



Review and Summary of Studies Containing Information Relating to Density Reduction / Groundwater Resource (DR/GR) Lands Southeastern Lee County, Florida

May 2007

Prepared for
Board of County Commissioners
Lee County, Florida

Prepared by

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Princeton, New Jersey

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Flemington, New Jersey

Head First, Inc.
Jacksonville, Florida

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ACRONYMS

ACOE	U.S. Army Corps of Engineers
ASR	Aquifer/Storage/Recovery
BMPs	best management practices
BOD	biochemical oxygen demand
CEM	conceptual ecological model
CM	conceptual model
CSM	conceptual site model
DCA	Department of Community Affairs
DO	dissolved oxygen
DOT	Department of Transportation
DR/GR	Density Reduction/Groundwater Resource
ESBA	Endangered Species Biological Assessment
ET	evapotranspiration
FDEP	Florida Department of Environmental Protection
FLUCCS	Florida Land Use and Cover Classification System
FLUCFCS	Florida Land Use, Cover and Forms Classification System
FNAI	Florida Natural Area Inventory
FS	feasibility study
FWC	Florida Fish and Wildlife Conservation Commission
GIS	Geographical Information Systems
GW	ground water
HGM	hydrogeomorphic
IHA	Indexes of Hydrologic Alterations
NEP	national estuary program
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resources Conservation Service
NWI	National Wetlands Inventory
NWL	normal water level
PM	performance measure
QA/QC	quality assurance/quality control
RMSE	root mean square error

SAV	submerged aquatic vegetation
SFWMD	South Florida Water Management District
SHCA	strategic habitat and conservation areas
SWFFS	Southwest Florida Feasibility Study
SWIM	surface water improvement and management program
TKN	Total Kjeldahl Nitrogen
TMDL	total maximum daily loads
TN	total nitrogen
TSS	total suspended solids
UMAM	Uniform Wetland Mitigation Assessment Method
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WMD	water management district
WRAP	Wetland Rapid Assessment Procedure
WT	water table

DEFINITIONS

<u>Term</u>	<u>Definition / Software / Model Description</u>
arcGIS 9.1	A software package designed to manipulate, analyze and display geographic information.
CH3D	Curvilinear-grid Hydrodynamic 3D Model calculates circulation, wave, sediment transport, water quality, light attenuation, and seagrass models.
ground-truthing	A term associated with remote sensing, satellite imagery, cartography, and other fields which refers to a process in which a pixel or node on an image is compared to what is located at that particular point in reality in order to verify the image's contents.
ha	hectares (1 ha = 10,000 sq m = 2.471 ac)
IWR	The IWR-MAIN Water Demand Management Suite© is used by water planners to project future water demands and analyze water conservation measures at the end use level.
kriging	A geostatistical technique to interpolate random field data (e.g. the elevation Z of the landscape as a function of the geographic location) at an unobserved location from observations of its value at nearby locations.
landscape mosaic	A common theme noted in all the documents that pertain to wildlife and habitat. The scale and specific habitat types (e.g. cypress swamps, mesic pine flatwoods, wet prairies, etc) at which these connections are important varies from species to species, however, the concept of an integrated “landscape mosaic” is thought to be of crucial importance to a wide range of species. For example, the Florida black bear uses many habitat types, such as pine flatwoods, cypress swamps, and mixed hardwood-pine, but may travel to specific locations to feed on palmetto berries in the fall. An interconnected habitat mosaic can also be important to animals with a smaller range. As another example, many species of salamanders cannot complete all phases of their life-cycle without wetlands (in which eggs must be laid) and high-quality uplands (crucial food supply habitat for adults). Therefore, the current practice of preserving small patches of wetlands without adequate attention to the integrity of the larger landscape is resulting in declines in the populations of many species of wildlife.
m	meter (1 m = 3.28 ft)

MIKE	MIKE is a 3-D modeling software tool designed to simulate hydrology, water quality, and sediment transport in estuaries, rivers, irrigation systems, and other bodies of water.
MODFLOW 2000	A USGS model which simulates both steady and non-steady groundwater flow in an irregularly shaped flow system in which aquifer layers can be confined, unconfined, or a combination of both.
PRISM	The Parameter-elevation Regressions on Independent Slopes Model (PRISM) is used to estimate climate parameters using both point data and a Digital Elevation Model (DEM).
SHE	MIKE SHE is a model used to simulate the land phase of the hydrologic cycle, aiding in both planning and management of water resources and environmental problems associated with groundwater and surface water bodies.
taxa	Groupings of organisms based upon biological relationships to each other. Taxa can refer to classifications at many levels of biological similarity.

Executive Summary

Lee County, in 1990, responded to concerns regarding growth rate, dwelling unit capacity, groundwater recharge, and future water supply within the County by creating a new Density Reduction / Groundwater Resource (DR/GR) future land use category. These lands allow a residential density of one dwelling unit per ten acres, and certain other uses including agriculture and resource extraction. Of the three original DR/GR land use areas in Lee County, this review focuses only on the DR/GR land located east of interstate highway I-75 and south of State Route 82.

One of Lee County's leading community development challenges is the current and future management of the DR/GR lands. Development pressures continue, as do concerns regarding the environmental health and integrity of these lands and the near-shore ecological communities with which they are connected.

As one step in ensuring a more informed approach to the management of DR/GR lands, Lee County commissioned a project in which a substantial number of the most important studies with relevance to DR/GR lands were reviewed to determine what information, if any, they contained about the current environmental conditions within the DR/GR area. This report describes that project and its findings.

To conduct the DR/GR study review, the County selected a team composed of the founding Principals of McLane Environmental, LLC; Amy S. Greene Environmental Consultants, Inc.; and Head First, Inc. These leading professionals in their respective fields, along with selected members of their staff, formed a team of consultants with complementary training and experience to address the many facets of the resources and interrelationships of ecological and hydrological processes that operate within the DR/GR lands.

At the outset of the review, the project team was aware that the DR/GR lands were designated to achieve (1) density reduction and (2) protection of groundwater recharge and resource areas. What became clear during the review is that the lands are also important because of their (3) ecological resources (wetlands, uplands, plant and animal species listed as threatened, endangered or of special concern by federal or state agencies, habitats, biodiversity hot spots, etc.). The lands are also very important because of their (4) surface water hydrology features, including flow ways. Finally, the DR/GR lands are not only

important on a piecemeal basis for the particular resource that might exist in a parcel, but because (5) the lands support overall landscape integrity due to an extensive, interconnected mosaic of habitats, allowing for wildlife range and migration corridors, interconnected flow ways that interlink wetlands and differing habitats, and connect the land to nearby coastal ecosystems.

Objectives of the DR/GR study review project included (1) reviewing and evaluating studies to glean from the best studies data that are most applicable to decision-making regarding the area of interest, (2) identifying the most important issues by linking commonalities among the various studies, and (3) evaluating the completeness of information contained in the documents reviewed. The resulting report is specifically designed to be a scientific summary, not a planning policy document. The study review report prepared by the project team does not contain conclusions regarding the appropriateness of the current density restrictions and currently permitted uses; does not examine the perceived value or suitability of any portion of these lands for future preservation or development; and does not make any recommendations regarding future land use within Lee County DR/GR lands.

The documents reviewed by the project team were selected by Lee County staff. Approximately two dozen documents were reviewed and are summarized in this report. Additionally, numerous other documents that provided background and context to the DR/GR lands were reviewed by the project team. These additional documents were also selected by Lee County staff.

The project team initiated its review with an examination of Lee County's planning documents. A list of key environmental resources, features, and issues relevant to DR/GR lands was identified in the planning documents. The selected DR/GR studies were then reviewed to determine the types of, and quality and completeness of, the information and scientific data contained in each study as it pertained to the key resources and issues list. As part of the review, key maps and overlays from each study report were identified and prioritized for possible future incorporation into the County's computerized geographic information system.

Common DR/GR resources, features, and attributes emerged from the review of the documents and studies. These commonalities comprise five major categories, as follows.

1. Density Reduction

1. Reduced residential density in the DR/GR area allows Lee County to meet State requirements and manage future growth.

This factor is as important today as it was when this land use category was created in 1990.

2. Groundwater Resource/Recharge

2. Groundwater in DR/GR lands is an important source of potable water.

Lee County currently relies on groundwater from existing well fields for a significant portion of its water supply from both public utilities and private wells.

3. Aquifer recharge occurs within the DR/GR.

A recent draft study has concluded that some of the higher-recharge land cover categories in Lee County are located within the DR/GR area.

4. Groundwater in the DR/GR area sustains important surface water bodies.

Shallow groundwater contributes flow to surface waters which are important for sustaining certain DR/GR ecological resources (e.g. wetlands) and in linking DR/GR lands to coastal ecosystems.

5. DR/GR aquifers are a potential source of new water supply for Lee County.

Future water use in Lee County is projected to increase, and the DR/GR contains areas that have the potential for new water supply development.

6. Computer models may serve as valuable tools for managing groundwater resources in DR/GR lands.

Development of potential water supplies that may affect the DR/GR water budget must be evaluated on a case-by-case basis. Quantitative tools such as computer models of groundwater flow can be used in evaluations of current and proposed future groundwater withdrawals.

7. Mining activities in DR/GR lands may have both positive and negative effects on the natural hydrologic system.

A recent draft study concluded that the effects of mining activities on groundwater

can be both positive and negative. Lakes created by mining can increase water storage capacity and the opportunity to enhance regional storage through the design and management of the mining-related lakes. However, lakes may increase susceptibility for the introduction of contaminants into the aquifer and there may be increased water losses due to evaporation.

3. Ecology

8. Existing wetlands are important ecological features of the DR/GR lands.

Several studies identify wetlands as important ecological features of the DR/GR because they provide a host of functions including: filtration and assimilation of rainfall runoff, groundwater recharge of groundwater aquifers, stabilization of sediment carried during storm flows and other surface water flows, hydraulic controls on floodwaters, nutrient cycling, and habitats for a wide variety of plant and animal species.

9. Native uplands are important habitat areas in DR/GR lands.

Similarly, native uplands are critically important to natural resources within the DR/GR. A healthy upland often provides similar functions to those provided by wetlands including sediment stabilization, nutrient cycling, habitats for a variety of plant and animal species, including refuge during floods for wetland species that are not aquatic, and aquifer recharge, especially in uplands with loose well-drained soils. One study noted specific areas within the DR/GR that are considered to be among the best remaining areas of pine flatwoods in this section of Florida, but they are not currently protected adequately by regulations.

10. Many State or federally listed or endangered species have been observed or have suitable habitat areas mapped within DR/GR lands.

DR/GR lands are home to a great number of State or federally listed or endangered species. These include mammals such as the Florida panther, Florida black bear, mastiff bat, and fox squirrel; birds including wood stork, little blue heron, red-cockaded woodpecker, southern bald eagle, and burrowing owl; and several reptiles and amphibian species. Various listed plant species were noted to occur in the DR/GR. These species may include beautiful pawpaw, birds nest fern, and lattice-vein fern.

11. DR/GR lands host a rich diversity of plant and animal species.

The DR/GR lands are important not only for the individual species that have been observed there, but for the overall diversity of species that the DR/GR lands support. The Florida Fish and Wildlife Conservation Commission has recommended certain lands referred to as Strategic Habitat Conservation Areas for additional protection, and the largest aerial extent of Strategic Habitat Conservation Areas determined to be important to the largest number of species in Lee County is concentrated within the DR/GR area. The Lee County Master Mitigation Plan embodies the concept of biodiversity areas and has been updating maps to reflect new information obtained for these areas within the County and within DR/GR lands. The Florida Fish and Wildlife Conservation Commission report also includes a separate set of maps, referred to as Regional Biodiversity Hot Spots, and one of the studies reviewed shows that there are many biodiversity “hot spots” within Lee County and that they are concentrated in the DR/GR area.

12. DR/GR lands are prime areas for wetlands mitigation and ecological restoration efforts.

The studies reviewed indicate that the DR/GR lands include extensive areas that, while they have been impacted, have good potential to be successful ecological restoration and/or enhancement areas including Florida panther primary and secondary habitat zones and many areas identified as Strategic Habitat Conservation Areas or biodiversity hot spots and/or lands directly adjacent to these areas. There is also extensive potential for these restoration areas to be used to enhance connectivity between existing protected and managed lands within the DR/GR if the appropriate actions are taken. The Lee County Master Mitigation Plan recognizes numerous potential habitat restoration sites within the DR/GR lands. Many of the documents reviewed contain information regarding potential restoration areas.

4. Surface Water

13. Surface water bodies within DR/GR lands are important hydrologic and ecological features.

While the DR/GR lands were originally designated for groundwater protection, studies reveal that surface waters are also important because they represent

hydrologic features with great significance for the ecological systems of the DR/GR lands. Wetlands and sloughs provide a habitat for a wide variety of plant, animal, and aquatic species.

14. Flows through the extensive system of channels, sloughs and wetlands within the DR/GR lands can act to remove nutrients, sediment, and contaminants from surface water to lessen impacts to surface water within the DR/GR and in nearby coastal waters.

Surface water ecosystems in DR/GR lands have the capacity to perform a cleaning process to some degree on the water that flows through them, thereby acting to lessen nutrient, sediment, and pollutant impacts on waters of rivers and creeks, and bays along the western coastline of Lee County to which the DR/GR lands drain.

15. DR/GR surface water systems are important for removing storm waters and reducing flood impacts.

DR/GR surface waters including channels, sloughs, and flow ways are important pathways that remove storm waters from DR/GR watersheds, thereby reducing impacts associated with flooding. The studies reviewed indicated that areas for mitigation of surface water flows have been identified within the DR/GR and mitigation projects are planned or underway.

16. Surface water systems may serve as sources of recharge to groundwater aquifers and well fields.

Groundwater in the shallow aquifer below the land surface and the surface water that flows in rivers, canals, wetlands, and sloughs are interconnected within the DR/GR. Surface water flows in the DR/GR in areas of groundwater withdrawals may serve as a source of recharge to the aquifer system.

5. Connections

One of the most important overall attributes of the DR/GR lands is the connections between the resources and systems that have been discussed above, and the scale over which these connections operate. Many of these connections have been alluded to in the previous discussions in this section, but the paragraphs below will describe them in more detail and make their importance clear.

17. DR/GR lands provide a large contiguous habitat area that is important to wide-ranging species.

DR/GR lands include large-scale (at a minimum of several kilometers in diameter) areas (landscapes) that consist of patches of interconnected, inter-dependent types of habitats which are repeated in a pattern (mosaic), at a scale that is unique to Lee County. From a natural resource perspective, this feature makes this area important to many wildlife species, especially the wide-ranging species such as the Florida panther, the Florida black bear, and the Eastern indigo snake.

18. DR/GR lands contain extensive areas of interconnected wetlands.

The DR/GR contains large areas of wetlands. While the studies reviewed provided no quantitative comparisons regarding wetlands within the DR/GR area in relation to the rest of Lee County or the rest of South Florida, the DR/GR does contain extensive acreage of many different types of wetlands (e.g. wet prairie, cypress dome, hydric pine flatwoods, mixed hardwood swamp), including the northernmost portion of the 60,000-acre Corkscrew Regional Ecosystem Watershed. These extensive wetlands, in combination with the mosaic of upland habitats described in the environmental studies, provide important nesting, roosting, denning, feeding, and refuge area for a diverse range of animal species and allow for the growth and reproduction of a diverse range of plant species.

