Low Impact Development (LID) Issues for Florida: What's Important and What Should Be Getting Monitored

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ABSTRACT

Low Impact Development, commonly referred to as "LID", is a stormwater design approach that replicates or maintains the hydrologic function of the natural system. LID advocates stormwater management practices based on soils and vegetation, designing for all rainfall events, large and small. Stormwater is managed as close to the source as possible, reducing conveyance, deep pipes, and large stormwater structures. Landscapes that reduce the amount of runoff are an important component of LID, as are measures that return water to the groundwater and atmosphere (through vegetation). The underlying concept of LID is to consider stormwater as a resource, not a disposal problem.

This paper discusses the monitoring needs to develop an LID approach suitable to Southwest Florida. Since LID is based on replicating the natural system, the first part of the monitoring effort relates to understanding the existing natural system, including past or on-going human impacts to that natural system. The second monitoring component relates to understanding the site-specific opportunities and limitations of a project area to apply LID and select appropriate stormwater measures for the given physical conditions of an area or the proposed land use. Finally, the third monitoring component relates to the actual performance or success of LID in achieving the stated goal of maintaining natural hydrologic function, and involves performance monitoring of constructed LID measures, as well as conventional measures for comparison. These performance parameters include volume control, rate control, water quality, and groundwater level. Also, as part of the "built performance" of LID, the construction costs (and potential savings and/or additional costs) should also be documented, as well as constructability and aesthetic acceptance. For LID to succeed, the issues of economics and practicality must be addressed and should be considered in any monitoring program. For discussion purposes, the project area of Starkey Ranch is considered.

INTRODUCTION

In Florida, where the issues of rapid land development and limited freshwater resources are so pressing, LID appears to be a solution to many problems associated with land development. LID can reduce the consumptive water use required to support landscapes, reduce the load of non-point source pollutants, return much-needed water to the aquifer, and potentially reduce the damaging impacts of large rainfalls and flooding. Equally important, LID has the potential to support natural habitats, maintaining the flora and fauna unique to southwest Florida even as human population growth and development continues.

EPA defines LID as follows:

"LID is a site design strategy with a goal of maintaining or replicating the pre-development hydrologic regime through the use of design techniques to create a functionally equivalent hydrologic landscape. Hydrologic functions of storage, infiltration, and ground water recharge, as well as the volume and frequency of discharges are maintained through the use of integrated and distributed micro-scale stormwater retention and detention areas, reduction of impervious surfaces, and the lengthening of flow paths and runoff time (Coffman, 2000). Other strategies include the preservation/protection of environmentally sensitive site features such as riparian buffers, wetlands, steep slopes, valuable (mature) trees, flood plains, woodlands and highly permeable soils." (EPA, 2000).

The following sections discuss the proposed monitoring requirements to successfully understand natural site conditions, design, and build a large-scale residential and mixed-use LID application. For discussion purposes, the proposed Starkey Ranch in Pasco County, Florida is discussed.

A PROPOSED LID APPLICATION

The vast majority of the original Starkey Ranch, about 13,000 acres, is currently protected in nature preserves, mainly the J.B. Starkey Wilderness Park in New Port Richey. The remaining 2,500 acres are proposed for a mixed-use development that would include 4,635 residential units, 500,000 square feet of retail, 355,000 square feet of office space, 120,000 square feet of Light Industrial, 70,000 square feet of civic uses, 30,000 square feet of day care use, 200 hotel rooms, a 16-screen movie theatre and two schools designed to accommodate 1,770 students. The proposed design is "new urbanist" in nature, with various uses intermixed and with reduced lot sizes. Portions of the proposed development will be very high density and urban in nature, while other areas will be more residential, and a number of public open spaces and facilities will be created (Figure 1). It is anticipated that some portions of Starkey will be served by a LID stormwater system, while other portions will be served by a conventional stormwater system. At this time, the detailed stormwater design for Starkey has not yet been developed.

