areas and species directly involved with the management of the ecopassage and surrounding habitats. Some aspects of a HMP could include:

Recommendations for vegetation control, including periodic burning and or mowing to reduce stem density and the percentage of tree and shrub coverage over potential turtle nesting areas between the shore line and the location of the ecopassage complex. Such clearing should be implemented every two years or as planned in the HMP. Clearing should be done during low periods of turtle nesting.

Creation of a HMP for surrounding watershed to sustain water quality and a level of natural biodiversity decided upon by the stakeholders and users of the area.

Water quality management recommendations, including the reduction of nutrient flow into the system from stormwater runoff and septic tanks in the area.

Careful planning and monitoring of human use should be considered. The location of parks, boat landings, and a determination of proper uses such as hunting, fishing, boating, and the impacts of land-based infrastructure such as roads and picnic areas should be determined as well as human carrying capacity for each activity.

7.4 Educational Program

Since the completed project will be visible from the highway, and people may become curious about the enhancements, it is recommended that a program designed to educate and inform residents and visitors about the Lake Jackson ecology and ecopassage be implemented as part of the project. The educational program could be as simple as a wayside kiosk or bulletin board offering posters about the importance of the lake ecosystem and the history of the project, or could be as large as a visitor center with well-developed and interactive exhibits on the Lake Jackson history, biology, hydrology, ecology, and the ecopassage project. The specifications of the educational program are outside the scope of this document; however, some things to consider when developing an educational program follow.

The educational program should include information on lake hydrology and ecology. The program should inform people about the periodic lake drydowns and the resulting mass migrations. It should include information about how the ecopassage was developed, and explain that though the ecopassage is an effective means of reducing wildlife mortality during periodic lake drydowns, no solution is likely to be completely effective in reducing all wildlife mortality along the roadway.

Development of the educational program should consider available space, as visitors will need a safe location to park and observe the information and ecopassage. With limited right-of-way, locations for a wayside kiosk will be limited to areas with available parking. Possible locations for a visitor center or kiosk include the existing boat ramp, proposed Jackson View Park, or acquisition of additional property (i.e. the existing liquor store at the northern limit of the Study Area) for that purpose.

Funding sources will be important in determining the scope and size of the educational program. Funding for educational resources should be explored if a well-developed educational program such as a visitors' center is desired.

The target-audience demographic/psychographic should be researched to determine if there should be specific information/exhibits geared to adults, children, sportsmen, naturalists, those with special needs, or foreign-language speakers.

Information should be communicated in an attractive, positive, manner to maximize the likelihood that people will stop to look at the exhibit and take the time to read and understand the material.

Maintenance and staffing needs for proposed educational facilities should be considered. Wayside kiosks or bulletin boards will need to be checked periodically for damage from elements or vandalism. A visitor center may require full-time staff. Staffing could be accomplished through a combination of full-time, part-time, or volunteer staff.

8.0 ENVIRONMENTAL COMPLIANCE AND PERMITTING ISSUES

The proposed enhancement measures include the construction of a diversion wall on either side of US 27 along the project study area and a series of four culvert crossings (including replacement of the existing culvert). Implementation of enhancement measures may result in minor impacts to wetlands associated with Lake Jackson. Permits from federal and state regulatory agencies, including the U.S. Army Corps of Engineers (USACE) and the Florida Department of Environmental Protection (FDEP), will be required if the proposed enhancements will impact wetland resources. Permits from local regulatory agencies, including an Environmental Permit from Leon County, will also be necessary.

8.1 Federal – U.S. Army Corps of Engineers

A Section 404 Permit from the USACE authorizing placement of fill in wetlands will be required if construction of proposed enhancement measures will result in impacts to wetlands. Preliminary assessment of the conceptual enhancements, which would include construction of a diversion wall barrier and culvert crossings, indicate that minor impacts to wetlands are expected. Based on preliminary calculations, wetland impacts associated with the proposed project are expected to be less than one acre (temporary and permanent impacts), and possibly less than 0.5 acre (permanent impacts).

The proposed project may qualify for a Nationwide Permit (NWP) 27 for Stream and Wetland Restoration Activities. There are no impact limits for a NWP 27 Permit. Delineation of existing wetland areas also is not required for a NWP 27. There are no permit fees associated with the USACE permit. Review of a NWP is estimated between three and six months.