19. DR/GR lands provide important connections to nearby and farther-reaching ecosystems.

In a similar fashion, because the concept of a mosaic of interrelated habitats is also important on a scale that includes external connections between the DR/GR lands and surrounding ecosystems, the DR/GR lands provide an important “link” in the “chain” of conservation areas throughout South Florida. On an even larger scale, the DR/GR contains habitats that provide important “stopover” locations for migratory birds. Several of the reports include discussions of the importance of habitats within the DR/GR lands to birds that migrate between North America and South America.

20. DR/GR lands connect both hydrologically and ecologically to nearby bays and coastal ecosystems.

The majority of the DR/GR lands drain via a number of rivers into the Estero Bay, an estuarine system recognized federally as a National Estuary and by the State of Florida as an Aquatic Preserve. The Estero Bay is home to abundant plant and animal species, including many that are listed federally and/or by the State of Florida as threatened or endangered. Estero Bay and inland waters, including the riverine systems connecting the DR/GR lands to the Estero Bay, exhibit water quality problems, including low dissolved oxygen, high nutrients (especially as measured by chlorophyll-a), and high levels of copper. Studies reviewed in this project indicate that water quality impairments and the changes in timing and quantity of freshwater entering the estuary have negative effects on a wide variety of plant and animal life, particularly the seagrasses, many invertebrates, and larval fish that are critically important to the maintenance of the area's many commercial fisheries. For these reasons, the connection of coastal areas to interior watersheds, and the preservation of interior habitats such as those located within the DR/GR lands, is crucial to some wildlife species.

At the beginning of the review process, the project team examined the Lee County Comprehensive Plan and identified more than 50 environmental resources, features, and issues potentially associated with the DR/GR lands that the County considered to be important for land use planning and management. At the conclusion of the review, the project team determined that the studies and reports revealed substantial descriptive information and scientific data regarding the DR/GR lands. The team found that every one of the 50-plus environmental resources, features, and issues identified in the Lee County Comprehensive Plan are discussed, addressed, or characterized to some extent in one or more of the studies.

This correlation between the County's stated environmental features of interest and the corresponding information provided in the documents indicates the following:

- There is a strong awareness on the part of the Lee County staff charged with managing the DR/GR area that these lands possess a large number of important resources, features, and issues.
- There is confirmation from the studies reviewed that numerous investigators also consider these DR/GR-related features to be important, and that the features (habitats, species, resources, recharge areas, etc.) have been identified as being present in the DR/GR area in southeastern Lee County.

- The studies, when viewed as a whole, reveal that the resources and ecological systems within the DR/GR area are interrelated in complex ways.
- The functioning of the DR/GR environmental system (both in terms of individual resources and interrelated systems) can be adversely impacted by certain land uses.
- There is the potential for a balance between use of the land and protection of the ecological and groundwater resources, with the nature of that balance requiring careful consideration of the DR/GR information and scientific data contained in the studies reviewed as part of this project and other similar studies.
- There is the potential for restoration of impacted portions of DR/GR lands.

The project team also found that there were a few major components of the overall character of the DR/GR lands that were not described in sufficient depth in the documents reviewed as part of this project to permit the project team to evaluate their importance or significance. These include possible saltwater intrusion effects on southeastern Lee County wellfields, ecological impacts associated with mining activities, and environmental impacts (both hydrologic and ecological) associated with agricultural activities. In the absence of information on these topics from the reports reviewed, it can not be determined whether they are important for the future management of DR/GR lands in southeastern Lee County. The topics are identified here for possible consideration by Lee County staff, which may be aware of additional studies that the project team has not reviewed, and not as recommendations for further study.

1.0 Introduction

Lee County, in 1990, responded to concerns regarding growth rate, dwelling unit capacity, groundwater recharge and future water supply within the County by creating a new Density Reduction / Groundwater Resource (DR/GR) land use category. These lands, located in several portions of the county, allow a residential density of one dwelling unit per ten acres, and use of the lands for agriculture, natural resource extraction and related facilities, conservation uses, publicly-owned gun range facilities, and private recreation facilities. This review focuses only on the DR/GR land located east of interstate highway I-75 and south of State Route 82.

One of Lee County's leading community development challenges is the current and future management of the DR/GR lands. Development interests continue as do concerns regarding the environmental health and integrity of these lands and the near-shore ecological communities with which they are connected.

In the years since the inception of the DR/GR land use category, numerous studies have been completed for the interconnected environmental systems, both ecological and hydrological, of Southwest Florida, and some studies have been performed specifically for the DR/GR lands in Lee County. As one step in ensuring a more informed approach to the management of DR/GR lands, Lee County commissioned a project in which a substantial number of the most important of those studies were reviewed to determine what information, if any, they contained about the current environmental conditions within the DR/GR area. This report describes that project and its findings.

To conduct the DR/GR study review, the County selected a team of consultants with complementary training and experience to address the many facets of the resources and interrelationships of ecological and hydrological processes that operate within the DR/GR lands. The team's project manager is Charles McLane, President of McLane Environmental, LLC. Dr. McLane is an environmental scientist who specializes in groundwater science. He has more than 20 years of experience in analyzing scientific data and performing quantitative studies, including computer modeling, for natural and development-impacted groundwater systems. Dr. McLane has served as an expert panel member to assist branches of the U.S. Government in managing response to various groundwater pollution problems, and regularly publishes and lectures to professional groups on topics related to the analysis and

interpretation of groundwater data. Dr. McLane was assisted in reviewing the hydrologic modeling portions of various studies by McLane Environmental staff members Dr. Liliana Cekan and Mr. Gregory Nelson.

Ecological expertise was provided by Amy Greene, President of Amy S. Greene Environmental Consultants, Inc. and by Ann Ertman, a member of her staff. Ms. Greene is recognized as an expert in the field of wetland science, environmental permitting, natural resources inventory, and environmental impact assessment. She has more than 20 years of experience in the performance and management of environmental studies. She has prepared wetland evaluations, delineations and mitigation plans for coastal and inland wetlands; has conducted wildlife habitat evaluations and surveys, endangered species surveys, natural resources inventories and environmental impact assessments; and has been involved in numerous projects involving environmental planning for residential, commercial, industrial and recreational and educational development and wastewater, sludge, solid waste and transportation facilities and for municipal, open space, and conservation planning.

Ms. Ertman has a strong background in inventory and analysis of ecological resources and the application of environmental regulations for the protection of those resources. With more than 12 years of experience, she has contributed to regional planning studies, and contributed to the development and application of a state-wide methodology for assessing the quantity and quality of wetland mitigation sites. Ms. Ertman has experience studying Florida ecosystems and in the application of relevant resource protection regulations from 1994 to 1998, as a member of Florida DEP, which she served as an environmental manager in charge of statewide oversight of mitigation and mitigation banking.

Geological and hydrological expertise was provided by Andrew Miller, President of Head First, Inc. With more than 20 years experience in the field of groundwater consulting, Mr. Miller has designed and implemented numerous water resources investigations and evaluations for private, municipal, and industrial clients. His work, which focuses on the sustainability of water supplies and a reduction or elimination of impacts due to excessive withdrawals, also includes investigations of the movement of contaminants and nutrients in groundwater systems. Mr. Miller operates a consulting firm based in Florida and has extensive experience with Florida aquifer systems and water supply issues.

2.0 Purpose and Methods

2.1 Purpose and Scope

As described in the original statement of work for this project, Lee County desired to review environmental studies and regulatory documents that the County had identified as important in characterizing the valuable resources in or regulating growth in the DR/GR portion of Lee County. Lee County has restricted land uses within the DR/GR to agriculture, mining, conservation and residential development at a maximum of one dwelling unit per 10 acres. The goal of the DR/GR designation was to control density and sprawl and to protect groundwater resource lands.

Defensible decisions regarding allowable density and the granting of permits requires a basis in sound science developed from available data and studies. Lee County retained the McLane Environmental project team to use multi-disciplinary skills to evaluate existing environmental studies and planning and mitigation documents. Within the designated studies and documents, the team searched for important and valid data, information and maps relevant to the DR/GR lands that would assist Lee County Staff and the Board of County Commissioners in making informed land use decisions. The resulting report is specifically designed to be a scientific summary, not a planning policy document. The County purposefully selected a consultant who would be unbiased, with no current or previous stake in any specific development or general growth or environmental objective in Lee County or its contiguous counties that could be perceived as a potential conflict of interest.

Objectives of the DR/GR study review project, as outlined in the statement of work included:

- Separating those studies that are more up-to-date and useful, from those that may be dated and less useful;
- Working with Lee County staff to identify studies not on the initial list that may be worthy of review;
- Gleaning from the best studies data that are most applicable to decision-making regarding the area of interest;
- Identifying the most important issues by linking commonalities among the various studies; and
- Evaluating the completeness of information contained in the documents reviewed.

The DR/GR study review project was guided by two primary concepts. The first is that there are numerous environmental resources, features, and issues that have been identified as having relevance to current conditions within, and future management of, DR/GR lands in southeastern Lee County. Those features were identified through a review of Lee County planning documents as described in Section 2.0.

In addition, it is clear that policy and plans for DR/GR land use in Lee County are intended to be based on sound science developed from available data and studies.

Based on this approach, a review of DR/GR-related studies was conducted to extract scientific information from the available studies, and that information was summarized as described in Section 3.0. During the review, a number of key attributes of DR/GR lands, and commonalities among environmental features of DR/GR lands, were identified as discussed in Section 4.0. Also during the review, potentially useful maps and overlays were identified as described in Section 5.0, for possible inclusion by the County into its existing Geographic Information System (GIS) data and map system. A summary of the information compiled during the review is presented in Section 6.0.

It is important to note that this study review report:

- does not originate land use planning or policy statements for Lee County DR/GR lands;
- does not provide recommendations regarding a particular status that should be attributed to DR/GR lands (e.g. “preservation lands”, “conservation lands”, “lands worthy of protection”, etc.)
- does not offer opinions regarding the appropriateness of the current density restrictions and currently permitted land uses;
- does not consider any factors relating to the perceived value or suitability for future development of one portion of the DR/GR lands over another; and
- does not provide any recommendations regarding particular activities that should be prohibited, restricted or monitored within DR/GR lands.

2.2 Documents Reviewed

The project plan specified that the project team was to review an initial set of 12 documents, with two additional studies to be added once the project was under way. Lee County, through an internal process and discussions with the project team, identified 12 documents and studies with relevance to DR/GR lands as the initial set to be reviewed (documents 1 through 12 in Appendix A). As the review progressed, two additional studies were identified by the County and submitted to the project team for consideration and review (documents 13 and 14 in Appendix A). Summaries of those documents are presented in Section 3.1 and in Appendix D.

In addition, the project team reviewed other documents relating to Lee County land use, and management of DR/GR lands, to provide context for the primary document review. These supplemental documents are summarized in Section 3.2.

2.3 Method and Objectives

As described in the project statement of work, the County wished to retain a consultant or team that had no stake in Lee County land use policy and decisions, and which possessed the requisite set of multidisciplinary skills to be able to conduct a review of studies that covered a wide range of environmental processes and issues. The McLane Environmental project team was assembled to provide expertise in the various scientific disciplines, as well as specific knowledge of geologic, hydrologic and ecological conditions in southern Florida, without any direct past or present involvement that could constitute a conflict of interest.

As the first step in the project, the team members briefly reviewed all of the initially selected documents in preparation for a meeting with the County Project Manager, Assistant County Manager, and various County Department staff. At the project kickoff meeting, the review team gained valuable insight into the rationale for the formulation of the DR/GR land use designation, and were provided with a number of useful background documents to provide context for the review. County staff provided information on a range of topics including operation and information reporting for the County's well fields, and background information on the County's GIS system which may be supplemented with certain map and overlay data identified as part of this project.

As part of the initial project meeting, project members participated in a one-hour fly-over of DR/GR lands. During the flight Lee County Department Directors described key features of the lands. Also, at the meeting a discussion was held regarding the appropriate framework for the review, which eventually led to the approach described below.

DR/GR Study Review Project Methodology

The following steps were taken by the project team in planning and conducting the DR/GR study review and in preparing this report:

1. The project team reviewed all initially selected documents shown in **Appendix A** to prepare for the project kickoff meeting and to begin formulating an approach for the review process and work products. Participated in the kickoff meeting with Lee County staff to discuss the history of DR/GR lands, to identify supporting background documents to enrich the review process, to conduct a DR/GR land fly-over, and to discuss an approach for review.
2. The project team reviewed key Lee County planning and mitigation documents to identify the sections of those documents most relevant to management of DR/GR lands. The summary of those key planning document sections is presented in **Appendix B**.
3. From the relevant sections of Lee County planning documents (in particular the Lee Comprehensive Plan), the project team identified key environmental resources, features of interest, or issues of concern that appear to be taken into consideration by the County in the land use planning. The list of more than 50 items is presented in **Appendix C**. Those key environmental features with relevance to the DR/GR lands were used to guide the review of the selected environmental studies so that relevant information and scientific data could be identified and recorded.
4. The project team reviewed the selected studies and prepared, for each study, a document review matrix (summary form) that captured key information from the study in an easy-to-access format. Those document summaries, which are presented in **Appendix D**, contain section and page numbers for each summarized item of information or data so that the interested reader can return to the original study for additional information on a particular topic.
5. During the review of the various studies, the project team identified more than 100 key maps and overlays that may be useful to Lee County in DR/GR land planning efforts or to enhance the current GIS map base for these lands. The list of key maps with relevance to DR/GR lands in southeastern Lee County is presented in **Appendix E**.

6. Upon completion of the document review, the project team reexamined the original list of key environmental features and noted that the review had identified information or data for every one of the more than 50 items in one or more of the documents. The list of key features and the sources that contain information regarding a particular feature is presented in **Appendix F**.
7. Finally, the project team integrated the information contained in the individual documents into a cohesive findings report. Brief summaries of each document are presented in **Section 3.0**. These summaries are intended to provide a brief capsule of each report in a way that might not be readily ascertained from the lengthier and more detailed summary matrices compiled in Appendix D. The project team's summary of the key features and characteristics of DR/GR lands in southeastern Lee County is presented in **Section 4.0**. The summary includes a discussion of the commonalities observed among the studies, both in terms of environmental features that are common to several of the reports, as well as connections among the environmental features that are apparent among and across the studies when they are viewed as an ensemble. Key maps from the various studies that may be useful to Lee County in future management of information relating to DR/GR lands are listed in **Section 5.0**. This section identifies approximately 40 key maps that may be considered of higher priority than others listed in Appendix E. **Section 6.0** presents a summary of the findings and conclusions of the project team. Each finding is presented as a statement supported by a brief explanation that draws on information contained in the documents reviewed. Key maps are summarized under four categories, and a brief discussion is provided of a small number of DR/GR land characteristics that were not discussed in the documents reviewed as part of this project.

