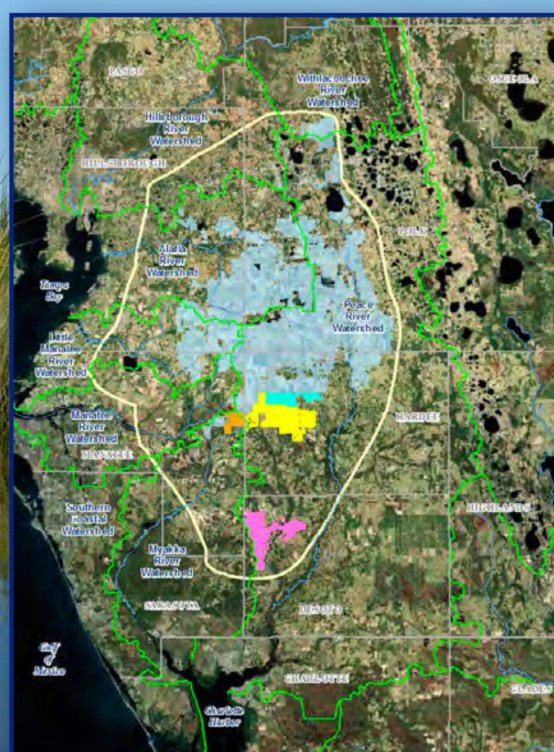
Chapter 3
Affected Environment



CHAPTER 3
AFFECTED ENVIRONMENT

This chapter provides a description of the environment that could be impacted through actions evaluated in this AEIS.

3.1 PHOSPHATE MINING IN THE CFPD

Review of the environmental features that can be impacted by phosphate mining requires an understanding of mining activities and infrastructure features. This affects the subsequent evaluation of the associated environmental effects, where and when they might occur, and how they can be avoided, minimized, or mitigated in accordance with applicable federal law.

Phosphate mining operations currently conducted by the phosphate mining industry in the CFPD fall into four major categories:

- Site preparation
- Matrix excavation and conveyance
- Beneficiation
- Waste management and mine reclamation

These activity categories and their potential environmental effects are described below. In addition, background information on the practicable distance for pumping phosphate ore from a mine to a beneficiation plant is provided.

3.1.1 Site Preparation

Mine site preparation activities typically include the following actions:

- Pre-clearing biological surveys, installation of erosion and sediment controls, and installation of monitoring wells and piezometers
- Land clearing and any special faunal or floral management actions or monitoring studies required to meet regulatory conditions stipulated in the applicable permits
- Major infrastructure development and equipment mobilization, including
  - Development of the primary infrastructure requirements (electrical power transmission lines, access roads, rail conveyance systems if applicable, utility crossings if applicable, surface water management systems/outfalls)
  - Installation of pipelines for water, matrix, clay, and sand conveyance

- – Mobilization of electric draglines
- – Construction of clay settling areas (CSAs)
- – Installation of water supply wells if applicable
- – Development of a beneficiation plant if applicable
- – Installation of ditch and berm systems at the mine boundaries to prevent uncontrolled offsite runoff and to maintain the water table to facilitate groundwater recharge to the adjacent streams and wetlands

For new mines, all of these elements are required prior to initiating overburden or matrix extraction and would be accomplished over several years. For extensions of existing mines, the new mining operations are generally integrated with the existing mine's infrastructure for at least a transitional period. For example, a new beneficiation plant might not be needed and existing CSAs with existing capacity would preferentially be used for handling clay materials from the mine extension. For new mines being developed adjacent to existing mines, the new mines can in some cases initiate operations using remaining CSA capacity of the adjacent mines, reducing the volume and overall footprint of new CSA construction.

Typically, site preparations are phased to be aligned with the specific mining units to be actively worked (mining blocks), which can be land areas of up to several hundred acres each. It is these mining blocks, or groups of mining blocks, where localized surficial groundwater management and excavation activities actually occur. These mining blocks also are the functional management units for many of the mine reclamation activities described below. There are unavoidable direct impacts on the land surface and associated natural resources from site preparation involving land clearing and infrastructure construction.