8.2 State

8.2.1 Florida Department of Environmental Protection

An Environmental Resource Permit (ERP) from the Florida Department of Environmental Protection (FDEP) will be required for any wetland impacts associated with the proposed enhancement measures. Since the amount and type of wetland impact associated with the project would most likely be minor, the project should be eligible for a General Environmental

Resource Permit for projects less than 40 acres associated with environmental enhancement or restoration activities. A permit fee of $300 is associated with this type of ERP. Review time for a general ERP is typically about three months.

A formal wetland delineation requires field-flagging wetland limits, submitting an application with a fee based on the size of the project (approximately $750), and field review of the flagged limits may be required.

8.2.2 Florida Department of Transportation

If the project is not designed and permitted by FDOT, then an FDOT General Permit for the construction of this project will be required.

8.3 Local – Leon County

A Leon County Environmental Permit, demonstrating the project's compliance with county environmental regulations, will be necessary for implementation of the proposed enhancement measures. Advisory Group member Clay Carithers, Environmental Review Supervisor for Leon County Growth and Environmental Management, provided information and guidance on county permitting issues and concerns regarding the proposed enhancements [*Appendix H*].

The primary permitting concern regarding implementation of these measures is the potential for proposed culvert crossings to create new hydrological connections between the Lake Jackson watershed and existing closed basin(s). Leon County has designated the area around Lake Jackson as an environmentally sensitive zone ("Special Development Zone"), and as such, it is subject to the special development standards as outlined in the Leon County Land Development Code (Section 10-192). Protections in place for the Special Development Zone (SDZ) include limitations on development and stringent requirements for stormwater treatment. Sites around the lake that have been demonstrated to be closed basins that do not naturally or artificially discharge into Lake Jackson are subject to different (i.e. less stringent) development and treatment standards than areas that are open to Lake Jackson. The Lakeside residential community includes one such closed-basin development, and, as such, permitting a connection across from the Lakeside stormwater basin (i.e. Culvert D) may not be possible.

The Lakeside closed basin also includes two sub-basins: Basin A and Basin C [*Appendix H*]. The County has indicated that Basins A and C may be considered two separate closed basins, however, this would need to be demonstrated though additional stormwater modeling. If a culvert were constructed to connect Lake Jackson with the Lakeside Closed Basin, Sub-Basin A (between Station 15 through 19 in *Appendix G*) then the development would be subject to the SDZ standards, which would limit development on the residential lots in the subdivision, as well as limit or prohibit certain uses on the two commercial lots on either side of Cool View Drive. These limitations would be considered a property "taking" and thus would not be permitted by the county. Additionally, though the 100-year floodplain elevation for Lake Jackson and the Lakeside Closed Basin are the same, creating a new connection in this area could adversely affect the frequency and duration of flooding. Impacting the floodplain in this manner is prohibited by county regulations, and likely would not be acceptable to residents whose property is within or adjacent to the floodplain.

Sub-Basin C of the Lakeside Closed Basin serves a much smaller area than Sub-Basin A, and includes only two residential lots. A connection in this area (between Station 12 and 15, *Appendix G*) would impose the same SDZ standards to land uses as applicable in Basin A; however, only two residential lots and no commercial lots would be affected. A connection in this area could also potentially affect floodplain frequency and duration, though only the two residential lots would be affected.

During permitting it will also be necessary to demonstrate that any proposed crossings in these areas will not adversely affect wetlands in the basins/sub-basins. This could be accomplished with stormwater modeling to show that pre- and post-development water levels will not be significantly affected.

A crossing south of Cool View Drive will also be difficult to permit due to the existence of the 100-year floodplain on the east side of US 27; most of the area west of US.27 (Sellers Parcel) appears to be located outside of the 100-year floodplain. The county has indicated that construction of a culvert crossing south of Cool View Drive would expand the existing 100-year floodplain to include areas on the Sellers Parcel that are not currently part of the floodplain area. Generation of additional floodplain areas in this manner is prohibited by county regulations. Additionally, creation of additional floodplain areas on the Sellers Parcel would subject the land to additional development/land use constraints and would likely be considered a taking, and

thus would not be permitted by the county. In addition, several closed basins exist on the Sellers Parcel, and connection of the Lake Jackson watershed to the closed basins would result in SDZ standards being imposed and restrictions on land use and development, which could be considered a taking and thus would not be allowed by the county.