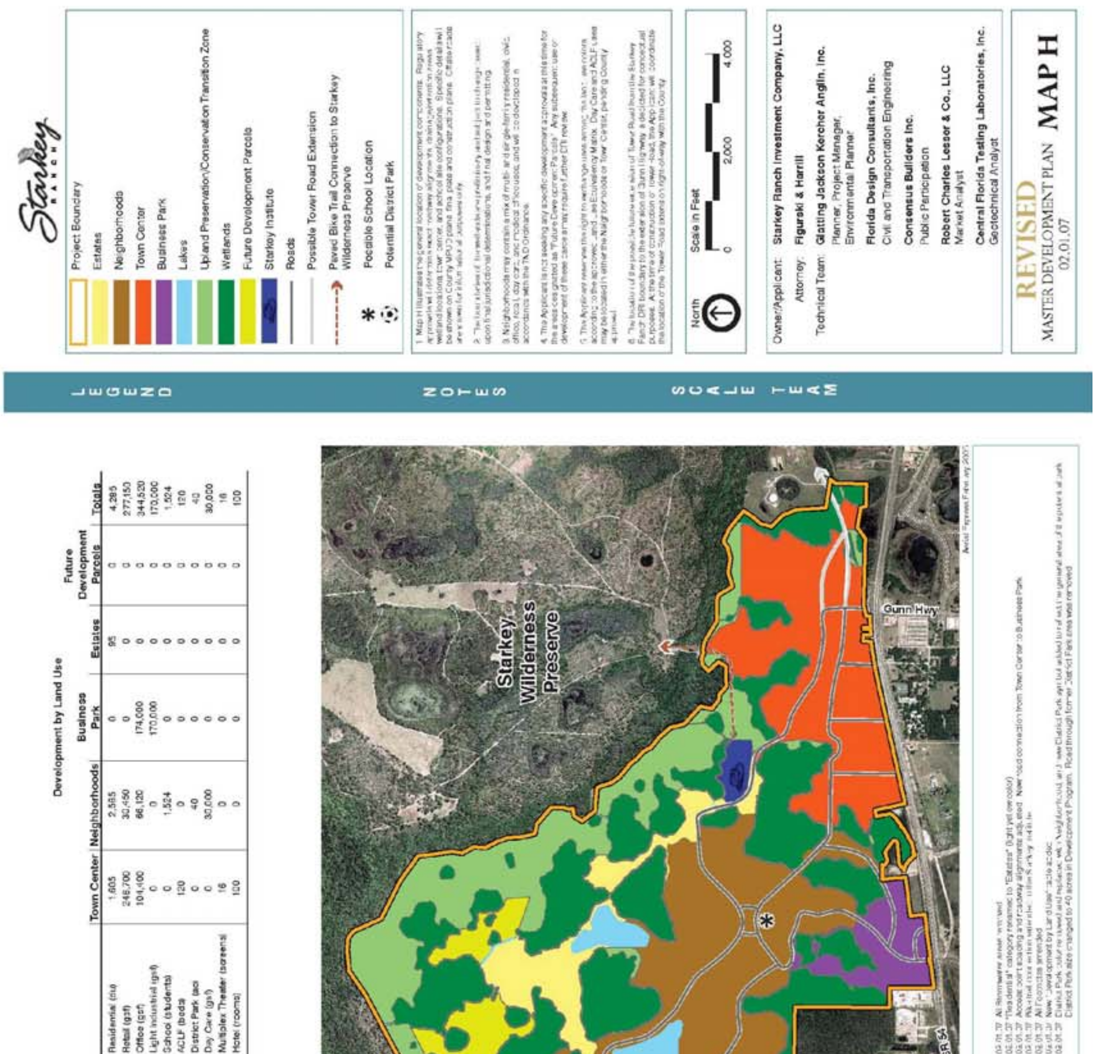

Figure 1. Master Development Plan for Starkey Ranch

UNDERSTANDING THE NATURAL SYSTEM

Starkey Ranch is located in Pasco County off of Route 54 as shown in Figure 2, Project Location. Much of the site has been permanently protected, with a high development density proposed for the remaining 2,500 acres. The proposed area of development includes both isolated and non-isolated wetlands, areas of 100-year floodplain, and is suitable habitat for burrowing tortoises. The existing land use is indicated in Figure 3, and wetlands in Figure 4.

The site has been disturbed in the past, having been extensively cleared for lumber prior to the 1930's, and converted to a cattle ranch, which continues to operate today.

The vegetative health of the isolated wetlands have shown increasing system decline as the annual high water level has declined in recent years. This is felt to be a result of an overall decline in the regional groundwater level due to public water supply withdrawal. A photograph indicating historical high water level for an isolated wetland is provided in Figure 5.

The underlying soils are mostly Smyrna sands, which are classified as USDA hydrologic soil group B/D, indicating that the soils are well-drained much of the year, but during the wet season are poorly drained due to high water table.