3.0 Brief Summaries of DR/GR-Related Studies

The following sections present summaries of the 14 primary documents reviewed as the main focus of this project (Section 3.1), as well as summaries of the supplemental documents supplied by Lee County (Section 3.2). The additional documents, although not subjected to a formal review and not summarized more completely in Appendix D, provided valuable background information for the project.

3.1 Primary DR/GR Documents

Presented below are brief summaries of the 14 documents reviewed during this project. Because several of the documents contained separate volumes or multiple related studies, a total of 25 documents, with more than 4,000 pages were reviewed. The brief summaries presented below are meant to cover the highlights of each study or document. If the reader is interested in a more detailed summary for one or more of the documents, these are provided in Appendix D. In addition, the summaries in Appendix D are keyed to specific sections and/or pages of the original document or study report, so that a particular topic, statement, or set of data can be traced to the source and explored further if so desired.

Documents Reviewed

1. Lee County Comprehensive Plan Update - December 2005

Sponsor/Publishing Agency: Lee County Department of Community Development, Division of Planning.

Applicability to DR/GR: Plan describes County's land use plans, guidelines, and requirements for DR/GR lands.

The Lee Plan, as reviewed, is designed to depict Lee County as it will appear in the year 2020. The Plan acknowledges that, due to a number of factors including the projected increase in population and the probable rate of technological change through 2020, it is impossible to describe the future face of the county with any degree of certainty or precision. However, the Plan lists a number of themes that will be of great importance as Lee County approaches the 2020 planning horizon, including the following:

- Growth patterns of the county will continue to be dictated by a Future Land Use map that will not change dramatically during the time frame of this plan.
- The county will protect its natural resource base in order to maintain a high quality of life for its residents and visitors.
- The Lee Plan's land use accommodation is based on an aggregation of allocations for 22 Planning Communities. These communities have been designed to capture the unique character of each of these areas of the county. Lee County DR/GR lands in southeast Lee County are designated as one of the County's unique Planning Communities.

The Lee Plan is intended to manage growth, land use, and future development within the County. It should be noted that, at the time of this report, the Lee Plan is being updated to extend the planning horizon to 2030.

2. Groundwater Resources and Mining Study - June 2005
Greg F. Rawl, PG, Michael Voorhees, PhD, PE.

Sponsor / Publishing Agency: Lee County.

Applicability to the DR/GR: The areas studied in this report cover all of the DR/GR.

This report provides an evaluation and assessment of groundwater resources and mining resources within Lee County; particularly in the southern portion of the County that encompasses the DR/GR lands. Geologic units underlying Lee County, and three main groundwater aquifers are identified and shown on maps and cross sections. The study is based on data from more than 1,700 wells. The report contains evaluations of groundwater levels and groundwater quality trends. Data are used to create a groundwater model. Recharge for the model area is estimated based on land use and land cover, and the estimates for the various land cover types are refined during calibration of the groundwater flow model.

The locations of former, current, and potential rock pits/mines are shown along with an evaluation of the current and future potential for the use of mining products. The report states there are nine rock mines currently operating in Lee County, and 329 excavations were inventoried for the report. The discussion in the Section "Mining Impact Analysis" is largely general and conceptual with essentially no calculations of quantitative analyses, with the

exception of a comparison of mining-related evaporation losses to other evaporation and plant transpiration losses in Lee County. The study considers agricultural areas within the county and within the DR/GR lands in estimating recharge as an input to the groundwater model, but the study includes no detailed discussion of agricultural operations or impacts.

Regarding the hydrology of the area, the report concludes that net recharge to the surficial aquifer is high in agricultural areas, due to agricultural withdrawals of groundwater from the aquifers and application of the groundwater to the land surface. Based on the recharge estimation method and the results of the groundwater model, the study concludes that regional net recharge capability to the aquifer is most significant in southeastern Lee County. An analysis of groundwater levels in the aquifers through time leads the investigators to the conclusion that major water level declines in the Sandstone and Mid-Hawthorne aquifers have occurred in the last 10 to 15 years.

The study compared water losses associated with mining to losses that occur in the natural hydrologic system due to evaporation from lakes and reservoirs, evaporation and transpiration from wetland areas, and transpiration from the invasive plant species melaleuca, and concluded that the volume of mining losses were no more significant than these other losses. The study concludes that mining can have both positive and negative effects on the water resources of Lee County, but does not elaborate. The report also states that surface water drainage features have significantly impacted groundwater levels in many areas of Lee County.

Hydrologic recommendations included in the report generally suggest more monitoring wells to measure aquifer water levels with an updating of the water level data base; collection of additional data to better define the geology of the area; further studies of the effects of drainage and land use alterations; and a recommendation that Lee County should continue its efforts to optimize groundwater storage for groundwater recharge purposes. Mining recommendations primarily target the design, permitting, and reporting requirements for rock mines; suggest that land uses with the potential to pollute groundwater be restricted in the vicinity of mines; and suggest additional evaluations, including the use of groundwater modeling, to examine potential rock mine impacts (both from borrow pits and surface water bodies), and to estimate more accurate groundwater travel times for wellfield protection.

**3. Lee Master Mitigation Plan (LMMP) - August 9, 2004
Lee County**

Sponsor/Publishing Agency: Lee County, Southwest Florida Regional Planning Council

Applicability to DR/GR: Mitigation Plan identifies resources to be protected and restored, and mitigation activities for DR/GR lands.

Lee County is proposing the Master Mitigation Plan to address environmental impacts associated with various infrastructure improvement projects. The Mitigation Plan points out that, while all public works projects are designed to avoid negative impacts to natural resources, there are times when impacts cannot be avoided. The Mitigation Plan is intended to provide consistency and a cumulative accountability for the primary and secondary impacts of its public works program. Such impacts, even when minimized, must be mitigated for, and such mitigation cannot always effectively occur on the site of the project. The Mitigation Plan states that the County proposes to pursue restoration and preservation opportunities for water pollution, fire hazards, wildlife and natural habitats.

The Mitigation Plan has three main purposes:

- 1) to provide a master strategy by which critical environmental features continue to be preserved.
- 2) to get conceptual concurrence from permitting agencies regarding planned mitigation projects that are required for the infrastructure needed to accommodate growth, which in turn will provide greater predictability in the budgeting and permitting processes, and
- 3) to restore degraded resources that are important for the health, safety, and welfare of the public.

The population growth and development in Lee County has, in many cases, caused fragmentation of important aquatic systems, destruction of upland areas, and filling or draining of freshwater, saltwater and tidal wetlands. These activities have led to the loss of important ecological values including water retention functions, drought-buffering capacity, and wildlife habitat. Freshwater and estuarine systems alike within Lee County have been listed as impaired by the Florida Department of Environmental Protection in recent years, and concern is mounting about the effects of human activities on the Gulf of Mexico.

The County has stated that offsetting the impacts of infrastructure projects that are necessary

to accommodate ongoing growth is of paramount importance. The Mitigation Plan is being developed to facilitate planning and budgeting for projects that will restore and protect natural resources of significant importance and foster the continued growth that has been forecast in the County.

As part of developing the Mitigation Plan in 2003 and 2004, private and publicly owned parcels that could be candidate projects for preservation, restoration, or mitigation activities were identified. These parcels were assessed in a preliminary manner and deemed potentially suitable for such activities. A map series has been created to facilitate the initiation of more detailed analysis. While the Mitigation Plan is not intended to provide an in-depth analysis of potential projects, the maps will serve as a starting point for efforts to select appropriate preservation, restoration, or mitigation sites.

The Mitigation Plan will be a component of the implementation of the Lee County Comprehensive Plan. Once in place, the Mitigation Plan will allow Lee County to more effectively accommodate the growth that is occurring and ensure the restoration and protection of the important natural resources that provide the framework for local economy and quality of life.

4. Water Resources Management Project – October 5, 1988
James M. Montgomery, Consulting Engineers, Inc.

Sponsor / Publishing Agency: Lee County Board of County Commissioners.

Applicability to the DR/GR: The areas studied in this report cover all of the DR/GR.

This report provides an identification and mapping of the upper aquifers in Lee County, a determination of water budgets (for the aquifers), aquifer storage, aquifer safe yields, and identifies aquifer recharge areas and potential well fields. The report also includes strategies for the protection of groundwater resources and wetlands, and water use projections and conservation strategies. Data sources and data quality assurance and quality control procedures are well-defined.

Some of the conservation strategies identified in the report may have already been implemented and some of the potential well fields already developed. A potential drawback related to this report is that the data may be slightly out of date.

5. Engineering Analysis for Properties Designated within the City of Bonita Springs as “Density Reduction/Groundwater Resource” (DR/GR) - July 2005
Greg Rawl, R.M. Edenfield, Paul Sebert.

Sponsor / Publishing Agency: City of Bonita Springs.

Applicability to the DR/GR: The report covers a portion of the DR/GR.

This report describes the existing land uses, environmental characteristics, upland and wetland plant communities, listed plant and animal species, geology, and hydrogeology of the study area. Several different land use scenarios and their potential impact on surface water quality are modeled and presented.

The report concludes that the use of best management practices for surface water management can lead to minimizing the potential impacts to surface water bodies and receiving waters (Estero Bay), and may improve recharge quality and quantity. The report also concludes that low density residential development appears to have the least impacts to the ecosystem.

6.0 Estero Bay: State of the Bay Reports

6.1 Estero Bay: State of the Bay Report- January 2000
Estero Bay Agency on Bay Management

Sponsor / Publishing Agency: Southwest Florida Regional Planning Council

Applicability to the DR/GR: The study area covers the entire DR/GR.

Conclusions not specific to DR/GR lands.

The Estero Bay State of the Bay Report (2000) is a summary of issues surrounding Estero Bay and its watershed. It was written with the intent of informing the general public on these issues. The entire Estero Bay Watershed is included within the study area, which is large in comparison to the DR/GR area. However, no specific mention of the DR/GR area lands is included in the report. The report includes a historic overview of the study area, a discussion of land use trends, and a discussion of plant and animal life, including plants and animals listed federally or by the State of Florida as threatened, endangered, or of special concern. Much of the document focuses on the Estero Bay Aquatic Preserve and the factors that negatively affect this water body, including effects of upland drainage areas, which include the DR/GR area.

6.2 Estero Bay: State of the Bay Update- May 2004

Estero Bay Agency on Bay Management

Sponsor / Publishing Agency: Southwest Florida Regional Planning Council

Applicability to the DR/GR: The study area covers the entire DR/GR.

Conclusions not specific to DR/GR lands.

The Estero Bay State of the Bay Update (2004) provides an update to the 2000 State of the Bay Report and focuses on water quality and wildlife status and trends within the Estero Bay and associated watershed. The study area and its relation to the DR/GR area are the same as the 2000 State of the Bay Report discussed above. Based on 2001 Florida Department of Environmental Protection water quality data, much of the DR/GR area is impaired for dissolved oxygen. The report identifies surface waters in the southern portion of the DR/GR as impaired for chlorophyll-a (an indicator of nutrient levels) and copper. Analysis of Florida Fish and Wildlife Conservation Commission data indicates negative trends in the number of red-cockaded woodpeckers and number of wading bird and brown pelican rookeries; extinction of the Florida scrub jay from the Estero Bay basin; positive trends in number of bald eagle nests from 1995-1999; and varying sources of negative impacts to gopher tortoise habitat from 1999-2003. A number of other negative trends such as altered hydrology resulting from a variety of intensified land use activities are discussed. A number of Estero Bay Agency on Bay Management recommendations regarding these trends are listed and discussed. The majority of these recommendations are relevant to land use and regulatory decisions within the DR/GR area. They include recommendations regarding zoning and variances, land management and acquisition, vegetation (mostly pertaining to planting of native vegetation, eradication of invasive vegetation, and the importance of isolated and seasonal wetlands), consideration to historic topography, including flow ways, new construction guidelines, biological controls as preferred methods of mosquito control, incentives for ecologically sensitive agriculture, effects of urban areas on the Estero Bay watershed, and guidance for future roadways.

7. Lower Charlotte Harbor Reconnaissance Report - 2005
Prepared by the Charlotte Harbor National Estuary Program

Sponsor / Publishing Agency: Charlotte Harbor National Estuary Program

Applicability to the DR/GR: The report covers areas larger than the DR/GR area; conclusions not specific to the DR/GR lands.

The Lower Charlotte Harbor Reconnaissance Report is a review and summary of existing information about the Lower Charlotte Harbor system in accordance with the Surface Water Improvement and Management program authorized by the State of Florida (F.S. 373.453). This document will be used by the South Florida Water Management District to develop the Surface Water Improvement and Management plan and includes a list of actions to be implemented to maintain and improve the water body. The study area includes a number of watersheds and is very large compared to the DR/GR area. This report includes extensive background information regarding a range of natural resources in the region. In general it was concluded that the Lower Charlotte Harbor area is an area that has experienced widespread growth in recent years. This growth is projected to continue into the foreseeable future. Surface waters in the DR/GR and the water bodies into which these waters discharge have been listed by the Florida Department of Environmental Protection as an area where water quality standards are not obtained. The study area is subject to many layers of government regulation. There are a number of existing programs currently being implemented by a variety of federal, state, regional, and local agencies and non-profit organizations within the study area to evaluate and manage the impacts of growth through research, planning, and regulatory measures. The study emphasizes the importance of making a concerted effort to coordinate these programs in order to maximize efficiency and reduce overlap.

8. Water Quality Data Analysis and Report - August 27, 2003.
Janicki Environmental, Inc.

Sponsor / Publishing Agency: Charlotte Harbor National Estuary Program

Applicability to the DR/GR: The report provides data for Estero Bay, which is the receiving water for lands within the DR/GR and the associated Estero Bay Watershed, in which most of the DR/GR is located.

This report compiles initial data sets for surface and ground water quality, hydrology, and rainfall. The data are reviewed and the data sets that meet the project criteria for availability, documentation of metadata, and quality control are provided.

The report prepares a summary of the data sets that meet the project criteria and will be used in the analysis of water quality status and trends. Analyses of temporal water quality variations (changes and trends) in the study area are conducted.

Potential drawbacks to this report are that there may be a data bias in that most of the data may have been collected in areas that have been impacted, and the report utilizes very few groundwater and surface water data points within the southern DR/GR.

The document is a review of water quality monitoring data collected from 1980 to 2000. Data sets for surface water quality, groundwater quality, hydrology, and rainfall were compiled and analyzed for the purposes of prioritizing areas of the estuary for improvements, identifying conditions that threaten habitats or provide opportunities for habitat enhancement, identifying water quality responses to sources of pollution in support of source reduction efforts, identifying impacts to freshwater inflows and salinity regimes, providing background scientific results for incorporation into public education materials, and providing a statistical framework for future monitoring of the effectiveness of management actions.

The study area includes many watersheds and is relatively large compared to the DR/GR area. The Estero Bay watershed (in which most of the DR/GR is located) is at the southernmost part of the study area. The DR/GR area and the tributaries into which the DR/GR area drains, especially the southern area of the DR/GR, are relatively underrepresented in this report.