Potential solutions for addressing the problems associated with connecting a culvert to a closed basin include taking measures to ensure that the culvert will not impact the closed basin or the floodplain. Theoretically, this could be accomplished through the construction of beams or by increasing the invert elevation of the culvert; however, given the proposed size of the culverts and/or the size of the available right-of-way and the existing elevations, these may not be practical options. Likewise, the installation of a “door” or floodgate that could be closed on the culvert when water levels reach a certain level would also not be practical, as some entity would need to be responsible for the operation of the floodgate, and the county may not be willing accept this responsibility. Design and implementation of an automated system would likely be cost-prohibitive, and could fail. A gate would also preclude the intended use (wildlife crossing) of the culvert during the times the gate was closed. Due to these permitting and design challenges, no culverts were proposed in the areas south of Station 13.

Based on conversations with Leon County staff, it appears that there is some potential for a southern culvert crossing between Stations 12 and 13 (Crossing D) which connects to sub-basin C. This location may be the most feasible for the southernmost culvert due to the small size of this sub-basin and the fact that very few developable properties will be affected by the connection to the Lake Jackson watershed and floodplain. Construction of a beam near the entrance of the culvert may still be necessary, and stormwater modeling will be essential to demonstrate that a culvert in this location will not adversely affect the basin or the floodplain. These issues will need to be addressed during the project design. If stormwater modeling and design cannot demonstrate compliance with the county regulations (i.e. that the proposed culvert will not impact closed-basin areas or floodplain areas) then a culvert crossing in this area will not be possible. If this is the case, the southernmost culvert will need to be located around Stations 10 and 11.

There were no significant permitting issues, such as the ones discussed above, associated with the replacement of the existing culvert, or the two central culverts (located between Stations 4, 7, and 10, respectively). However the design of these culverts will need to take into account the

same environmental issues, including impacts to wetlands, floodplains, and existing drainage basins, as above.

Typical review time for County Environmental Resource Permits is approximately six to nine months.

9.0 IMPLEMENTATION PLAN

Based on the preferred alternative selected through this Study, it is recommended that the existing corrugated steel pipe be replaced with a concrete box culvert or similar type structure of similar dimensions to the existing culvert. In addition, up to three (3) additional culverts should be constructed at the locations depicted in *Figure 7.* Also depicted on *Figure 7* is the location of retaining wall structures that should be constructed at a minimum height of five feet above the ground on the activity side. These retaining walls should be constructed with a top cap, having a minimum offset of six inches from the face of the wall in order to reduce wildlife climbing over the wall. Passageways should be of a minimum eight-foot by eight-foot dimension. Conceptual typical sections showing proposed ecopassage culvert locations and dimensions are attached in *Appendix F*.

This Study has made recommendations for the locations and sizes of proposed culverts and walls. However the implementation of these recommendations will be dependent upon existing conditions including surface elevations and the presence of environmentally sensitive zones such as drainage basins, wetlands, and floodplains.

Passageway sizes were based on available data suggesting that larger culverts will have greater success as functional ecopassages. It is known that the current 12-foot diameter culvert is currently operating as a functional ecopassage. Recommendation was made that proposed passages be no less than eight feet by eight feet. This is to ensure that adequate light enters the passage, and that the horizon is visible—two factors believed to be imperative in the success of ecopassages. Based on existing topography, elevation of the existing roadway will likely be necessary to accommodate the larger culverts. Additional data including topographical survey and geotechnical information will need to be obtained during the design phase of this project in order to determine the exact locations and sizes of culverts.

The county has indicated that there are some issues that need to be addressed regarding floodplains, wetlands, and drainage basins. The presence of closed drainage basins and areas of the 100-year floodplain could limit the locations of culverts, in particular, the southernmost culvert (Culvert D). If design measures and stormwater modeling are not able to demonstrate compliance with county regulations, this passageway may not be feasible.