3.1.2 Matrix Excavation and Conveyance

The primary elements of typical dragline-based mining of phosphate ore in central Florida are shown schematically in Figure 3-1. Prior to mining, geologic exploration identifies the approximate depths of the ore body (known in the industry as the matrix) in the surficial aquifer at the mine site, and its relative thickness and quality. In the CFPD, access to the ore body, which consists of a combination of phosphate rock, clay, and sand, is typically achieved through excavations by dragline. In special cases (such as the Wingate Creek Mine), hydraulic dredging technologies have been used for excavation in place of draglines. Draglines and hydraulic dredges currently being used by the phosphate mining industry in the CFPD are electrically powered.

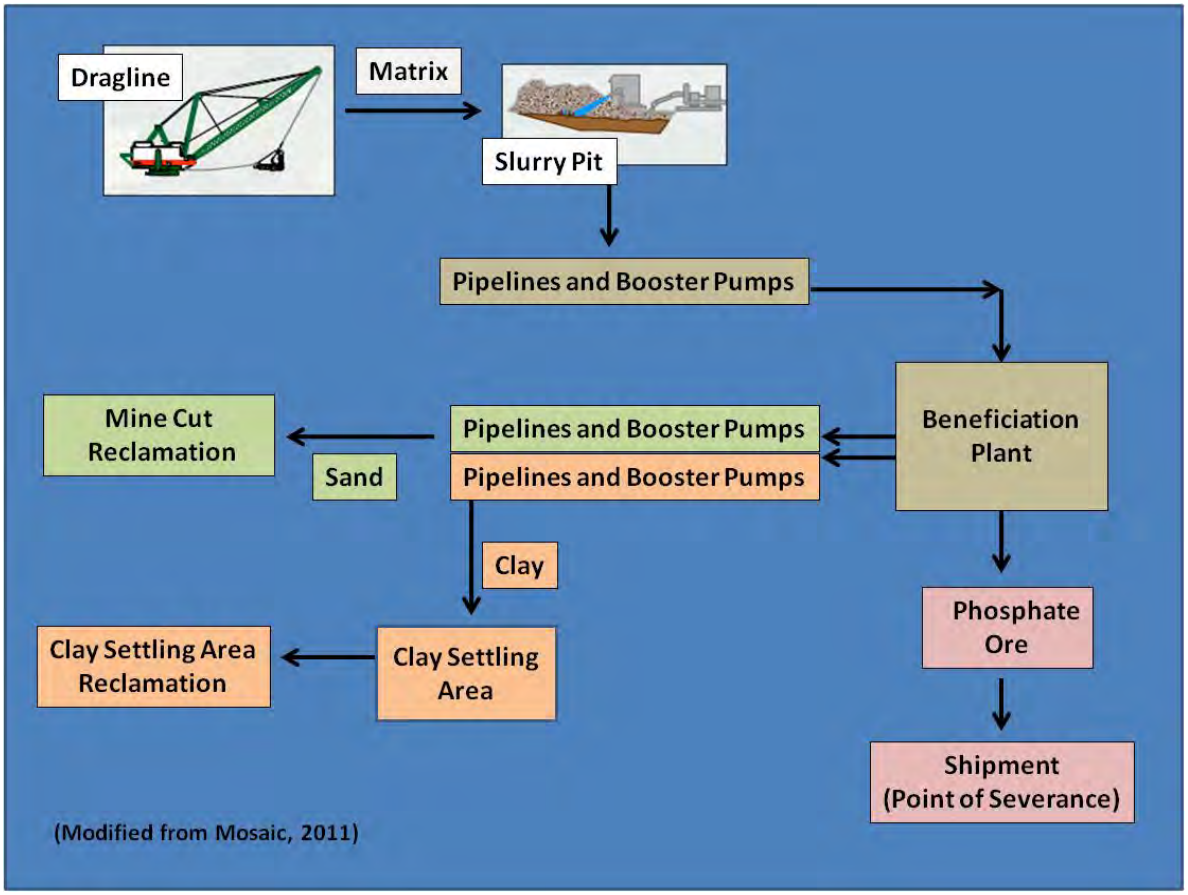


Figure 3-1. Typical Elements of a Dragline-Based CFPD Phosphate Mine Operation

Matrix excavation involves removing the overburden (the soils located above the mineable ore) and subsequently the ore matrix in parallel excavations or cuts in a mining block. Dewatering may be necessary to allow overburden removal and excavation of the matrix containing the phosphate ore. Groundwater dewatering for an active mining block is conducted through mine pit or shallow well pumping to achieve localized drawdown of the surficial aquifer system (SAS) on an as-needed basis.