Estero Bay tributaries show declining trends in surface water quality, especially for nutrients, dissolved oxygen, and turbidity. According to the report, "Many of the water quality changes in these areas were characterized as declining water quality. These results do not indicate directly that changes in stream flow were the primary reason for the changes in water quality, but the results do present a coincidence over the years of changes in stream flow timing and volume with changes in surface water quality. Other potential sources of surface water quality declines include increased pollutant loading from non-point sources in the watershed, point sources, and or atmospheric deposition."

No trend in the rainfall data was detected. Rainfall varied from year to year and was predictable throughout the year. Changes in water quality can not be attributed to changes in rainfall alone. Stream flow data indicate that many alterations to the hydrology have

occurred in the tributaries of the Estero Bay watershed, in which most of the DR/GR is located. There were not enough ground water samples to do large regional evaluations. There was however enough sampling to indicate problem areas – for instance, the primary fluoride standard was frequently exceeded in the Floridan Aquifer in the Estero River portion of the Estero Bay basin.

9. How much is enough? Landscape-scale Conservation for the Florida Panther - February 2005

Randy Kautz (FWC), Robert Kawula (FWC), Thomas Hctor (Univ. of Florida), Jane Comiskey (Univ. of Tennessee), Deborah Jansen (Big Cypress National Preserve), Dawn Jennings (USFWS), John Kasbohm (USFWS), Frank Mazzotti (Ft. Lauderdale Research and Education Center), Roy McBride (No affiliation information given), Larry Richardson (USFWS), and Karen Root (Bowling Green State University)

Sponsor / Publishing Agency: Science Direct – Biological Conservation/ELSEVIER

Applicability to the DR/GR: All DR/GR lands are within the study area.

This scientific study was conducted by a team of wildlife biologists from government agencies and academia to review and analyze existing information regarding Florida panther telemetry and habitat data to guide implementation of recovery actions for this species. The authors used compositional and Euclidean distance analysis (two of many statistical techniques used to analyze data, which include clustering and fragmentation issues) to identify regions of south Florida that are of value to support a self-sustaining population and create a model of important landscape components. The model was used in combination with radio telemetry data, home range overlaps, land use/land cover data, and satellite imagery.

The authors concluded that much of the DR/GR area is primary habitat for the Florida panther. This primary zone has been identified as “essential to the long-term viability and survival of the Florida panther.” The DR/GR lands also contain secondary habitat which is not as high quality for Florida panthers and not utilized as heavily but could still provide resources for Florida panthers, especially where environmental restoration or enhancement could be implemented. The DR/GR also includes areas identified as “least-cost” paths most likely to be taken by Florida panthers dispersing out of South Florida. This dispersal could provide genetic intermixing between future sub-populations which could increase long-term species viability. The authors recommend that any proposed activities within the primary

zone should achieve no net loss of landscape function and should avoid reduction of aerial extent of habitat, degradation of habitat, further habitat fragmentation, and changes in land use moving along a gradient from natural conditions to pasture, to urban.

10. Closing the Gaps in Florida's Wildlife Habitat Conservation System (Gaps Report) - 1994

James Cox, Randy Kautz, Maureen MacLaughlin, and Terry Gilbert, Florida Fish and Wildlife Conservation Commission (Formerly Florida Game and Fresh Water Fish Commission)

Sponsor/Publishing Agency: Florida Fish and Wildlife Conservation Commission - Florida Marine Research Institute – Florida Department of Environmental Protection

Applicability to the DR/GR: The study area covers DR/GR lands as well as the entire state.

Although the originally published maps regarding aerial extent of vegetation cover, wildlife habitat, and wildlife distributions have been updated extensively since the publication of this report, it remains an important planning document in terms of conserving scarce government resources and taking a proactive approach to land use planning and acquisition issues. This study was conducted to assess the habitat conservation needs and identify lands that must be preserved to meet the long-term habitat needs of Florida's flora and fauna using a focal species approach, to identify areas important to several globally endangered species of plants and animals, to identify regional areas of high biological diversity "hot spots", and to focus on-going land conservation efforts where they will provide the most protection to Florida's biodiversity. The report presents findings regarding these topics and extensive introductory material discussing why it is important to preserve Florida's biodiversity in terms of economic issues, public opinion, and factors not as easy to quantify, such as aesthetics. The report also includes extensive summaries of many topics relevant to wildlife and conservation biology.

The authors concluded that existing conserved lands are not adequate to protect Florida's biodiversity and recommended that future land acquisitions should target key areas identified in studies. These areas are available in regional scale and are updated periodically. Agencies wishing to use this information should contact the Florida Fish and Wildlife Conservation Commission for most up-to-date information. They also recommend that land identified as high priority can be most effectively protected through acquisition or through conservation easements and land-use agreements. Although outright acquisition is considered to be the

best way to assure protection, it is noted that the area needed to sustain the populations of Florida panther and black bear alone would consume all the funds currently available for land acquisition. The document includes a summary of recommendations developed for each of the focal species.

11. Southwest Florida Feasibility Study

11.1. Southwest Florida Feasibility Study: Feasibility Scoping Meeting Documentation- Nov. 2005 US Army Corps of Engineers (Corps) – Jacksonville District – South Atlantic Division

Sponsor / Publishing Agency: South Florida Water Management District
Applicability to the DR/GR: The areas studied in this report cover all of the DR/GR.

This report is a regional plan of action to address the health of aquatic and upland ecosystems; the quantity, quality, timing, and distribution of water flows; agricultural, environmental, and urban water supply; the sustainability of economic and natural resources; flood protection; fish and wildlife; biological diversity; and natural habitat.

The report presents selected models for hydrologic, water quality, salinity, and coastal mixing modeling purposes, as well as the Southwest Florida management measures.

This study covers a large area in comparison to the DR/GR lands and for information regarding natural resources it can be difficult to evaluate the DR/GR area on the maps, because the maps are based on large cell sizes (i.e., 20 acres for the vegetation map).

11.2. The Caloosahatchee Conceptual Model - May 22, 2006

Tomma Barnes, South Florida Water Management District and Mark Salvato, U.S. Fish & Wildlife Service

Sponsor / Publishing Agency: South Florida Water Management District

Applicability to the DR/GR: The report covers Caloosahatchee River watershed, adjacent to the DR/GR lands (No map of Caloosahatchee River watershed).

This report describes the study area to understand how this system responds to stressors, to improve management decisions.

For Caloosahatchee River watershed the ecological stressors are: altered hydrology and freshwater flow; habitat alteration and loss; changes in water quality and increased sediment contaminants; and boating and fishing.

The ecological attributes identified as indicators of biological/ecological stress are: submerged aquatic vegetation, oyster bar, mesohaline benthic community (organisms living in the bottom substrates of moderately brackish water bodies), fisheries, manatee, shoreline, algal blooms and wading birds community structure and function.

The ecological effects are: loss of shoreline habitat and function, altered salinity regime, increased manatee mortality, decrease of submerged aquatic vegetation, increased nutrients and contaminants, changes in sediment, and decrease of fish populations.

The report also presents a summary of water quality assessments in the Caloosahatchee Estuary, San Carlos Bay, Pine Island Sound and Matlacha Pass. The Florida Department of Environmental Protection classified three water bodies in the Caloosahatchee Estuary and Lower Charlotte Harbor as potentially impaired based on chlorophyll-a, dissolved oxygen, fecal coliform, copper, lead, and or biology. The report presents the S-79, Shell Point, and San Carlos Bay freshwater inflow limitations to maintain salinity in the targeted ranges.

11.3. The Big Cypress Conceptual Model - May 22, 2006

Art Roybal, U.S. Fish and Wildlife Service

Sponsor / Publishing Agency: South Florida Water Management District

Applicability to the DR/GR: Report covers Big Cypress region, adjacent to the DR/GR lands (No map of Big Cypress Basin).

This report describes the study area to understand how this system responds to stressors, to improve management decisions.

For the Big Cypress region, the ecological stressors are: development for agricultural and residential use, which will not only cause habitat loss on the affected lands, but also fragmentation of the habitat mosaic.

For the Big Cypress region the ecological attributes are: vegetation community gradients and habitat mosaic; breeding birds (including red-cockaded woodpecker); aquatic fauna; wood stork and wading birds; Florida panther and prey.

The ecological effects are:

- 1) for vegetation community gradients and habitat mosaic: relationship of vegetation to reduced hydrologic regime; to habitat loss and fragmentation; to exotic plant invasion; to exotic hog impacts; to fire; and to nutrient inputs;
- 2) for wetland aquatic fauna: relationship to habitat loss; to hydroperiod; to exotic fishes; to health of aquatic fauna to environmental contaminants; and relationship of macroinvertebrate and herpetofauna (reptile and amphibian) populations to controlling variables and functional importance.
- 3) for wood stork & wading birds: relationship of wood stork nesting to density, size structure and seasonal concentration of marsh fish populations
- 4) for Florida panther: relationship of Florida panther population to habitat loss and fragmentation; and relationship of Florida panther health to bioaccumulation of environmental contaminants.

Florida Department Of Environmental Protection indicates that three water bodies influencing water quality within the Big Cypress Swamp are potentially impaired for dissolved oxygen, fish consumption (for mercury), cadmium, and copper in the Tamiami Trail; dissolved oxygen and nutrients in the L-28 Interceptor, and dissolved oxygen in the L-28 Gap.

11.4. The April 2006 Scoping Letter – April 27, 2006
Marie G. Burns, Chief, Environmental Branch

Sponsor / Publishing Agency: Department of the Army, Jacksonville District Corps of Engineers, P.O. Box 4970, Jacksonville, FL 32232-0019

Applicability to the DR/GR: The SWFFS study area covers approximately 4,300 square miles including all of Lee County (including DR/GR lands east of Interstate 75), as well as other nearby counties.

This letter announces the initiation of the US Army Corps of Engineers Southwest Florida Feasibility Study, which represents a more recent and more localized phase (with respect to Lee County DR/GR lands) of the study described in the 1999 South Florida Feasibility Study report. The objective of the Feasibility Study is to develop a comprehensive regional plan for addressing water resource problems and opportunities. The study will develop and evaluate alternative plans and recommendations for structural, non-structural, and operational modifications and improvements in the region. The study will compile information on and consider a wide variety of environmental factors and issues including: restoration of estuarine, aquatic, wetland and upland ecosystems; water flows; future agricultural, environmental, and urban water demand and supply; socio-economic resources; aquifer recharge; conversion of public conservation lands to water storage areas; water quality; impacts to the estuaries; flood protection; land acquisition; fish and wildlife resources; impacts to protected species; cultural resources; fragmentation and/or loss of habitat; and other impacts identified as the study progresses.

11.5. The Project Component Map - September 19, 2006
US Army Corps of Engineers

Sponsor/Publishing Agency: Department of the Army, Corps of Engineers

Applicability to DR/GR: The study covers 4300 square miles including all of Lee County, including DR/GR lands east of Interstate 75.

The Southwest Florida Feasibility Study area covers approximately 4,300 square miles including all of Lee County (including DR/GR lands east of Interstate 75), as well as other nearby counties. This map was prepared to show the location of feasibility study components in southwest Florida including Lee County. Certain of the designated (yellow-colored) areas on this map show the location of feasibility study components within the DR/GR lands of southeast Lee County.

This map, which is useful in depicting the location and geographic interrelationships of the planned components of the Southwest Florida Feasibility Study, was designed to accompany other documents that describe the study area and feasibility study components.

11.6. The Comprehensive Everglades Restoration Plan System-wide Performance Measures - April 27, 2006
Comprehensive Everglades Restoration Plan

Sponsor / Publishing Agency: Central And South Florida Project
Applicability to the DR/GR: Covers Caloosahatchee Basin

This report identifies and documents the specific set of system-wide performance measures (PM) developed by the RECOVER technical teams to date, and reviews the processes for developing and revising performance measures. The report also describes the application of performance measures in Comprehensive Everglades Restoration Plan planning and some of the uncertainty associated with this application. To fully understand the performance measures and how they are to be properly used, the document discusses the scope and purpose of performance measures, history of PM development, criteria for choosing performance measures, detailed review process for new and revised performance measures, the place of performance measures in the Comprehensive Everglades Restoration Plan Adaptive Management Strategy, connection between performance measures and other aspects of the Comprehensive Everglades Restoration Plan Adaptive Management Strategy (i.e., Monitoring and Assessment Program, interim goals and targets), simplification of conceptual ecological models for application to the Comprehensive Everglades Restoration Plan and how performance measures relate to these models, application of performance measures in evaluating alternative plans and assessing system response to Comprehensive Everglades Restoration Plan implementation, and uncertainty associated with using performance measures. A documentation sheet is provided for performance measures, which are organized into six categories: four physiographic regions (Lake Okeechobee, Northern Estuaries, Greater Everglades Wetlands, and Southern Estuaries), the total system, and water supply and flood protection of urban and agricultural areas.

**11.7. The Greater Everglades Wetlands Conceptual Ecological Model –
March 16, 2006
Comprehensive Everglades Restoration Plan**

Sponsor/Publishing Agency: South Florida Water Management District

Applicability to DR/GR: The study reports on wetlands which could influence DR/GR lands.

This report (or section of the report) describes the Greater Everglades Wetlands' Conceptual Ecological Models. The study covers many wetlands in South Florida including the wetlands near Lake Okeechobee which could influence the DR/GR lands downstream. The various conceptual ecological models used by the Comprehensive Everglades Restoration Plan to describe the Greater Everglades Wetlands are discussed. The Comprehensive Everglades Restoration Plan has designed projects to improve certain ecological aspects of the study area based on the ecological models described in this report. Performance measures used to track the progress and success/failure of Comprehensive Everglades Restoration Plan projects on restoring the Greater Everglades are listed.

**11.8. The Northern Estuaries Conceptual Model - March 16, 2006
Comprehensive Everglades Restoration Plan**

Sponsor/Publishing Agency: South Florida Water Management District

Applicability to DR/GR: The Caloosahatchee Estuary is within Lee County and alongside DR/GR lands.

This describes the Northern Estuaries' Conceptual Ecological Model. The various conceptual ecological models used by Comprehensive Everglades Restoration Plan to describe the Northern Estuaries are discussed. Comprehensive Everglades Restoration Plan has designed projects to improve certain ecological aspects of the study area based on the ecological models described in this report. Performance measures used to track the progress and success/failure of Comprehensive Everglades Restoration Plan projects on restoring the Northern Estuaries are listed.

11.9. The Caloosahatchee Estuary Salinity Envelope - September 9, 2005

Comprehensive Everglades Restoration Plan

Sponsor/Publishing Agency: South Florida Water Management District

Applicability to DR/GR: Proximity of Caloosahatchee Estuary to DR/GR lands.

One of the Comprehensive Everglades Restoration Plan performance measures on the Northern Estuaries is the Caloosahatchee Estuary Salinity Envelope. This performance measure is described in this paper. Various ways of controlling and monitoring the salinity envelope are described – i.e. controlling the inflow to the estuary would control the salinity fluctuations caused by large influxes of fresh water. It is suggested that the salinity of the estuary be monitored through measurements of the valued ecosystem components, such as tape grass or American oyster.