Implementation of the proposed enhancements will require the following:

Project Development and Environment (PD&E) Study

Discussions with FDOT and the Federal Highway Administration (FHWA) indicated the need to conduct a PD&E Study for the project. Based on the level of detail involved in public participation and alternative selection during the Study, the PD&E will consider the preferred alternative and the no action alternative. The anticipated level of environmental documentation required under the National Environmental Policy Act (NEPA) is Categorical Exclusion.

Design of the Proposed Enhancements

Prior to design of the proposed enhancements, additional topographic survey and geotechnical exploration will be required. Drainage analysis will be necessary during design to ensure that proposed culverts will not adversely affect existing floodplains or drainage basins.

Identify, Propose, and Acquire Lands

Additional land necessary to implement proposed enhancements should be identified during the design phase. Other land acquisition (for preservation and enhancement purposes) should be identified and acquired during the course of the project, as well.

Regulatory Permitting of Proposed Enhancements

Design of the proposed enhancements will need to be completed prior to submittal of federal, state, and local regulatory permits.

Develop a Monitoring and Maintenance Plan for Ecopassage

A Monitoring and Maintenance Plan should be developed prior to construction of the proposed project. Baseline data should also be collected prior to construction of the project.

Develop and Implement a Habitat Management Plan

A Habitat Management Plan should be developed for the Study Area. The HMP could be implemented before or after construction of the project, though ideally it should be implemented prior to or concurrently with construction of the project.

Develop and Implement an Educational Program

An educational program about the ecopassage should be developed and implemented prior to completion of construction of the proposed project. An educational program to inform residents about the reasons for the construction and the construction schedule (such as a website or telephone hotline) may also be considered, as construction of the ecopassage is likely to result in traffic delays.

9.1 Interim Measures

Assuming funding is readily available, the PD&E Study could take from six to nine months, and design and permitting of the proposed project could take up to 12 months. Construction of the proposed alternative could take an additional six to nine months. Complete implementation of the project could take two years. Due to the time lag associated with the construction of the proposed project, interim measures, such as the temporary fence with monitoring, should be implemented until the project can be constructed. The temporary fence already exists. Matt Aresco has been monitoring and maintaining the fence since he installed it in 2000. Measures to ensure the maintenance of the temporary fence and a means to provide adequate monitoring will be required to implement an interim program. Funding for the interim program could be obtained through special grant programs for wildlife or conservation projects.

9.2 Estimated Planning Level Cost

Table 9-1 provides a planning level cost estimate for construction of the preferred alternative. This cost estimate includes construction costs only, and is subject to change based on final design of the project.

LAKE JACKSON ECOPASSAGE FEASIBILITY STUDY

ESTIMATED CONSTRUCTION COSTS

Summary of Roadway Pay Items

BID ITEM No.	DESCRIPTION	UNIT	QUANTITY	UNIT COST	PROJECT COST
101-1	MOBILIZATION	LS	1	70,000.00	70,000
102-1	MAINTENANCE OF TRAFFIC	LS	1	50,000.00	50,000
102-1-1	TEMPORARY PAVEMENT	SY	2,000	17.50	35,000
104-2	PREVENTION, CONTROL, & ABATEMENT OF EROSION & WATER POLLUTION	LS	1	25,000.00	25,000
110-1-1	CLEARING & GRUBBING (STANDARD)	AC	2.07	8,500.00	17,595
	6'X12' BOX CULVERT	LF	612	2,250.00	1,377,000
120-71	REGULAR EXCAVATION	CY	2,200	4.25	9,350
160-4	TYPE B STABILIZATION (12")	SY	3,600	2.00	7,200
285-709	OPTIONAL BASE (BASE GROUP 9)	SY	3,600	8.75	31,500
331-72-24	TYPE S ASPHALTIC CONCRETE (2 1/2 ")	SY	3,600	7.50	27,000
339-1	ASPHALT PAVEMENT MISCELLANEOUS	TN	145	1,000.00	145,000
400-1-12	CLASS I CONCRETE (ENDWALLS)	CY	121	590.00	71,390
	GRAVITY WALL	LF	4,000	365.00	1,460,000
536-1-1	GUARDRAIL (ROADWAY)	LF	4,000	16.00	64,000
575-1-4	SODDING (ST. AUGUSTINE)	SY	4,270	2.25	9,608
706-3	REFLECTIVE PAVEMENT MARKERS	EA	50	5.00	250
711-33	6" WHITE (10'-30' SKIP) (THERMOPASTIC)	LF	1,000	1.00	1,000
711-35-61	6" WHITE (THERMOPASTIC)	LF	2,000	1.00	2,000
711-36-61	6" YELLOW (THERMOPASTIC)	LF	2,000	1.00	2,000
		SUB-TOTALTOTAL CONST.			**$3,404,893**
		CONTINGENCY (10%)			**$340,489**
		TOTAL			**$3,745,382**