The dragline excavates the overburden and side-casts it in spoil piles located in the previous dragline cut or on undeveloped ground. The dragline then excavates the ore body, and deposits it in an earthen pit adjacent to the dragline work site. High-pressure water guns are used to create a matrix slurry, which is pumped to the beneficiation plant through pipelines. Electric booster pumps are used to maintain slurry conveyance through the pipelines. The historical industry convention has been to limit the total length of these pipelines between the slurry pits and the beneficiation plants to 10 miles, with booster pumps located at approximately 1-mile intervals. The practicable distance for pumping phosphate ore from a mine to a beneficiation plant is discussed further below in Section 3.1.5.

The conveyance system booster pumps require a clean water source for pump seal maintenance. Historically, this supplemental water supply is obtained from adjacent ditches or from groundwater wells drilled into the intermediate aquifer system (IAS) or upper Floridan Aquifer System (FAS). When used, pump seal wells are generally of small diameter and capacity and are located along the major pipeline conveyance corridors. Some newer mine pipeline conveyance systems have been designed to minimize the need for sealing water wells. Regardless, most of the water used in the seals remains in the pipeline and becomes part of the overall onsite water inventory.

The mine's overall drainage and water recirculation system is a more substantive element of a mine's infrastructure. It includes the canals, ditch and berm systems, and CSAs used to manage the overall mine's surface water balance. This includes providing water to operate the beneficiation plant, to support the various pipeline operations used for conveying matrix to the beneficiation plant, and to convey sands and clays from the beneficiation plant to CSAs or mine cut reclamation areas. Managing the mine's drainage and recirculation system is a vitally important element of mine operations that affects how the mine impacts adjacent lands, downstream water bodies, and associated ecological systems.

The primary potential direct or indirect impacts to the affected environment of mine block dewatering (which is done prior to dragline excavation activities and other related drainage and recirculation system operations) are effects to surface water habitats and wetlands. Under the provisions of current water use permits from SWFWMD, the industry is required to provide infrastructure and groundwater best management practices (BMPs) to minimize the associated impacts on adjacent properties and/or habitats designated for hydrologic protection. However, the potential for such effects is an ongoing consideration and the reason for SWFWMD's dewatering monitoring requirements and BMP provisions that are now incorporated into water use permit conditions.

3.1.3 Beneficiation

Beneficiation is the process of physically separating the phosphate rock from the sand and clay materials in the matrix. As mined, the phosphate and sand particles are embedded in compacted mud (phosphatic clay). During beneficiation, all the phosphate and sand particles must be separated from the clay material. This process starts at the mine cut, where the excavated matrix is converted to a slurry with high pressure water sprays, and to a lesser extent while the matrix slurry is flowing through the pipeline from the mine cut to the beneficiation plant. While in the pipeline, the matrix is exposed to shear forces as it passes through the various booster pumps. The combination of slurrying and transport causes a significant percentage of the sand and phosphate particles to be liberated from the clay by the time they arrive at the plant.

Beneficiation involves several steps, including washing the material through screens to separate coarse phosphate rock from sand and clay and various flotation steps in which water is used to separate sand-sized phosphate and silica. Specific chemicals ("reagents") are applied to allow the flotation processes to

selectively remove the phosphate ore from the sand (Metcalf & Eddy/AECOM, 2007). The overall objective of beneficiation is to sort the phosphate ore from the clay and sand materials. As described in the following section, the sand and clay materials are retained on the mine site. The ore produced is shipped from the mine site, typically by railroad or truck.

The water used in beneficiation is recycled and used to support conveying clay to CSAs and sand to sand storage areas and/or mine reclamation sites. Several concerns exist regarding beneficiation water. One relates to the ultimate fate and potential environmental effects of the chemical reagents used to support the flotation steps. Another concern is whether beneficiation liberates trace metals from the matrix that might find their way into mine surface water management systems and subsequently to waters of the state through the mines' permitted NPDES discharge outfalls. Because of these mining-related processes, and their close relationship to the use and reuse of the mine's recirculation system waters, offsite discharge of water and potentially elevated concentrations of mining-related pollutants was an issue expressed by stakeholders during the AEIS scoping process.