11.10. NE-7 Caloosahatchee Estuary Nutrient (TP and TN) Loading and Concentration - September 9, 2005

Comprehensive Everglades Restoration Plan

Sponsor/Publishing Agency: Comprehensive Everglades Restoration Plan

Applicability to DR/GR: Lands can be affected by estuary.

The purpose of this report is to describe the Caloosahatchee Estuary Nutrient Loading and Concentration performance measure as defined by the Comprehensive Everglades Restoration Plan. Nutrients, total phosphorous (TP) and total nitrogen (TN), will be used as performance measures for determining the effectiveness of the Comprehensive Everglades Restoration Plan projects. Target load reductions are suggested to meet Florida Estuary median values for TP and TN in the upper estuary. Comprehensive Everglades Restoration Plan projects that will be constructed upstream from the estuary may also affect water quality nutrient loads to the estuary. TP and TN must be measured to determine if the projects are improving or degrading water quality.

12. The South Florida Multi-species Recovery Plan - May 18, 1999

U.S. Fish and Wildlife Service

Sponsor/Publishing Agency: U.S. Fish and Wildlife Service

Applicability to DR/GR: Study covers all of South Florida including Lee County and DR/GR lands.

This document includes a plan to aid in the recovery of 68 listed species (including State of Florida listed species) through the landscape-level restoration of natural ecological communities throughout South Florida in ways that will optimize benefits to the greatest number of species. It includes recovery criteria, actions needed to achieve recovery plans, and estimates of costs of recovery implementation. The report includes a section listing important ecological communities (a group of plants and animals that occur together in an area and interact with each other) such as pine flatwoods, cypress swamps, and wet prairies; and a discussion of how each of these communities interact with one another to provide the habitat that is crucially important to support Florida's diversity of plant and animal species. The document includes input from a diverse team of government, conservation agency, industry, and academic members.

The authors conclude that many listed species are habitat limited. For these species, limiting factors are similar and include upland and wetland habitat loss, fragmentation, and degradation resulting from urbanization and other land-use conversions, wetland drainage and alteration of hydrology, invasion of exotic species, fire suppression, soil subsidence, and increased levels of contamination. These are all issues pertinent to land use decisions within the DR/GR area and are discussed in greater detail in Section 2 of this document. They found that for some species, including the Florida panther, recovery will require more suitable habitat than currently exists. The document includes a summary of plans to form the Multi-Species/Ecosystem Recovery Implementation Team to coordinate implementation of the Multi-Species Recovery Plan. This will be accomplished through an adaptive management approach focusing on multi-agency coordination. The Multi-Species/Ecosystem Recovery Implementation Team was formed as planned and was instrumental in the development of the draft implementation schedule (published in the Federal Register, April 2, 2004) and final implementation schedule (published in the Federal Register, March 26, 2007) of the Multi-Species Recovery Plan.

13. County Road 951 Project Development & Environmental Study Wetland

**Evaluation and Endangered Species Reports. Assessments of wetland and environmental resources within the right-of-way of proposed highway alignments.
- July 2006**

Quest Ecology, Inc. in association with Dyer, Riddle, Mills & Precourt, Inc.

Sponsor/Publishing Agency: Lee County Department of Transportation

Applicability to DR/GR: Study area overlaps with DR/GR and includes the southern part of the DR/GR lands.

These studies were conducted to evaluate the impacts of the proposed extension of County Road 951 on wetlands and endangered species. This information was gathered to aid in determining type, design, and location of the proposed extension. The study area includes the southeastern portion of the DR/GR area and extends south. It includes a delineation of wetlands within the study area in accordance with State of Florida and U.S. Army Corps of Engineers rules. Wetland quality was assessed using the Wetland Rapid Assessment Procedure, a wetland assessment method developed by the South Florida Water Management District to track compliance of permitted wetland mitigation projects.

The study area consists of a mosaic of upland and wetland habitats including a variety of ecological communities (a group of plants and animals that occur together in an area and interact with each other). Federal and State wildlife species listed as threatened, endangered, or of special concern (listed species) observed in the study area during field surveys include Big Cypress fox squirrels, wood storks, gopher tortoises, and American alligator. Listed species identified as using the study area based on a literature search and input from wildlife experts include Florida panther, Florida black bear, and Eastern indigo snake. Agency correspondence is included with the document which suggests that the following species should also be considered to be likely to occur within the study area: swallow-tail kite, American crocodile, burrowing owl, red cockaded woodpecker, and Florida mastiff bat. No federally listed plant species were observed. State-listed plant species observed within the project area were cinnamon fern, royal fern, bromeliads, giant wild pine, stiff-leaved wild pine, and inflated wild pine. Based on the information provided in the report, these plant and animal species could be expected to occur within the DR/GR area.

14. South Lee County Watershed Plan– July 1999

**Johnson Engineering, Inc., Agnoli, Barber & Brundage, Inc., Boylan
Environmental Consultants, Inc.**

**Sponsor / Publishing Agency: South Florida Water Management District,
Contract C-8812.**

Applicability to the DR/GR: Report includes all of the southern DR/GR.

This report describes the southern Lee County flood event of summer 1995. The study identifies the problems associated with "piecemeal" permitting, not integrating the potential effects of developments, and not recognizing the cumulative effects of developments on the entire resources of the watershed (e.g., ecological, groundwater, surface water runoff).

Basin boundaries have been changed through development and man-induced activities (e.g., berms, ditches, roads, housing developments). Results of changes are a constriction of flow and re-routing of sheet flow (e.g., culverts under US 41 and I-75). An additional and significant result of the changes induced within the basin is that under high rainfall periods, the basin boundaries overlap and existing flow structures cannot handle the flow, resulting in flooding.

3.2 Supplemental DR/GR Documents

Prior to and during the review of the 14 primary documents, the project team was provided with a number of other documents relating to Lee County land use planning and/or the resources within, and management of DR/GR lands. These documents provided background information that was valuable in providing context for the review. Brief summaries of these documents are presented below. Because these documents were provided for reference, and were not subjected to the full review and summary process, summary forms for these documents are not prepared for inclusion in Appendix D.

Origins and History of DR/GR, last updated June 2003

The Origins and History of the DR/GR is a binder of state mandates, settlements, ordinances, and other documents compiled by Lee County staff to record the history of the Density Reduction/Groundwater Resource Lands from 1984 through June 2003.

Arnold Committee Report and Recommendations – October 1996

In 1991-92 the Florida Board of Regents, through a siting process, selected a site in southeast Lee County for the new Florida Gulf Coast University campus. Federal agencies and challengers to the permits that were to be issued for the site raised concerns about the direct and secondary impacts of construction on sensitive on-site and off-site natural resources. Negotiations over permit issuance led to the creation of the Arnold Committee and an assessment of overall land uses and natural system, environmental protection, and mitigation tools for this area of Lee County.

One of the major purposes of the Committee report was to identify key information needs that should guide growth and development. By identifying ongoing studies, and suggesting additional information that should be collected or considered in planning for sustainable growth, the Committee provided a forum to discuss many DR/GR issues in Southeast Lee County and Estero Bay.

The Committee's report appears to attempt to take a consensus-building or middle ground approach, recognizing that growth may continue in some manner in this portion of Lee County, but arguing that growth should occur in a coordinated program of sustained resource management that attempts to maintain connections and a balance between public and private needs. This report mentions the Lee County Comprehensive Plan, the "Closing the Gaps" study, and numerous other plans. In mentioning these documents it is neither consistent nor inconsistent with them, but demonstrates the interconnectedness of Lee County's guidelines, management agencies, scientific studies, and planning efforts.

The Seventh Annual Ecological Monitoring of the Corkscrew Wellfield, Lee County Florida

The *Seventh Annual Ecological Monitoring Report for the Corkscrew Wellfield Lee County, Florida* documents the ecological monitoring performed near the Corkscrew wellfield in Florida in 2002. Invading grasses that were thought to have been removed with herbicide the year before were found in the study areas. More herbicide was recommended to remove them. The exotic melaleuca plant was also observed in the monitoring; it is unknown whether the implemented remedy for the melaleuca plant will work. No analysis of correlation between pumping and vegetation was performed.

Green Meadows Wellfield 2005 Annual Ecological Monitoring Report

The *Green Meadows Wellfield 2005 Annual Ecological Monitoring Report* documents the ecological monitoring performed in wetlands near the Green Meadows Wellfield. Monitoring is conducted annually in May and October with a report published at the end of each year. The monitoring is conducted to determine and/or track the influence on nearby wetlands of pumping the surficial aquifer. Based on observations made in May and October, a “prevalence index” is calculated using the frequency of occurrence of several categories of wetland and upland species. Correlation between the “prevalence index” and rainfall and between the “prevalence index” and pumpage at the wellfield was examined and an R-squared value was computed. Both R-squared values calculated for 2005 are 0.31, indicating low correlation. With respect to pumping of the wellfield, the low R-squared value reaffirms (as has been noted in the past) that there is little correlation between the amount of surficial aquifer groundwater withdrawals and the prevalence index for the ecological species examined. The health of the wetlands is reported as good, and the report concludes that pumpage from the wellfield does not appear to have adversely affected onsite wetlands at the Green Meadows Wellfield to date.

Lee County Utilities Pine Woods Wellfield Monitoring Report

The *Lee County Utilities: Pine Woods Wellfield Monitoring Report* documents the ecological monitoring performed near the Pine Woods Wellfield in May of 2006. Several years before this monitoring event, melaleuca was removed from most areas and still show signs of its removal; this removal opened the canopy which is now being replaced by native species. Human influence can be seen/inferred through damage to the fence and from human collectors of arboreal bromeliads. “With control of access and melaleuca regeneration, the vegetation system remains in dynamic ecological equilibrium.”

Lee County Future Land Use Map

The Lee County Future Land Use Map was developed by the Lee County Department of Community Development and approved by the Florida Department of Community Affairs as a planning tool for growth and development through the year 2020.

Lee County Flow Ways Map

The Lee County Flow Ways Map was compiled as part of the 2005 Groundwater Resources and Mining Study to illustrate historic and current (circa 2005) water flow ways throughout Lee County.

Lee County Conservation 20/20 Map

The Lee County Conservation 20/20 Map illustrates the status of land acquired or suggested for acquisition by Lee County Government to preserve environmentally sensitive land through the county's tax-supported willing sellers program.

Florida Natural Areas Inventory Database

The Florida Natural Areas Inventory (FNAI) is an office of the Florida State University Institute of Science and Public Affairs. The Florida Natural Areas Inventory is dedicated to gathering, interpreting, and disseminating information pertaining to Florida's biological diversity. The Inventory includes occurrences of rare plants and animals and high quality natural communities that provide habitat for these plants and animals. The Inventory is continually updated by staff. This information is used by public agencies, private firms, and citizens as a tool for public decision-making and education.

4.0 Key Features of Lee County DR/GR Lands

This section presents the key environmental features of DR/GR lands that were identified during the review of the various studies. Many of these features were identified in several of the studies, indicating by their commonality that they are generally recognized as being important to the proper management of resources or mitigation of problems within DR/GR lands.

At the outset of the review, the project team was aware that the DR/GR lands were designated to achieve (1) density reduction and (2) protection of groundwater recharge and resources. What has become clear during our review is that the lands are also important because of their (3) ecological resources (wetlands, uplands, plant and animal species listed as threatened, endangered or of special concern by federal or state agencies, habitats, biodiversity hot spots, etc.). The lands are also very important because of their (4) surface water hydrology features, primarily flow ways. Finally, the DR/GR lands are not only important on a piecemeal basis for the particular resource that might exist in a parcel, but because (5) the lands support overall landscape integrity due to an extensive, interconnected mosaic of habitats, allowing for wildlife range and migration corridors, interconnected flow ways that interlink wetlands and differing habitats and connect the land to nearby coastal ecosystems.

The following sections describe the various factors that were identified during this review of existing studies as imparting to the Lee County DR/GR lands their special character.

4.1 Density Reduction

As the name implies, a primary motivation for the designation of DR/GR lands was to provide a mechanism to reduce or manage residential population density within the County. DR/GR lands are still important for that reason. By one agency's estimate, Lee County's population is projected to grow steadily and reach an estimated 979,000 by the year 2030, increasing the population density of 649 to 1,127 persons per square mile (Florida Bureau of Economic and Business Research 2006). Maximum density in the DR/GR area was lowered to one dwelling unit per ten acres when the new land use category was designated in 1990, and remains at that level today.

4.2 Groundwater Recharge/Resource

DR/GR lands are important areas within Lee County for groundwater resources. Studies demonstrate that significant amounts of recharge enter the subsurface within DR/GR lands. This recharge feeds underground aquifers which store groundwater and provide flow to well fields that supply Lee County water for public use. A number of the ways in which DR/GR lands are important from a groundwater resource perspective are discussed below.

- Land areas within the DR/GR are recharge areas.

There is agreement among the groundwater-related documents that recharge occurs within the DR/GR land areas. The amount of recharge depends largely upon land use/land cover. Some of the higher-recharge categories are within the DR/GR and include non-vegetated lands, native vegetation areas, and possibly agricultural areas. Recharge could possibly be increased through the elimination of exotic species, such as melaleuca.

- The DR/GR contains areas that have the potential for water supply development.

Lee currently draws a significant portion of its water supply from underground aquifers in the DR/GR area, and Lee County's studies and plans indicate that additional development of water from these aquifers is feasible. An important aspect for the potential for groundwater withdrawals from the water table aquifer is whether a balance between groundwater withdrawals and surface water levels necessary for the maintenance of ecosystem health can be achieved. The development of water supplies from deeper aquifers within the DR/GR is possible as well. Hydrogeology reports reviewed as part of this project contain maps that show aquifer thickness and storage within the DR/GR.

- Development of potential water supplies that may affect the DR/GR water budget must be modeled on a case-by-case basis.

The evaluations must take into account the regional and seasonal impacts of water withdrawals on surface water bodies. The model areas must also be large enough to evaluate potential impacts to flow ways. Additionally, the evaluations must take into account the cumulative effects of all water withdrawals that may affect the water balance within the DR/GR.

- Some of the current Lee County well fields depend on recharge that occurs within the DR/GR.
- Groundwater recharge within the DR/GR directly affects surface water levels.

Surface water is important for sustaining certain DR/GR ecological resources (e.g. wetlands) described in Section 4.3 and in linking DR/GR lands to coastal ecosystems as discussed in Section 4.5. The relatively flat topography within the DR/GR area means that even small changes in aquifer levels can have significant effects on surface water-related habitats and ecosystems as discussed further in Section 4.3.

Additionally, shallow groundwater from the DR/GR may discharge to the Estero Bay area, which currently may be at critical nutrient loading levels. Additional nutrient loading from any sources, including sources of nutrients from within the DR/GR may further damage the resource.

- The quality of surface water runoff and recharge may be declining.

Some studies show that point sources of nutrients may be entering the Estero Bay receiving waters. There is also the possibility of non-point sources of nutrients entering Estero Bay waters. Best management practices for runoff and recharge could reduce nutrient loading.