10.0 REFERENCES

The following references used in the preparation of this report.

Aresco, M. J. 2004. Mitigation Measures To Reduce Excessive Highway Mortality Of Turtles And Other Herpetofauana At A North Florida Lake. The Journal of Wildlife Management: In press.

Ibid., 2004. Reproductive ecology of *Pseudemys floridana* and *Trachemys scripta* (Testudines: Emyididae) in northwestern Florida. Journal of Herpetology 38:89-96.

Ibid., In press. The effect of sex-specific terrestrial movements and roads on the sex ratio of freshwater turtles. Biological Conservation.

Ashton, R. E., Jr., and P. S. Ashton.1981 (2ed). *Handbook of Reptiles and Amphibians of Florida, Vol 1. The Snakes*, Windward Press, Miami.

Ibid., 1985 (3rd ed). *Handbook of Reptiles and Amphibians of Florida: Vol.2, Lizards, Turtles, and Crocodilians.* Windward Publ., Inc., Miami.

Ibid., 1988. *Handbook of Reptiles and Amphibians of Florida: Vol.3, The Amphibians.* Windward Publ., Inc., Miami.

Bennett, D. H.1972. Notes on the terrestrial wintering of mud turtles (*Kinosternon subrubrum*). Herpetologica 28:245-247.

Buhlmann, K. A., and J. C. Vaughan. 1991. Ecology of the turtle *Pseudemys concinna* in the New River, West Virginia. Herp. Review 16:84-85.

Cagle, F. R. 1937. Egg laying habits of the slider turtle (Pseudemys troostii), the painted turtle (Chrysemys picta), and the musk turtle (Sternontherus odoratus). J. Tennessee Acad. Sci. 12:87-95.

Cagle, F. R. 1944. Activity and winter changes of hatchling *Pseudemys*. Copeia 1944:105-109.

Cagle, F. R. 1950. The life history of the slider turtle, Pseudemys scripta troostii (Holbrook). Ecol. Monogr. 20:31-54.

Carr, Archie. 1952. *Handbook of turtles: The turtles of the United States, Canada, and Baja California.* Comstock Publ. Assoc., Cornell University Press, Ithica.

Congdon, J. D., J. W. Gibbons, and J. L. Greene. 1983. Parental investment in the chicken turtle (*Deirochelys reticularia*). Ecology 64:419-425.

Congello, K. 1978. Nesting and egg laying behavior in *Terrapene carolina*. Proc. Pennsylvania Acad. Sci. 52:51-56.

Deitz, D. C., and D. R. Jackson. 1979. Use of American alligator nests by nesting turtles. J. Herp. 3(4):510-512.

Dodd, K. C., Jr. 2001. *North American box turtles: A natural history.* University of Oklahoma Press, Norman.

Ernst, C. H., J. E. Lovich, and R. W. Barbour. 1994. *Turtles of the United States and Canada.* Smithsonian Institution Press, Washington.

Ernst, C. H., and R. W. Barbour. 1972. *Turtles of the United States.* University of Kentucky Press, Lexington. 347 pp.

Ernst, C. H., R. W. Barbour, E. M. Ernst, and J. R. Butler. 1973. Growth of the mud turtle, *Kinosternon subrubrum*, in Florida. Herpetologica 29:247-250.

Ewert, M. A. 1979. The embryo and its egg: Development and natural history. *In* Harless, M., and H. Morlock, eds. Turtles: Perspectives and research, 333-413. John Wiley & Sons, New York.