Historically, phosphate mining operations have used industrial water supply wells installed in the FAS to provide supplemental water for the beneficiation process and/or recirculation system on an as-needed basis. While water conservation and reuse have improved over time, using FAS wells remains an element of phosphate mining. The potential effect of this use on the FAS is one of the key issues raised during the AEIS scoping process. This chapter addresses the existing FAS conditions as a basis for evaluating how mining water supply withdrawals from the FAS contribute to the regional aquifer drawdown impacts in this portion of SWFWMD's jurisdictional area.

3.1.4 Waste Management and Mine Reclamation

The last major component of phosphate mining, as currently conducted in the CFPD, includes managing clay and sand tailings from the beneficiation plant. Clay slurries are pumped through pipeline/booster pump systems to dedicated CSAs, which are typically 400 to 600 acres. Earthen levees are constructed around selected mined areas to create impoundments to receive waste clays as the matrix is processed at the beneficiation plant. The extremely fine-grained clay slurry has slow consolidation rates; therefore, large settling basins are required to achieve material settling and water clarification. Typically, CSAs are developed to service an extended period of mine operations--on the order of decades.

Multiple CSAs are needed to support a given mine; in the aggregate, CSA footprints historically have represented up to 40 percent of a mine's total acreage at the completion of the life of the mine. CSA designs have changed over time, with more modern designs resulting in a lower percentage of the overall mine area being dedicated to these storage areas. Additionally, the relative sand/clay/phosphate ore content of the matrix varies, with relatively lower clay percentages encountered in the southern portions of

the CFPD. This has contributed to lowering the CSA fraction of the total mine acreage, as reflected in the Ona and Desoto Mine plans.

Currently applied BMPs for CSA operations involve multiple phases of filling and consolidation that result in expanded CSA storage capacity with a smaller footprint and reduced time required to achieve CSA reclamation when its service life has been expended. Reclaiming CSAs following consolidation still requires extended periods of time. Eventually, perimeter levees are graded to provide a more gradual topographic transition to adjacent lands and vegetative cover is established. The physical characteristics of the materials deposited and consolidated in CSAs present subsequent land use option limitations. To date, most CSAs have been returned to some form of agricultural land use that does not require weight-bearing structures. Some of the key issues for the affected environment addressed in this AEIS are the relative rate of CSA reclamation and the physical characteristics of the reclaimed land areas in relation to potential residual effects on recharge rates for the SAS and/or runoff rates contributing to streams and downstream river reaches.

The other waste material coming out of the beneficiation plant is the sand separated from the matrix. The traditional approach for sand management has been to re-slurry it and pump it through the pipeline/booster pump infrastructure to mining blocks scheduled for reclamation per state of Florida mine reclamation rules. Some of the key issues regarding the affected environment are the relative rate of mine block reclamation with this sand material and the physical characteristics of the reclaimed land areas as compared to native, un-mined lands--again in relation to potential residual effects on recharge rates for the SAS, aquifer flow characteristics, and/or runoff rates contributing to streams and downstream river reaches.

As explained in Section 1.3.1, the mineral processing plants that produce phosphogypsum as a byproduct, and the phosphogypsum stacks associated with those facilities, are considered by the USACE to have independent utility from the phosphate mining activity. However, there are processing facilities and phosphogypsum stacks in the CFPD, and therefore the purpose of this section of Chapter 3 is to provide information on this part of the affected environment.

Currently there are 22 gypsum stacks in the CFPD: of these, 4 are active, 14 are closed, and 4 are inactive and are in the process of being closed (FDEP, 2013a). Only one stack discharges in the Peace River watershed, to Whidden Creek, and it is in process of being closed (inactive); no stacks are located in the Myakka River watershed.