4.3 Ecology

Lee County DR/GR lands are rich in ecological resources. Ecosystems function and interact to sustain a wide variety of species and habitats. Key ecological features identified during the review are summarized below.

4.3.1 Wetlands

- There was general agreement among the studies reviewed that wetlands are an important ecological resource within the DR/GR lands.

The Lee County Comprehensive Plan and the Lee County Master Mitigation Plan indicate that Lee County recognizes the important ecological functions of wetlands including: filtration and assimilation of runoff, groundwater recharge, sediment stabilization, flood control, and habitat for wildlife. The other documents reviewed discuss the importance of wetlands in terms of these functions and in the context of a large-scale pattern of interconnected habitat types that is critically important to a wide variety of plant and animal species within the State of Florida.

- The DR/GR area includes many seasonal wetlands. Regulatory and land-use decisions are resulting in inadequate protection of this ecologically important type of wetland.

Three of the documents reviewed – the Lower Charlotte Harbor Reconnaissance Report, the Multi-Species Recovery Plan, and the Estero Bay State of the Bay report make special mention of seasonal wetlands. These wetlands only contain standing water or water at the soil surface for part of the year. Many species of wildlife, including amphibians, reptiles, and mammals are listed by the State of Florida as dependent on seasonal wetlands for survival (obligate). These seasonal wetlands are particularly vulnerable to even small changes in the water table and therefore any hydrologic alteration within the area can have negative effects on seasonal wetlands even in cases

where the footprint of the wetlands is not directly altered.

4.3.2 Native uplands

- Native uplands within the DR/GR, particularly pine flatwoods, are ecologically important to a large range of plant and animal species. This type of upland was once the most common upland habitat in South Florida but has been extensively impacted.

There is also general agreement among the studies, including those conducted by the U.S. Fish and Wildlife Service (Multi-species Recovery Plan) and the Florida Fish and Wildlife Conservation Commission (Closing the Gaps Report), both of which include extensive input from federal, state, and local government experts, academia, and the private sector, that native uplands are crucially important to the natural resources within the DR/GR area and throughout Florida.

The Multi-species Recovery Plan notes specific areas within the DR/GR that are not currently protected that are also considered to be the “best remaining areas” of pine flatwoods in this section of Florida. This document also notes that attempts to create pine flatwoods have been unsuccessful. However, the DR/GR contains many areas that were historically pine flatwoods that could likely be restored successfully.

4.3.3 Listed species

DR/GR lands are home to a great number of state or federally listed, endangered, and threatened species (i.e., those plant and animal species listed federally or by the State of Florida as endangered, threatened, or of special concern).

- The DR/GR provides habitat for a variety of state and federally listed plant and animal species

The following list includes plant and animal species likely to occur within the DR/GR area based on the documents reviewed and Florida Natural Area Inventory data regarding locations of plants and animals within the State of Florida.

4.3.3.1 Animals

Mammals

- Florida panther

The Florida panther is a wide-ranging mammal for which large, relatively unfragmented areas like the DR/GR lands are critically important. Due to the extremely imperiled status of the Florida panther population, there is extensive quantitative information regarding the importance of habitat to the Florida panther at a level that is not available for other species. One study conducted by a group of scientists from the Florida Fish and Wildlife Conservation Commission, the U.S. Fish and Wildlife Service, and a number of universities focused on specific regions of the South Florida landscape that are of high value to support a self-sustaining Florida

panther population. The investigators developed an ecological model based on telemetry data and habitat locations that allowed them to identify Primary habitat (critically important to a self-sustaining population), Secondary habitat (lands immediately adjacent to Primary habitat but of lower quality with fewer occurrences of Florida panther use), and habitat linkages of importance to the Florida panther. Extensive Primary habitat is located within Lee County, specifically within the DR/GR area. Secondary habitat is also located within Lee County and the DR/GR area. Although some modifications have recently been made to these maps by the U.S. Fish and Wildlife Service, the majority of the DR/GR area is still designated as Primary or Secondary habitat.

- Florida black bear
- Florida mastiff bat
- Big Cypress fox squirrel

Birds

- Wading birds, including wood stork, white ibis, little blue heron, limpkin, tri-colored heron, snowy egret, great egret, and roseate spoonbill

Habitat fragmentation and hydrologic alterations have resulted in an overall decline in most wading bird species. There has been a particularly dramatic decline in the populations of wood storks, white ibis, tri-colored herons, and snowy egrets (see Estero Bay State of the Bay update). Although large colonies once common to the State of Florida prior to extensive habitat fragmentation are now very scarce, these wading birds still congregate in smaller “ephemeral” colonies. The concentration of birds that occur within these colonies can cause the misleading impression that these birds are widely abundant throughout Florida. However, quantitative wildlife censuses consistently show that, in relation to historic numbers, populations of wading birds have seen dramatic declines.

- Snail kite
- Red-cockaded woodpecker
- Southern bald eagle
- Burrowing owl

Reptiles

- Eastern indigo snake
- Gopher tortoise
- American alligator

Amphibian

- Florida gopher frog

4.3.3.2 Plants

- Beautiful pawpaw
- Birds nest fern
- Lattice –vein fern
- Toothed lattice-veined fern
- Cinnamon fern
- Royal fern
- Giant wild pine
- Still-leaved wild pine
- Inflated wild pine

4.3.4 Strategic Habitat Conservation Areas

- The “Closing the Gaps” Report identified many Strategic Habitat Conservation Areas within Lee County. The largest aerial extent of Strategic Habitat Conservation Areas determined to be important to the largest number of species in Lee County is concentrated within the DR/GR area.

The Florida Fish and Wildlife Conservation Commission (formerly the Florida Game and Freshwater Fish Commission) conducted a statewide study of lands that are important to the maintenance of Florida’s biodiversity. Lands recommended in the report for additional protection are referred to as Strategic Habitat Conservation Areas. The development of these Strategic Habitat Conservation Areas was based on extensive wildlife conservation biology and ecological theory and took into account the habitat needs of 30 species of wildlife, high quality and/or rare upland habitats, bat maternity caves, wetlands important to the success of eight species of wading birds, and lands important to the long-term survival of 105 globally rare species of plants. The importance of this research is noted by Lee County in the Lee County Master Mitigation Plan. Note that the maps included in the originally published 1994 study have since been updated.

4.3.5 Biodiversity “Hot Spots”

- The “Closing the Gaps” Report identified many biodiversity “hot spots” within Lee County. The largest aerial extent of Strategic Habitat Conservation Areas determined to be important to the largest number of species in Lee County is concentrated within the DR/GR area.

The Florida Fish and Wildlife Conservation Commission report also includes a separate set of maps, referred to as Regional Biodiversity Hot Spots. These maps were created to display information on a regional level and include information regarding areas where large numbers of species co-occur, areas supporting rare plant and wildlife communities, known locations of rare plants, animals, and natural communities, and coastal areas that support key components of biological diversity. A number of these “hot spots” are

located within Lee County and are concentrated in the DR/GR area. See Appendix D for a more detailed review of this study.

4.3.6 Potential habitat restoration/enhancement areas

- The DR/GR area includes extensive areas that have been impacted but have good potential to be successful ecological restoration and/or enhancement areas.

The Lee County Master Mitigation Plan recognizes numerous potential habitat restoration sites within the DR/GR lands. Many of the documents reviewed contain information regarding potential restoration areas. These include Florida panther secondary habitat zones and many areas identified as Strategic Habitat Conservation Areas or biodiversity hot spots and/or lands directly adjacent to these areas. There is also extensive potential for these restoration areas to be used to enhance connectivity between existing protected and managed lands within the DR/GR.

4.4 Surface Water Hydrology

- The groundwater and surface water regimes are interconnected within the DR/GR and groundwater withdrawals, if not properly controlled, would adversely effect wetlands and flow ways.
- Topographic relief within the DR/GR is relatively small. Therefore changes to the topography in the form of even small, low drainage control structures (e.g., low dikes) can have significant and far-reaching effects to the entire drainage basins.
- The construction of drainage control structures has constricted flow to relatively few, small drainage ways and has interrupted the natural sheet flow type of surface water discharge.
- Areas for mitigation of surface water flows have been identified within the DR/GR.
- Nutrient loading of surface waters (or groundwater) within the DR/GR may have an adverse effect on the receiving waters (e.g., Estero Bay).

4.5 Connections

One of the most important attributes of the DR/GR lands identified in several of the documents selected for review is the concept of spatial continuity and interconnectedness of the resources and processes that exist within DR/GR lands, and which connect DR/GR lands to surrounding ecosystems of importance. Examples of these connections, involving hydrologic processes and ecological systems are presented below.

4.5.1 Landscape mosaic – within the DR/GR lands

- The DR/GR lands include large-scale (at a minimum of several kilometers in diameter) areas (landscapes) that consist of patches of interconnected, interdependent types of habitats which are repeated in a pattern (mosaic), at a scale that is unique to Lee County. From a natural resource perspective, this feature makes this area important to many wildlife species, especially the wide-ranging species such as the Florida panther, the Florida black bear, and the Eastern indigo snake.
- The DR/GR contains some of the least impacted lands within Lee County and the most contiguous inland habitat. These areas lend themselves to a combination of flow ways, recharge areas, and less impacted groundwater/surface water environments.

The importance of this type of large-scale “landscape mosaic” is a common theme noted in all the documents that pertain to wildlife and habitat. The scale and specific habitat types (e.g. cypress swamps, mesic pine flatwoods, wet prairies, etc.) at which these connections are important varies from species to species, however, the concept of an integrated “landscape mosaic” is thought to be of crucial importance to a wide range of species. For example, the Florida black bear uses many habitat types, such as pine flatwoods, cypress swamps, and mixed hardwood-pine, but may travel to specific locations to feed on palmetto berries in the fall. An interconnected habitat mosaic can also be important to animals with a smaller range. As another example, many species of salamanders cannot complete all phases of their life-cycle without wetlands (in which eggs must be laid) and high-quality uplands (crucial food supply habitat for adults). Therefore, the current practice of preserving small patches of wetlands without adequate attention to the integrity of the larger landscape is resulting in declines in the populations of many species of wildlife.

4.5.2 Contiguous upland habitats

- The DR/GR contains large stands of ecologically important upland habitats.

The “Ecological Communities” (Section 3) of the United States Fish and Wildlife Service Multi-species Recovery Plan provides a good summary of the ecological importance of the upland habitats that occur within the DR/GR area. For example, the DR/GR contains contiguous stands of mesic pine flatwoods, a habitat type the United States Fish and Wildlife Service considers to be “of critical, regional importance to the biota of South Florida”. Mesic pine flatwoods provide habitat for large carnivores, such as the Florida panther; mid sized animals, such as the fox squirrel; deer (important prey for large carnivores); tree-cavity dependent birds such as the red-cockaded woodpecker; a variety of migratory birds; many reptiles including the black racer, Eastern indigo snake, and box turtle; and many tree-dependent frogs. Mesic pine flatwoods are the principal dry ground areas in South Florida and provide critically important dry areas to a wide range of non-

aquatic animals during floods. Mesic pine flatwoods also contain a wide variety of invertebrate species, a group that has not been extensively studied but is recognized as being biologically important in terms of food chain support. It is thought that the wide diversity of invertebrate species in mesic pine flatwoods occurs due to hydrologic variability, vegetation diversity, and the abundance of small-scale habitat types that are available within the mesic pine flatwoods system.

Mesic pine flatwoods are historically the most abundant upland habitats in South Florida. They have also been impacted at a higher rate than most other habitats and are in danger of becoming one of the rarest habitats. Mesic pine flatwoods are not maintainable nor sustainable in small “postage stamp” parcels.

Page 3-228 of the “Ecological Communities” section of the Multi-Species Recovery Plan identifies the area within the DR/GR between the Corkscrew Regional Ecosystem Watershed and the Southwest Airport Mitigation Lands as an important connecting area for mesic pine flatwoods in terms of conservation of wide-ranging state and federally listed species. Page 3-224 identifies a number of potential land acquisition areas, including Save Our River and Conservation and Recreation Lands proposed acquisition areas associated with the Corkscrew Regional Ecosystem Watershed that are considered to be the “best remaining areas” of mesic pine flatwoods in South Florida.

4.5.3 Inland wetlands

- The DR/GR contains large areas of inland wetlands.

No quantitative comparisons were made regarding wetlands within the DR/GR area in relation to the rest of Lee County or the rest of South Florida. However, the DR/GR does contain extensive acreage of many different types of wetlands (e.g. – wet prairie, cypress dome, hydric pine flatwoods, mixed hardwood swamp), including the northernmost portion of the 60,000-acre Corkscrew Regional Ecosystem Watershed.

These extensive inland wetlands, in combination with the upland habitats listed above, provide important nesting, roosting, denning, feeding, and refuge area for a diverse range of animal species and allow for the growth and reproduction of a diverse range of plant species.

4.5.4 Coastal zone connection

- The majority of the DR/GR lands drain via a number of rivers into the Estero Bay, an estuarine system recognized federally as a National Estuary and by the State of Florida as an Aquatic Preserve.
- A combination of both surface water and groundwater that originates within the DR/GR discharges to Estero Bay. Changes in the quality and quantity of groundwater discharge will affect the bay.

As in most systems with interconnected groundwater and surface water systems, a portion of the shallow groundwater within the DR/GR discharges to surface water. Additionally, surface water in some areas of the DR/GR recharges shallow groundwater. Modifications to land cover, drainage basins, surface water and groundwater elevations, and flow ways will affect the balance between surface water and groundwater interactions. Changes to nutrient loading (e.g., fertilization, septic systems) will affect the quality of both the surface water and groundwater resources and downstream receptors of the water (e.g., Estero Bay).

The Estero Bay is home to abundant plant and animal species, including many that are listed federally and/or by the State of Florida as threatened or endangered; including the West Indian manatee, loggerhead sea turtle, Florida panther, bald eagle, big cypress fox squirrel, red-cockaded woodpecker, and snowy plover. Thousands of birds, including the brown pelican, frigate birds, herons, egrets, cormorants, and ibises, use this area for nesting, roosting, and feeding.

- Estero Bay and inland waters, including the riverine systems connecting the DR/GR lands to the Estero Bay, have water quality problems, including low dissolved oxygen, high nutrients (especially as measured by chlorophyll-a), and high levels of copper.

A variety of sources including the South Florida Water Management District, the Florida Department of Environmental Protection, and results of a number of volunteer efforts under way within the Estero Bay area were reviewed. These studies indicate that water quality impairments and the changes in timing and quantity of freshwater entering the estuary have negative effects on a wide variety of plant and animal life, particularly the seagrasses, many invertebrates, and larval fish that are critically important to the maintenance of the area's many commercial fisheries.

- The connection of coastal areas to interior watersheds, and the preservation of interior habitats such as those located within the DR/GR lands, is crucial to some wildlife species.

For example, many wading birds in Lee County and throughout South Florida forage in freshwater habitats during the wet season but concentrate nesting or feeding activities in saltwater wetlands on a seasonal basis or during periods of drought (Estero Bay, State of the Bay Report).

4.5.5 Migratory bird pathways

- The DR/GR contains habitats that provide important “stopover” locations for migratory birds.