Ewert, M. A. 1991. Cold torpor, diapause, delayed hatching and aestivation in reptiles and birds. *In* Deeming, D. C., and M. W. J. Ferguson, eds. *Egg incubation: Its effects on embryonic development in birds and reptiles,* 173-191. Cambridge University Press, New York.

Florida Department of Natural Resources (Florida Fish and Wildlife Conservation Commission). Lake Jackson Aquatic Preserve Management Plan. Bureau of Submerged Lands and Preserved, Division of State Lands, July 23, 1991.

Florida Fish and Wildlife Conservation Commission, 1997. List of State Listed Wildlife.

Gibbons, J. W. 1983. Reproductive characteristics and ecology of the mud turtle, *Kinosternon subrubrum* (Lacepede). Herpetologica 39(3):254-271.

Gibbons, J. W., and J. L. Greene. 1978. Selected aspects of the ecology of the chicken turtle, *Deirochelys reticularia* (Latreille) (Reptilia, Testudines, Dmydidae). J. Herp. 12:237-241.

Gibbons, J. W., J. L. Greene, and J. D. Congdon. 1983. Drought-related responses of aquatic turtle populations. J. Herp. 17(3):242-246.

Gibbons, J. W., and D. H. Nelson. 1978. The evolutionary significance of delayed emergence from the nest by hatchling turtles. Evolution 32:297-303.

Hamilton, W. J., Jr. 1947. Egg laying of *Trionyx ferox*. Copeia 1947: 209.

Iverson, J. B. 1977. Reproduction in freshwater and terrestrial turtles of North Florida. Herpetologica 33:205-212.

Jackson, D. R. 1988. Reproductive strategies of sympatric freshwater emydid turtles in northern peninsular Florida. Bull. Florida St. Mus. Biol. Sci. 33:113-158.

Jackson, D. R. 1991a. Multiple clutches and nesting behavior in the Gulf Coast box turtle. Florida Field Nature. 19:14-16.

Jackson, D. R. 1991b. Trionyx ferox: Reproduction. Herp. Review. 22(2):56.

Jackson, D. R., and M. A. Ewert. 1997. *Chelydra serpentina*: Reproduction. Herp. Review. 28(2):87.

Kish, Stephen A., Balsille, James H., and Milla, Katherine. Poster of “A Remote Sensing and GIS Study of Long Term Water Mass Balance – Lake Jackson, Florida”. Division of Agricultural Sciences, Florida A&M University, Tallahassee, Florida. 2002.

Lardie, R. L. 1975. Observations on reproduction in *Kinosternon*. J. Herp. 9:260-264.

Livingston, R. J. 1987. The Ecology of Lake Jackson: An Interim Report. Center for Aquatic Research and Resource Mgt. FSU Special Publication Series No. 88. pgs 1-78.

Macmillan, Tyler and Eidse, Faith, et al. Poster of "Drydown and Restoration of Lake Jackson" Northwest Florida Water Management District. Havana, Florida. 2002.

McGinnis, Harry, PhD, et al. The Economic Value of Lake Jackson. A. L. Burruss Institute of Public Service, Kennesaw State College and Florida State University Department of Economics. 1994.

Mount, R. H. 1975. *The reptiles and amphibians of Alabama.* Auburn Printing Co., Auburn, AL.

Myers, R.L and J.J. Ewel (eds) 1990. *Ecosystems of Florida.* Univ. of Florida Press, Gainesville, FL.

Punzo, F. 1975. Studies on the feeding behavior, diet, nesting habits and temperature relationships of Chelydra serpentine osceola (Chelonia: Chelydridae). J. Herp. 9:207-210.

Smith, S.L. 1989. Vertebrate Wildlife Resources in and Surrounding Lake Jackson. Special Report, Dept. of Natural Resources. 26pp.

U.S. Department of Agriculture, Soil Conservation Service. Soil Survey of Leon County, Florida. U.S. Department of Agriculture. February 1981.

U.S. Department of Transportation, Federal Highway Administration. Critter Crossings: Linking Habitats and Reducing Roadkill. USDOT Office of Natural Environment, 2000.

Wagner, J. R. 1984, Hydrogeological Assessment of the October 1982 Draining of Lake Jackson, NW Fla. Water Manag. Dist. Rep. 84. 1-42 pp.