3.1.5 Practicable Pumping Distance for Phosphate Ore

The USACE did not consider the practicable distance for pumping phosphate ore from a mine to a beneficiation plant during the alternatives screening described in Chapter 2. However, during the screening process, when a screening step resulted in elimination of the specific environmental or

avoidance features that were of interest, some alternatives were below the minimum practicable mine size of 8,100 acres. While these were eliminated as a reasonable alternative for more detailed evaluation in the AEIS, if they were within a practicable distance for pumping phosphate ore from a mine to an existing beneficiation plant, it was noted that these areas could be considered in the future as either in-fill areas or extensions for future mining. The USACE also did not consider the practicable distance for pumping phosphate ore in its alternatives evaluation in Chapter 4 for similar reasons. In both cases, the USACE's intent was to avoid further limiting the number of alternatives being considered in the AEIS. However, the USACE may use the practicable distance for pumping phosphate ore from a mine to a beneficiation plant in its further evaluations of the Applicants' Preferred Alternatives, either as part of its review under NEPA or as part of its review pursuant to Section 404(b) (1) guidelines (40 CFR 230). Therefore, the USACE is presenting this information here for reference.

The Applicants assert that 10 miles should be accepted as the furthest practicable distance for pumping phosphate ore from a mine to a beneficiation plant, measured radially, because of the costs, technological limitations, and logistics associated with transporting the phosphate matrix beyond that distance. The USACE acknowledges that if phosphate mines are not within a practicable pumping distance of a beneficiation plant, a new beneficiation plant will be required. Additionally, the USACE recognizes that any alternatives for mine expansions must be within a practicable pumping distance of the existing beneficiation plant. As identifying a practicable pumping distance has the effect of limiting alternatives, especially with respect to mining expansions around existing beneficiation plants, the USACE evaluated whether it would be practicable to pump phosphate ore further than 10 miles. This evaluation included independent verification of publications from the Florida Industrial and Phosphate Research Institute (FIPR Institute) and of information provided by the Applicants in support of their claim.

The FIPR Institute has performed multiple studies on different aspects of phosphate matrix transport, including reviewing the effect of modifying the matrix slurry densities (GIW Testing Laboratories, 1989), of using alternative pump types (GIW Industries, 2005; GIW Industries, 2009), and of using a conveyor system in place of pipelines to transport the phosphate matrix (Rail-Veyor Technology, 2002). Additionally, the FIPR Institute sponsors a Pumping Course to educate the industry on pumping procedures and technology.

Phosphate ore transportation in the CFPD is done by slurry pipeline. In this process, the ore is mixed with water to create slurry. This slurry is pumped through a pipeline to the beneficiation plant for further processing. Typical slurry pipelines in the CFPD are 18 to 22 inches in diameter and have the capability to transport 1,000 to 1,800 tons per hour (TPH) of solids. Phosphate slurry is different than most other materials that are pumped due to the particle size distribution and characteristics of the ore. Other long pumping systems handle liquids, gas, or uniformly sized material that has been ground to a very fine consistency. Phosphate ore, as it is pumped, contains rock particles from 8 inches in diameter down to

clay size material. This variation in particle size requires high slurry velocities to keep the larger particles from settling to the bottom and choking the pipeline. Centrifugal slurry pumps are utilized to handle this variation in particle size. These pumps are typically equipped with up to 54-inch impellers and motors ranging from 1,250 to 2,000 horsepower. Due to the nature of the slurry, it is necessary to place booster pumps along the pipeline route. These boosters are routinely spaced 4,000 to 6,000 feet apart, with the average being about 1 mile. The centrifugal pumps break up clay balls, facilitating the separation of materials at the beneficiation plants. The present systems transport slurry ranging from 30 to 35 percent solids. If the 35 percent solids contained only 25 percent by weight phosphate, then every ton of matrix moved in a pipeline would contain only 0.09 ton of phosphate rock per ton of slurry moved and 0.65 ton of water.

The Applicants report that the costs of the operation/maintenance of these pipelines increase proportionally as the pipeline lengths increase. Specifically, "Maintenance and repair requirements are proportional to transportation pumping distances or pipe lengths. Longer distances result in higher capital, operating, and power costs. An example of the additional cost is that booster pumps are required for matrix and sand tailings slurry pipelines nominally at a one pump per mile spacing. These booster pumps and associated electrical gear cost approximately $1 million each; therefore, distances greater than about 10 miles between the ore deposit/tract and the beneficiation plant result in additional costs of more than $10 million for the additional pumps, electrical gear, pipelines and set-up."