The Multi-species Recovery Plan, the “Closing the Gaps Report, and the Estero Bay State of the Bay Report include discussions of the importance of habitats within the DR/GR lands to birds that migrate between North America and South America (neotropical migrants). Florida is important to many of these birds because of its geographic position between North and South America and its close proximity to the West Indies. Southwest Florida in particular is important to birds that must “refuel” after an extended non-stop flight across the Gulf of Mexico. Although there is general agreement that preservation of habitat along the southwest coast of Florida, especially forested habitat, is important to these birds, none of the studies include quantitative data regarding specific species and amounts of habitat required.

4.5.6 Landscape mosaic – regional

- The DR/GR lands provide an important “link” in the “chain” of conservation areas throughout South Florida.

The concept of a mosaic of interrelated habitats is also important on a scale that includes external connections between the DR/GR lands and surrounding ecosystems. For example, the range of a male Florida panther can be larger than 100,000 acres. Places like the DR/GR lands and other conservation areas within South Florida can be in part, like a link in a chain, of an interconnected series of important habitats that can adequately serve and protect even these wide-ranging species. The scale at which the documents reviewed have been conducted, many spanning the area of several watersheds or even all of South Florida, are an indication that natural resource managers in South Florida are striving to preserve and restore this type of region-wide habitat connection.

4.5.7 Groundwater Connection

- Shallow groundwater discharges to surface water and surface water recharges shallow groundwater. Changes in the amounts and quality of either will affect the other.
- Groundwater within the DR/GR discharges to Estero Bay, and changes in the quality and quantity of groundwater discharge will affect the bay.

Effects of changes in quality and quantity on the Estero Bay are not well-measured or understood. There is concern that the many drawdowns for activities such as mining, agriculture, and domestic supplies may have significantly reduced this historic supply of fresh water to the Estero Bay.

5.0 DR/GR Maps and Overlays

Lee County has developed and maintains a Geographic Information System; a computer-based system of maps and overlays that depict features of interest within the county. As part of the review of DR/GR study reports, the project review team was asked to identify maps and overlays within the reports that depicted hydrologic and ecological resources or features of particular importance for the County's efforts to manage DR/GR lands. Maps of particular relevance and interest are listed by document in Appendix E.

In addition, the review team prioritized the list of maps to identify maps of particular significance, so that the County could approach the incorporation of the maps into its GIS map base in a phased manner as resources permit. The key maps selected are summarized in the table below.

Primary DR/GR-Related Maps and Overlays for Possible Inclusion in Lee County Geographic Information System			
Page	Fig No	Title/Caption	Environmental Resource/Feature
2. Groundwater Resources and Mining Study			
	VI-3	Location map of wells with lithologic data	Map showing wells in Lee County for which geologic data are available to define the aquifer system. The map depicts the locations of those wells from an initial database of 1,080 wells that fall within the study area plus an additional 629 wells in and adjacent to Lee County that were added specifically for this study.
	VI-4	Digital elevation model interpolated to 500 ft grid	Lee County land surface elevation map.
	VI-5	Contour map of Holocene thickness	Map showing thickness of one of the geologic units (the Holocene unit) that comprise the drinking water aquifer; supersedes previous

			thickness data from Montgomery 1988 report.
	VI-6	Contour map of Pliocene thickness	Pliocene unit thickness.
	VI-9	Contour map of Ochopee thickness	Ochopee unit thickness.
	VI-11	Contour map of Peace River Sandstone thickness	Peace River Sandstone unit thickness.
	VI-13	Contour map of Arcadia thickness	Arcadia unit thickness.
	VI-36	Location map of wells with water level data	Map showing locations of approximately 550 monitoring wells in the study area in which over 280,000 aquifer water level measurements have been recorded.
	VII-24	Location of existing borrow pits	Depicts the location of approximately 329 borrow pits inventoried for this study.
	VII-37	Net recharge to water table average annual season steady state	Map showing zones of recharge to aquifer in Lee County and, in particular, in the DR/GR area.
4. Water Resources Management Project			
	4-5	Water table aquifer wet season total storage	Depicts magnitude of aquifer storage for drinking water supply in millions of gallons per square mile.
	4-50	Groundwater flow – water table aquifer	Shows groundwater flow entering shallow aquifer in DR/GR lands of Lee County from surrounding counties.
	4-51	Groundwater flow – lower Tamiami aquifer	Shows groundwater flow entering lower Tamiami aquifer in DR/GR lands of Lee County from surrounding counties.
	Plate 79	Recharge area for water table	Depicts recharge areas for shallow

		aquifer	aquifer.
	Plate 80	Recharge area for lower Tamiami aquifer	Recharge to lower Tamiami aquifer.
	Plate 81	Recharge area for Sandstone aquifer	Recharge to Sandstone aquifer.
	Plate 82	Recharge area for mid-Hawthorn aquifer	Recharge to mid-Hawthorn aquifer.
	Plate 83	Potential well development areas for public water supply – water table aquifer	Areas in DR/GR lands identified as having potential for development as a water supply in the shallow aquifer.
	Plate 84	Potential well development areas for public water supply – lower Tamiami aquifer	Areas in DR/GR lands identified as having potential for development as a water supply in the lower Tamiami aquifer.
	Plate 85	Potential well development areas for public water supply – Sandstone aquifer	Areas in DR/GR lands identified as having potential for development as a water supply in the Sandstone aquifer.

6.2 Estero Bay – State of the Bay Update 2004			
6-2	8	Estero Verified 2002 303d	This map shows water quality impairments determined by Florida Department of Environmental Protection in relation to sub-basin geography delineated by South Florida Water Management District. (Note: This map is already included in the Lee Master Mitigation Plan document, and so may already be in the County GIS.)
7. Lower Charlotte Harbor Reconnaissance Report			
55	26	Lands in conservation	Public conservation lands

56	27	Conservation easements	Conservation easements under private management
58	30	Identified lands for potential future acquisition	Proposed acquisition lands
8. Water Quality Data Analysis and Report for the Charlotte Harbor National Estuary Program			
8-3	6-14	CHNEP Basins – Southern Coast – Surface – Dissolved Oxygen	Map depicts trends (improving or declining) for measured concentrations of the named constituent (e.g. Dissolved Oxygen) in the indicated surface water zone (Surface or Bottom) in Lee County and particularly in DR/GR lands.
8-4	6-15	CHNEP Basins – Southern Coast – Bottom – Dissolved Oxygen	Same as above.
8-11	6-32	CHNEP Basins – Southern Coast – Surface – Chlorophyll-a (corrected)	Same as above.
8-12	6-35	CHNEP Basins – Southern Coast – Surface – Nitrate + Nitrite	Same as above.
8-13	6-36	CHNEP Basins – Southern Coast – Bottom – Nitrate + Nitrite	Same as above.
8-20	6-49	CHNEP Basins – Southern Coast – Surface – Total Phosphate	Same as above.
8-21	6-50	CHNEP Basins – Southern Coast – Bottom – Total Phosphate	Same as above.
8-26	6-62	CHNEP Basins – Southern Coast – Surface – Fecal Coliform	Same as above.

9. How Much is Enough? Landscape-scale Conservation for the Florida Panther			
120	1	South Florida study area for habitats important to the conservation of the Florida panther	Map of entire Florida panther study area.
128	5	Locations of Primary, Dispersal, and Secondary habitat zones as important lands for conservation of Florida panther	<p>Depicts those areas that the study has determined to be:</p> <p>Primary Zone – areas of suitable habitat that have been consistently occupied by panthers in the past 20 years (Note: these lands are primarily located south of the Caloosahatchee River, with a portion lying in Lee County DR/GR lands);</p> <p>Secondary Zone – adjacent areas that would be most likely to be occupied by an expanding panther population; and</p> <p>Dispersal Zone – areas that would best facilitate dispersal and population expansion.</p>
10. Closing the Gaps in Florida's Wildlife Conservation System			
53	48	Potential black bear habitat in and around Big Cypress National Preserve	Black bear habitat.
68	65	Proposed Strategic Habitat Conservation Areas for the Florida Panther	Florida panther habitat.
123	141	Overlay of coarse habitat distribution maps for 120 rare species	Rare species habitat.

172	170b	Strategic Habitat Conservation Areas	(Note: A map representing these or similar Strategic Habitat Conservation areas has already been included by the County in the Lee Master Mitigation Plan.)
173	170c	Hotspots of biological resources.	(Note: A map representing these or similar Biodiversity Hotspot areas has already been included by the County in the Lee Master Mitigation Plan.)
11.1 Southwest Florida Feasibility Study – Scoping Meeting November 2005			
6	1	Southwest Florida Feasibility Area boundary	Study area encompassing Lee County and surrounding counties.
83	10	Potential restoration sites in study area	Depicts numerous natural areas in the Southwest Florida region that have been identified as potential sites for ecological and hydrological restoration. All delineated areas have experienced some degree of habitat quality degradation, and most are from a variety of causes. Several of these areas are located in Lee County DR/GR lands.
91	11	Species richness	Map indicates a high degree of biodiversity in Lee County DR/GR lands.
92	12	Biodiversity hotspots	Depicts a concentration of biodiversity hotspots in DR/GR lands. Map includes 44 focal species as well as other factors including globally rare plant species; bat maternity and winter roosting caves; pine rockland

			communities, sandhill communities; scrub communities; tropical hardwood hammock communities; and wetlands important to wading birds.
97	13	Unnatural flows to the coast	Depicts the location and interconnections of surface water drainage canals and flow ways, many of which are in DR/GR lands. Also depicts location of proposed reservoirs planned as mitigation measures.
107	14	Southwest Florida restoration projects (Phase 1)	Depicts areas of grouped management measures (ideas to achieve the planning goals and objectives). The map indicates that projects in Lee County DR/GR lands are primarily in the “Highest Priority” category.
12. South Florida Multi-species Recovery Plan			
3-198	1	Distribution of hydric and mesic pine flatwoods in South Florida (data from USGS-BRD 1996)	Depicts distribution of pine flatwoods (pine barrens) which are of critical regional importance to biota in south Florida. They provide essential forested habitat for a variety of wildlife species via tree canopy, and by serving as the principal dry ground in south Florida. Hydric pine flatwoods are unique to south Florida. This habitat, which seasonally functions as a wetland and an upland, allows for an abundant diversity of plant life and wildlife. Although the scale

			of the map and the delineated land units makes the map difficult to read as presented in the report, it clearly shows pine flatwoods in Lee County DR/GR lands.

6.0 Findings, Key Maps, and Conclusions

The project team reviewed more than two dozen documents relating to environmental resources and issues in southwest Florida in general and in Lee County DR/GR lands in particular. To meet the objectives of the review project, the team identified scientific data and information contained in the documents that provide a description of conditions, processes, species, features, and issues within Lee County's southeastern DR/GR lands. The team also identified in the various studies key maps or spatial data overlays that might be worthy of consideration for eventual incorporation into Lee County's planning Geographic Information System. Finally, the team has identified a number of "data gaps" for which more information might prove beneficial as Lee County continues to formulate land use policy and plans for its DR/GR lands. Summaries of the results of the project team's review are presented in the following sections.

6.1 Review Team Findings

The project team noted that almost all the documents contained information (guidance, requirements, scientific data, issues, mitigation projects) that were directly and specifically relevant to Lee County DR/GR lands. Many of the documents focused specifically on Lee County DR/GR lands; while several studies were conducted at a larger scale that encompassed the DR/GR. Two of the studies, one a study of groundwater and mining in Lee County and the other an engineering report for Bonita Springs DR/GR lands, were commissioned specifically to study the DR/GR lands. Several other investigations encompassed the DR/GR lands within the area of study; for example, a study of the Florida Panther, and certain of the watershed studies.

A number of studies contained valuable information regarding the coastal zone and bay areas to which DR/GR lands are connected through surface water drainage, and groundwater discharge into the near-shore coastal environments. Several other studies provided information on DR/GR lands from the perspective of infrastructure projects (e.g. the County Road 951 project) or mitigation projects currently planned or under way (e.g. certain of the Southwest Florida Feasibility Study documents).

Based on the documents reviewed, the project team identified five categories of attributes or features that give the DR/GR its unique character. These are summarized as follows:

6. Density Reduction

1. Reduced residential density in the DR/GR area allows Lee County to meet State requirements.

The DR/GR land use category was originally created in 1990, in large part, to provide a mechanism for reducing or managing residential population density within the County. With the steady increase in population within the County that has been observed in recent years, and which is projected to continue for the next several decades, this feature of DR/GR lands remains as important today as it was when it was instituted.

7. Groundwater Resource/Recharge

2. Groundwater in DR/GR lands is an important source of potable water.

Lee County relies on groundwater for a significant portion of its water supply from both public utilities and private wells. The County utility system currently provides for approximately 48,000 water customers and has a potable water capacity of approximately 27 million gallons per day. Additional water needs are met by other utility companies and private wells. Projections for future water needs show that the County's utility system capacity will need to increase to 45 million gallons per day by 2020, and additional withdrawals will be met by other utilities and private wells. Water supply development, treatment capacity expansion, conservation, and innovative water supply strategies such as aquifer storage and recovery will need to be utilized to meet that need. These developments will likely call for an increase in groundwater withdrawals to meet demand.

3. Recharge at the land surface within the DR/GR supplies water to underlying aquifers.

Land areas within the DR/GR have been identified as areas in which rainfall seeps into the ground to recharge underlying groundwater aquifers. The amount of recharge depends upon land use and land cover. Some of the higher-recharge land categories in Lee County are located within the DR/GR.

4. Groundwater in the DR/GR area acts to sustain important surface water bodies.

Recharge to aquifers within the DR/GR can act to raise groundwater levels and, because the shallow aquifer is connected to overlying surface water bodies, aquifer recharge can also sustain surface water levels and flows. Surface water is important for sustaining certain DR/GR ecological resources (e.g. wetlands) and in linking DR/GR lands to coastal ecosystems.

5. DR/GR aquifers are a potential source of new water supply for Lee County.

Current Lee County groundwater supplies (e.g. Lee County utilities, private wells) depend on recharge that occurs within the DR/GR for their current supply of groundwater. In addition, the DR/GR contains areas that have the potential for new water supply development. However, because pumping of groundwater can lower groundwater levels and diminish surface water flows, a balance between groundwater withdrawals and adequate groundwater and surface water levels must be maintained.

6. Computer models may serve as valuable tools for managing groundwater resources in DR/GR lands.

Development of potential water supplies that may affect the DR/GR water budget must be evaluated on a case-by-case basis. Evaluations should take into account the regional and seasonal impacts of water withdrawals on surface water bodies including rivers and wetlands. Quantitative tools such as the computer models of groundwater flow can be used in evaluations of current and proposed groundwater withdrawals.

7. Mining activities in DR/GR lands may have both positive and negative effects on the natural hydrologic system.

As pointed out in the recent Lee County groundwater and mining study, mining activities have the potential to impact groundwater in both a positive and negative manner. Positive effects include increased capacity for water storage in the open excavations left behind by mining, and the opportunity to enhance regional storage through design and management of the mining-related lakes. Negative effects associated with mining-related lakes include increased susceptibility to introduce potential contaminants into aquifers and increased water loss due to evaporation.