Limited information is available to define how the existing natural hydrologic system is working. There is little technical data to define the movement of water into and out of isolated wetlands, although the continued health and function of those wetlands to be preserved is of critical importance. Understanding how water moves into (and out of) isolated wetlands in terms of volume, timing, and temperature is important.

Additionally, little information exists related to the shallow groundwater table, soil moisture, and ability of the soils to receive and infiltrate runoff. There is some concern that infiltration techniques may work at some times of the year, but not at others, due to high water table. Finally, the health and viability of the species in the wetlands has not been well documented.

It is hypothesized that in a natural condition, rainfall infiltrates into the soils and moves laterally into (and out of) these wetland systems, and that an LID approach that returned water to the shallow groundwater would support and improve these wetlands, and represent a healthier influx of water than that delivered in "surges" by a piped conventional stormwater system (See Figure 6, Stormwater Impacted Wetland). Impacts of temperature and water quality would be buffered by a system based on infiltration that provided longterm inflow to the wetland systems. It is also hypothesized that longterm recharge of the underlying groundwater aquifer could be better supported by an LID approach.

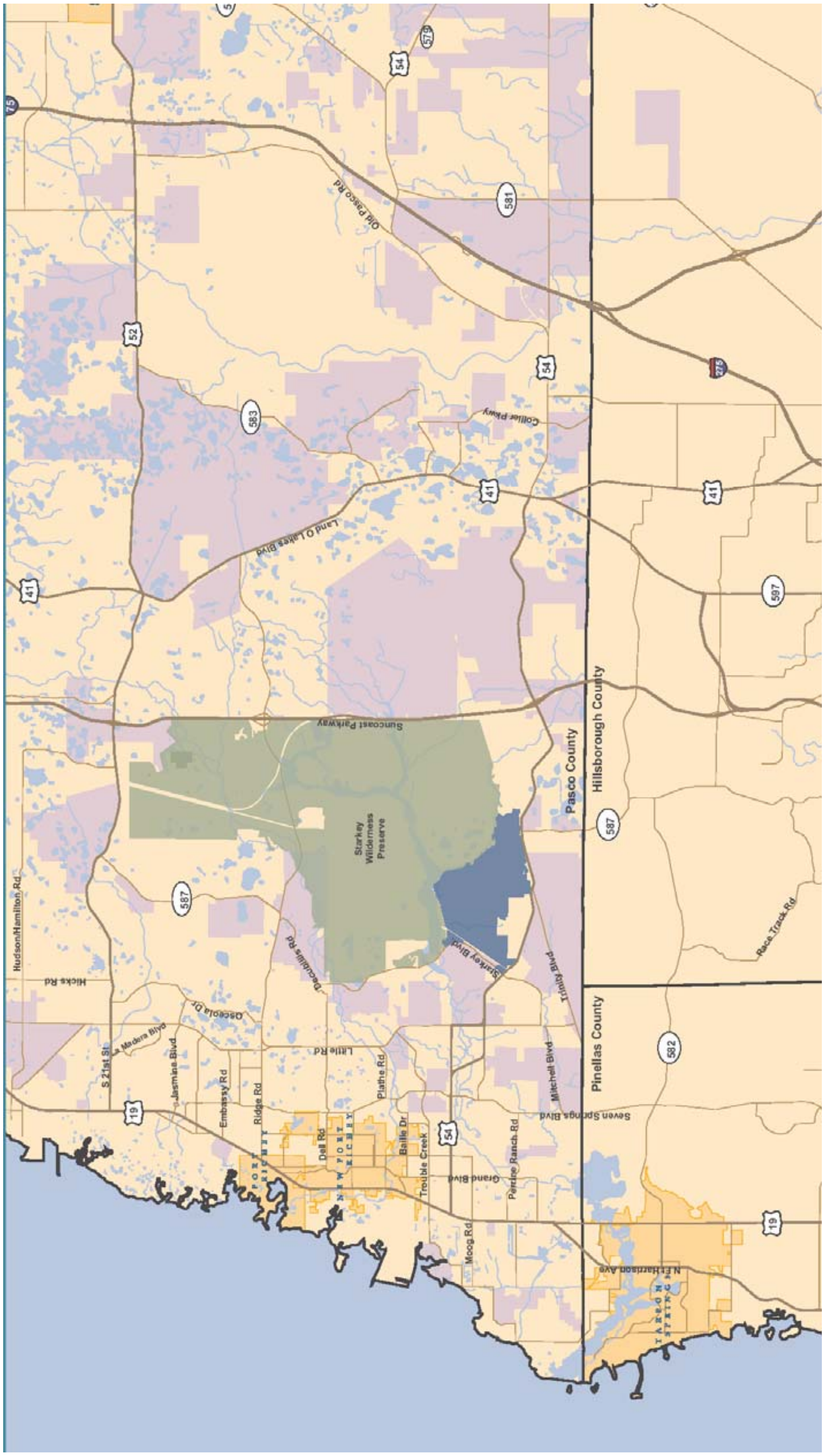

Figure 2. Location map showing Starkey Ranch Project

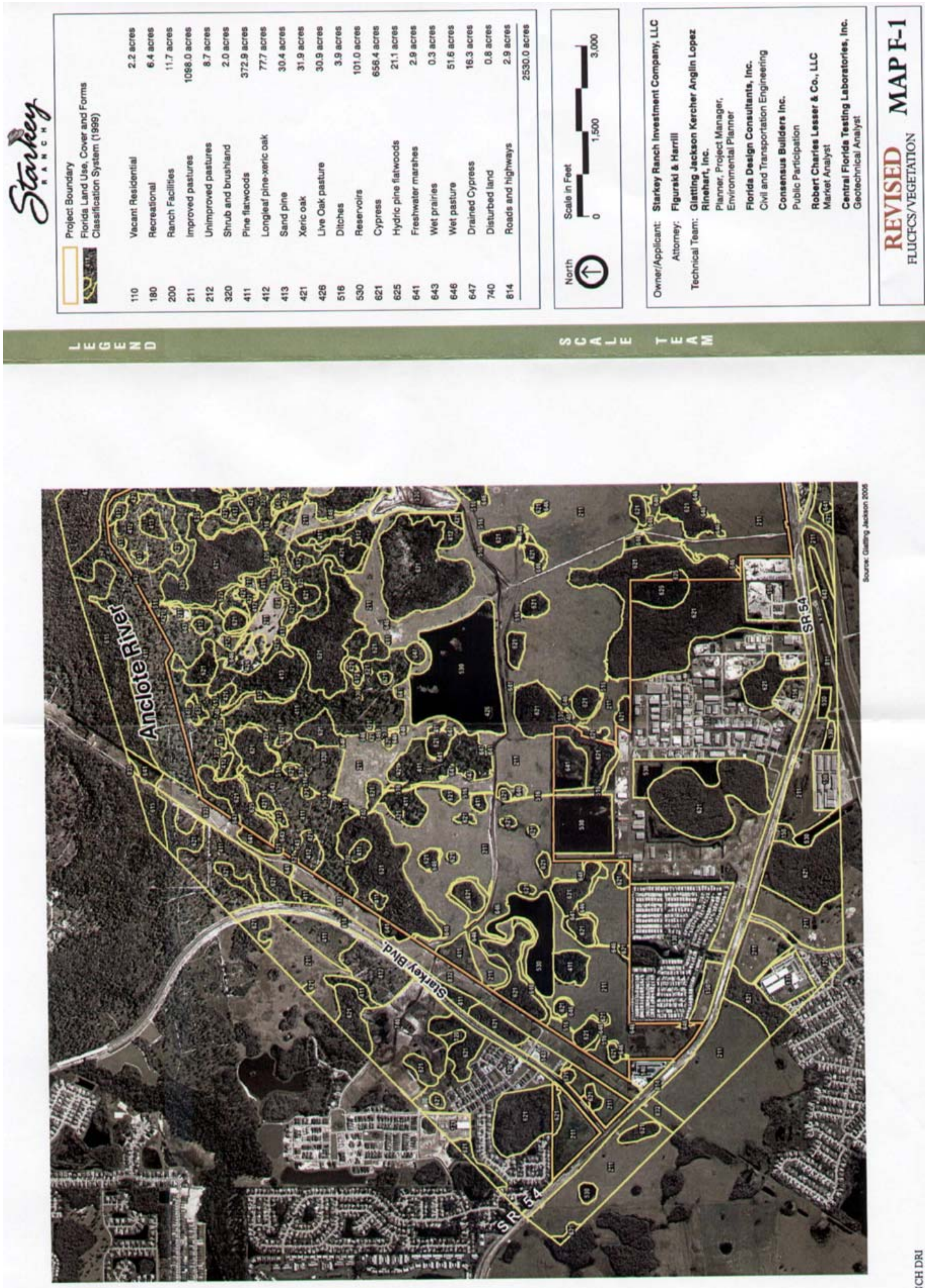

Figure 3. Existing Land Use

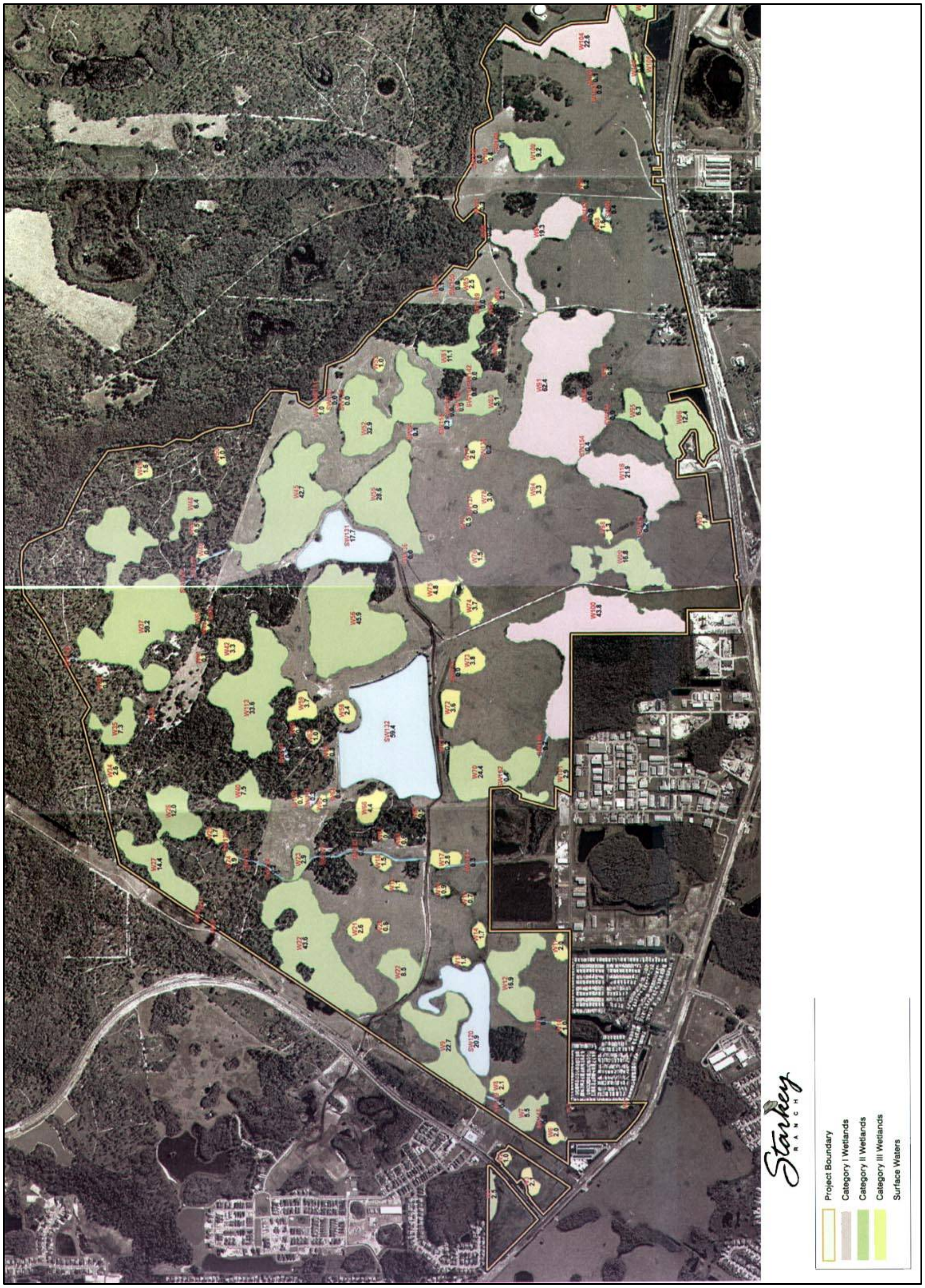

Figure 4. Wetlands

Figure 5. Example of historic high water level in isolated wetlands at Starkey Ranch

Figure 6. Isolated Wetland impacted by conventional stormwater discharge

To understand the current functioning of the natural hydrologic system (or at least a baseline of the existing system) at Starkey Ranch, the following elements are proposed:

- Installation of a continuous recording rain gage, to record rainfall in 15-minute increments.
- Continuous recording of the water elevation in the existing shallow well system (6 wells), to document the groundwater elevation at different locations in response to rainfall events. These wells are not currently in use.
- Installation of recording soil moisture probes at a variety of locations across the site to determine the soil moisture levels at different locations and depths in response to rainfall. Moisture probes should record on a daily basis.
- Installation of shallow membrane piezometers to measure shallow groundwater level at a variety of locations across an extended time period. It is anticipated that a number of locations should include isolated wetlands, areas of proposed development, and areas where there is concern of seasonal high-water table that could limit infiltration. Piezometers should record on a daily basis.
- Documentation of the flora and health of several existing isolated wetlands that will remain, with the assumption that several isolated wetlands will be located in an area with LID, and several isolated wetlands will be located in an area of conventional design and subject to stormwater surges into these wetlands.
- Water quality parameters should be monitored in at least two isolated wetlands systems (one that will be subject to conventional stormwater discharges, and one that will be located in an LID area and will not receive direct runoff after development). Parameters to be monitored include pH, temperature and dissolved oxygen levels (continuous recording, four readings per day), as well as discreet sampling for TSS.

All parameters measured should represent both the area that will be developed with LID and the area that will be developed with conventional stormwater management. This will allow a future understanding of the differences in soil moisture, local shallow groundwater table elevation, and habitat as a result of two different approaches to stormwater management. By establishing baseline conditions, it will be possible to compare any differences and potential benefits or liabilities associated with each type of stormwater management.

UNDERSTANDING THE SITE CONDITIONS FOR DESIGN DECISIONS

The second component of the monitoring program involves site-specific investigations of a larger number of locations throughout the proposed development area. At a number of locations throughout the site, the soil conditions, water level, and infiltration capability of the soil must be investigated. At each location, a deep hole (six to eight feet deep and three feet wide should be excavated to determine conditions. It is recommended that each location be tested at least once during the dry season and once during the wet season, prior to construction, to determine any differences in water level and soil capabilities. An extensive number of test locations (4 to 6 per acre) should be investigated in an area proposed for LID, and a similarly extensive number of test locations should be evaluated in an area proposed for conventional stormwater management.

PERFORMANCE MONITORING

It is anticipated that the first phase of development will include an area served by LID and a separately draining area served by conventional stormwater management. The LID area will be designed so that there is no increase in runoff volume for all storms of the two-year frequency or less. Measures to be used include a variety of distributed infiltration systems, as well as capture-reuse cisterns for landscape needs, and vegetative systems. No large detention facilities will be constructed. Additionally, efforts will be made to include native, low-maintenance landscaping.

The conventional area will be served by a traditional system of inlets and pipes, conveying runoff to isolated wetlands (for water quality) or to larger detention elements for peak rate control. It is anticipated that landscaping will be traditional in design and maintenance.

It is proposed that monitoring of rainfall, water levels, and water quality in the isolated wetlands continue during the construction period to document any construction impacts, and that this should continue through site stabilization. Additionally, monitoring of the shallow groundwater table through piezometers should continue.

Following site stabilization, a two-year period of monitoring is recommended to document the differences, if any, between the two areas with different stormwater designs. Monitoring should continue for rainfall, groundwater levels in wells, shallow groundwater conditions, and water quality in the two selected isolated wetlands (one receiving direct discharge from conventional stormwater and one in the LID area).

Additionally, field evaluation of the aquatic health of the two isolated wetlands should be conducted twice per year to determine what changes, if any, are occurring in the health and diversity of species.

Finally, to measure total discharge from both the LID area and the conventional design, a location will be designed at each area that receives all surface water discharge from a given drainage area (after development occurs). It is anticipated that this location may consist of a pipe or other structure such that a continuous velocity-area gage can be installed to measure discharge rate and corresponding total runoff volume. This will allow for measurement of the critical parameter of runoff volume differences and flow rate timing differences between conventional design and LID.

SUMMARY

The proposed sampling program hopes to establish a rigorous comparison of the stormwater performance of an LID approach and a conventional approach for a controlled project area where the existing pre-development conditions and proposed land use are essentially similar. Additionally, it is anticipated that the benefits of LID in maintaining and potentially restoring natural systems (i.e, isolated wetland areas and local groundwater levels) can be documented.

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