8. Ecology

8. Existing wetlands are important ecological features of the DR/GR lands.

Lee County DR/GR lands are rich in ecological resources. Ecosystems function and interact to sustain a wide variety of species and habitats. Several studies reviewed identified wetlands as important ecological features of the DR/GR because they provide a host of functions, including: filtration and assimilation of rainfall runoff, recharge of groundwater aquifers, stabilization of sediment carried during storm flows and other surface water flows, hydraulic controls on floodwaters, and habitats for a wide variety of plant and animal species.

9. Native uplands are important habitat areas in DR/GR lands.

Similarly, native uplands are critically important to natural resources within the DR/GR. These areas are often not well-protected by current regulations. The Multispecies Recovery Plan notes specific areas within the DR/GR that are not currently protected, but which are considered to be among the best remaining areas of pine flatwoods in this section of Florida.

10. Many state or federally listed or endangered species have been observed or have suitable habitat areas mapped within DR/GR lands.

DR/GR lands are home to a great number of state or federally listed or endangered species. These include mammals such as the Florida panther, Florida black bear, mastiff bat, and fox squirrel; birds including wood stork, little blue heron, red-cockaded woodpecker, southern bald eagle, and burrowing owl; and several reptiles and amphibian species. Various listed plant species may occur in the DR/GR. These species may include beautiful pawpaw, birds nest fern, and lattice-vein fern.

11. DR/GR lands host a rich diversity of plant and animal species.

It is important to recognize that the DR/GR lands are important not only for the species that have been observed there, but also for the overall diversity of species that the DR/GR lands support. The Florida Fish and Wildlife Conservation Commission conducted a statewide study of lands that are important to the maintenance of Florida's biodiversity, and recommended lands for additional protection that are referred to as Strategic Habitat Conservation Areas. The largest aerial extent of Strategic Habitat Conservation Areas determined to be important to the largest

number of species in Lee County is concentrated within the DR/GR area. The Lee County Master Mitigation Plan embodies the concept of biodiversity areas and has been updating maps to reflect new information obtained for these areas within the County and within DR/GR lands.

The Florida Fish and Wildlife Conservation Commission report also includes a separate set of maps, referred to as Regional Biodiversity Hot Spots. These maps were created to display information on a regional level and include information regarding areas where large numbers of species co-occur; areas supporting rare plant and wildlife communities; known locations of rare plants, animals, and natural communities; and coastal areas that support key components of biological diversity. The “Closing the Gaps” Report shows that there are many biodiversity “hot spots” within Lee County and that they are concentrated in the DR/GR area.

12. DR/GR lands are prime areas for wetlands mitigation and ecological restoration efforts.

The studies reviewed indicate that the DR/GR lands include extensive areas that, while they have been impacted, have good potential to be successful ecological restoration and/or enhancement areas. The Lee County Master Mitigation Plan recognizes numerous potential habitat restoration sites within the DR/GR lands. Many of the documents reviewed contain information regarding potential restoration areas. These include Florida panther secondary habitat zones and many areas identified as Strategic Habitat Conservation Areas or biodiversity hot spots and/or lands directly adjacent to these areas. There is also extensive potential for these restoration areas to be used to enhance connectivity between existing protected and managed lands within the DR/GR if the appropriate actions are taken.

9. Surface Water

13. Surface water bodies within DR/GR lands are important hydrologic and ecological features.

The DR/GR lands were originally designated as groundwater protection areas, but the documents reviewed as part of this project reveal that surface water within the DR/GR lands is also very important for a number of reasons. First, the surface water bodies, whether channelized and flowing continuously, broad shallow and ponded, or active primarily during storm events, are hydrologic features with great significance

for the ecological systems of the DR/GR lands. Wetlands and sloughs are broad, shallow, ponded or slow moving bodies of surface water that provide habitat for a wide variety of plant, animal, and aquatic species.

14. Flows through the extensive system of channels, sloughs and wetlands within the DR/GR lands can act to remove nutrients, sediment, and contaminants from surface water to lessen impacts to surface water within the DR/GR and in nearby coastal waters.

In addition, these surface water ecosystems have the capacity (due to the slow rate of flow) to perform a cleaning process to some degree on the water that flows through them. Surface water that flows within the DR/GR ultimately discharges to the waters of rivers, creeks, and bays along the western coastline of Lee County. This means that if the ability of the surface water ecological systems to remove chemicals and nutrients become overwhelmed due to development, agriculture, mining, or other sources of pollution, then not only will DR/GR surface waters be impacted, but also the receiving waters in the coastal ecosystems, including the Estero Bay Aquatic Preserve.

15. DR/GR surface water systems are important for removing storm waters and reducing flood impacts.

DR/GR surface waters are also important for reasons related to flooding. Topographic relief within the DR/GR is relatively small. Therefore changes to the topography in the form of even small drainage control structures (e.g., low dikes) can have significant and far-reaching effects on the entire drainage basins or watersheds. Studies have determined that construction of drainage control structures in DR/GR lands has constricted flow to relatively few, small drainage ways. These constrictions have interrupted the natural sheet flow type of surface water discharge and may create point sources of potential nutrient and sediment contamination that can impact receiving waters. Areas for mitigation of surface water flows have been identified within the DR/GR and mitigation projects are planned or under way.

16. Surface water systems may serve as sources of recharge to groundwater aquifers and well fields.

Finally, groundwater in the shallow aquifer and surface water that flows in rivers, canals, wetlands, and sloughs are interconnected within the DR/GR. As discussed previously, groundwater withdrawals, if not managed properly, could adversely affect

rivers, wetlands and other surface water flows. Conversely, surface water flows in the DR/GR could serve as a source of recharge to the aquifer system if managed properly. This means that surface and groundwater within the DR/GR must be studied, monitored, and managed together to avoid or mitigate hydrologic and ecological problems.

10. Connections

One of the most important overall attributes of the DR/GR lands is the connections between all of the resources and systems that have been discussed above, and the scale over which these connections operate. Many of these connections have been alluded to in the previous discussions in this section, but the paragraphs below will describe them in more detail and make their importance clear.

17. DR/GR lands provide a large contiguous habitat area that is important to wide-ranging species.

Several of the documents reviewed provided information that made clear the spatial continuity and interconnectedness of hydrologic and ecological systems within the DR/GR lands and between DR/GR lands and surrounding ecosystems. For example, DR/GR lands include large-scale (at a minimum of several kilometers in diameter) areas (landscapes) that consist of patches of interconnected, inter-dependent types of habitats which are repeated in a pattern (mosaic), at a scale that is unique to Lee County. From a natural resource perspective, this feature makes this area important to many wildlife species, especially the wide-ranging species such as the Florida panther, the Florida black bear, and the Eastern indigo snake.

18. DR/GR lands contain extensive areas of interconnected wetlands.

The DR/GR also contains large areas of wetlands. While the studies reviewed provided no quantitative comparisons regarding wetlands within the DR/GR area in relation to the rest of Lee County or the rest of South Florida, the DR/GR does contain extensive acreage of many different types of wetlands (e.g. – wet prairie, cypress dome, mixed hardwood swamp), including the northernmost portion of the 60,000-acre Corkscrew Regional Ecosystem Watershed. These extensive wetlands, in combination with the mosaic of upland habitats described in the environmental studies, provide important nesting, roosting, denning, feeding, and refuge area for a diverse range of animal species and allow for the growth and reproduction of a diverse range of plant species.

19. DR/GR lands provide important connections to nearby and farther-reaching ecosystems.

In a similar fashion, because the concept of a mosaic of interrelated habitats is also important on a scale that includes external connections between the DR/GR lands and surrounding ecosystems, the DR/GR lands provide an important “link” in the “chain” of conservation areas throughout South Florida. On an even larger scale, the DR/GR contains habitats that provide important “stopover” locations for migratory birds. The Multi-species Recovery Plan, the Closing the Gaps Report, and the Estero Bay State of the Bay Report include discussions of the importance of habitats within the DR/GR lands to birds that migrate between North America and South America (neotropical migrants). Although none of the studies include quantitative data regarding specific species and amounts of habitat required, there is general agreement that preservation of habitat along the southwest coast of Florida, especially forested habitat, is important to these birds.

20. DR/GR lands connect in important ways both hydrologically and ecologically to nearby bays and coastal ecosystems.

Finally, as discussed above, the majority of the DR/GR lands drain via a number of rivers into the Estero Bay, an estuarine system recognized federally as a National Estuary and by the State of Florida as an Aquatic Preserve. The Estero Bay is home to abundant plant and animal species, including many that are listed federally and/or by the State of Florida as threatened or endangered. Estero Bay and inland waters, including the riverine systems connecting the DR/GR lands to the Estero Bay, have water quality problems, including low dissolved oxygen, high nutrients (especially as measured by chlorophyll-a), and high levels of copper. The studies reviewed in this project indicate that water quality impairments and the changes in timing and quantity of freshwater entering the estuary have negative effects on a wide variety of plant and animal life, particularly the seagrasses, many invertebrates, and larval fish that are critically important to the maintenance of the area’s many commercial fisheries. For these reasons, the connection of coastal areas to interior watersheds, and the preservation of interior habitats such as those located within the DR/GR lands, is crucial to some wildlife species.

6.2 Key Map Information

Almost all of the studies reviewed contained maps. These maps supplemented and enhanced each report by presenting in a graphic format the spatial aspect of the data described in the text (e.g., the distribution of up and down arrows spread across the DR/GR area that showed the temporal water quality trends described in the Charlotte Harbor Estuary water quality data analysis report). Maps also quantified in a way the text could not, the exact area being described, the patterns of intensity of a particular feature (for example the color shading denoting the degree of biodiversity determined in each area of the DR/GR), and the adjacency and spatial connections between habitats of a certain type (for example the range of panther habitat; or maps that showed rivers, flow ways, and impacted unnatural flows (i.e. canals) draining from DR/GR lands to the coastal waters).

Of the hundreds of maps reviewed, and the 120 or so maps selected in Appendix E as having particular relevance to Lee County DR/GR lands, the review team selected approximately four dozen maps (Section 5.0) of particular significance (many of which could be grouped to form a smaller number of map categories). These map categories are summarized below:

1. Hydrology, Hydrogeology and Aquifer Properties

Several of the key maps depict the thickness of the geologic units that comprise the aquifer beneath the DR/GR that supplies water for residential use, agriculture, and other uses in Lee County. The thickness of the units provides a measure of the capacity of the aquifer to store water and deliver it to well fields. Maps also depicted areas of recharge and potential areas for water supply well fields in the DR/GR area.

2. Ecological Habitat and Biodiversity

Many of the maps depicted habitat for the numerous listed, threatened, or endangered species that have been identified in the DR/GR. Certain of the maps are intended to show habitat for a particular species (e.g. Florida panther or Florida black bear); certain of the maps are intended to depict types of habitat lands (e.g. wetlands, or pine flatwoods); and certain of the maps are intended to show special biodiversity hotspot areas that allow for a diverse interrelated community of species.

3. Water Quality

Several of the maps depict water quality measurements for surface water within

DR/GR lands, in the bays and estuary waters into which the DR/GR drains. Certain maps depict not simply a “snapshot” of water quality, but the patterns over time (improving or declining) in water quality parameters that are measures of the health of the DR/GR-related surface waters.

4. Conservation and Mitigation Lands

Maps in the Lee County Master Mitigation Plan and in related documents (e.g. Lower Charlotte Harbor Reconnaissance Report) delineate land areas, many of which are located in the DR/GR, that are either under public or private conservation management, or which are targeted for potential future acquisition. In addition, certain maps depict currently impaired or impacted areas that are targeted for mitigation through a number of environmental and engineering projects (e.g. the management measures described and depicted in the Southwest Florida Feasibility Study Scoping Meeting document).

There is a wealth of spatial information that, if integrated, built upon, maintained, and periodically updated, would assist Lee County in characterizing, understanding, monitoring, and better managing the DR/GR lands. The key maps identified in this study, when coupled with information already contained in the Lee County Geographic Information System, were intended to provide a robust map-portfolio base with which to better examine resources, patterns, trends, impacts and restoration efforts in the DR/GR lands.

6.3 Conclusions

The first step of the review process by the project team was the identification of more than 50 environmental resources, features, and issues potentially associated with the DR/GR lands. These resources, features, and issues are considered to be of importance to Lee County because they are taken directly from the Lee County Comprehensive Plan. They are shown in Appendix C.

At the conclusion of the review, the project team determined that the studies and reports revealed substantial descriptive information and scientific data regarding the DR/GR lands. As shown in Appendix F, every one of the 50-plus environmental resources, features, and issues identified in the Lee County Comprehensive Plan are discussed, addressed, or characterized to some extent in one or more of the studies.

This correlation between the County's stated environmental features of interest and the corresponding information provided in the documents indicates the following:

- There is a strong awareness on the part of the Lee County staff charged with managing the DR/GR area that these lands possess a large number of important resources, features, and issues.
- There is confirmation from the studies reviewed that numerous investigators also consider these DR/GR-related features to be important, and that the features (habitats, species, resources, recharge areas, etc.) have been identified as being present in the DR/GR area in southeastern Lee County.
- The studies, when viewed as a whole, reveal that the resources and ecological systems within the DR/GR area are interrelated in complex ways.
- The functioning of the DR/GR environmental system (both in terms of individual resources and interrelated systems) can be adversely impacted by certain land uses.
- There is the potential for a balance between use of the land and protection of the ecological and groundwater resources, with the nature of that balance requiring careful consideration of the DR/GR information and scientific data contained in the studies reviewed as part of this project and other similar studies.
- There is the potential for restoration of impacted portions of DR/GR lands.

The review of the individual studies revealed that some were more current than others and some contained more depth and robustness of characterization of the DR/GR land in southeastern Lee County than others. Brief statements regarding the characteristics of the studies in these and other respects may be found in Appendix D.

The review also revealed that there were a few major components of the overall character of the DR/GR lands that were not described in sufficient depth in the documents reviewed as part of this project to permit the project team to evaluate their importance or significance. For example, while one of the earlier water resource studies made brief mention of potential saltwater intrusion impacts for wells in southeastern Lee County, none of the studies provided more detail on this subject. Similarly, none of the studies provided a concise hydrologic water budget for the DR/GR lands. These elements, missing in the documents reviewed, may be addressed in other documents, studies, and reports beyond those reviewed by the project team.

Several of the studies mentioned potential groundwater quality impacts associated with certain land uses, but did not present a current background data set against which future groundwater quality changes could be measured. One of the studies described potential hydrologic impacts associated with mining, but none of the studies described potential ecological impacts. In addition, while several of the documents mentioned agriculture as a permitted DR/GR land use, they did not provide information on the hydrologic, water quality, or ecological impacts associated with agricultural use of these lands.

As stated above, in the absence of information on these topics from the reports reviewed, it can not be determined whether they are important for the future management of DR/GR lands in southeastern Lee County. The topics are identified here for possible consideration by Lee County staff, which may be aware of additional studies that the project team has not reviewed, and not as recommendations for further study.