In 1999, the FIPR Institute analyzed the costs of the pipeline slurry system as a function of distance. The capital costs associated with constructing a slurry pipeline system increased from $5 million for a 1-mile pipeline to over $16 million for a 10-mile pipeline. Additionally, operating costs rose from $2.5 million at 1 mile to $7.5 million at 10 miles. These costs do not take into account energy costs, which the FIPR Institute study estimated to range from 0.64 to 0.77 kilowatt hour (kWh) per ton-mile in the following comparison:

- Pipeline: Given a 20-inch pipeline moving 1,900 TPH at 35 percent solids = 17,000 gallons per minute (gpm) or 17.5 feet per minute (fpm) with a friction loss 4.0 feet head/100 feet = 0.77 kWh/ton-mile.

- Using the same comparison, a pipeline moving 1,700 TPH at 35 percent solids = 15,300 gpm at 15.6 fpm with a friction loss 3.3 feet head/100 feet = 0.64 kWh/ton-mile.

The FIPR Institute studies support the Applicants' statements that costs increase significantly with increased distance the material has to be transported. In a 2009 study on centrifugal slurry pump concentration limit testing (Publication No. 04-069-233), the FIPR Institute states that "the energy cost for long-distance pumping of such a huge amount of slurry is tremendous. During its peak production years, the Florida phosphate industry consumed about 4 billion kWh of electricity annually, equivalent to

$200 million at a price of five cents per KWH. Slurry pumping is believed to account for about one third of the total energy consumption" (GIW Industries, 2009).

There are other technological and logistical factors that show increased difficulty with maintaining and managing pipelines as pipeline distances increase. For example, as pipelines become longer, there is an increased chance for breakdown and required maintenance among the additional pumps. A short pipeline using only one pump could be expected to operate 95 percent of the time, with a 5 percent maintenance requirement. Lengthening that line to require two pumps could decrease the effective operation to 90 percent of the time, as each pump would still operate 95 percent of the time, but there would then be twice the number of pumps to maintain and twice the likelihood of a breakdown that would affect the system. While some of the required maintenance could be done in an overlapping fashion (at the same time), some of the maintenance or a breakdown in service would occur such that only one pump would be left operating, causing the entire pipeline to be shut down. The operational time of a two-pump system could decrease to as low as 90.25 percent (95 percent of 95 percent = 90.25 percent). A pipeline with six pumps could have its operational time decrease to as low as 74 percent (six pumps operating at 95 percent each). For a pipeline with 12 pumps, the operational time could decrease to as low as 54 percent (95 percent for each of the 12 pumps). Other factors that cumulatively affect the viability of long pipelines for slurry transport include the following:

- Longer systems require more startup and washout time. This wastes energy and lowers production capacity. Greater lengths of exposed pipeline have a greater chance of developing leaks.
- Longer pumping systems are subject to more and higher pressure surges that can cause leaks and equipment damage.
- More protective berms and inspections are required to protect against these increased upset conditions.
- More monitoring and instrument maintenance are required due to the increase in upset conditions.
- Proportionally more time is spent to transport employees to and from their work location, by supervisors traveling between work sites, and by maintenance and operations field personnel traveling from one job to the next. The travel time increases costs, increases personnel requirements, and lowers productivity.
- Mine power systems are more vulnerable to lightning and wind damage as they become more dispersed and cover larger areas in support of the longer pipelines. This means more downtime, higher cost, and lower production compared to shorter pipelines.

- Safety can be affected by:
  - The requirement for more miles to be driven over unpaved mine roads that cross pipelines, railroads, highways, bridges, etc.
  - The need to travel longer distances, increasing response time to medical or accident emergencies.
  - The presence of increased leaks, which can lead to increases in slips and falls for employees working to correct the spill.
- Reclamation is made more difficult because of the following:
  - Long pumping distances require long corridors for pipelines, power lines, and access roads. These corridors are mined in a retreating fashion toward the plant. Costs increase as these corridors are reclaimed because more hauled fill and earthwork are necessary to place fill material to comply with reclamation plans and standards.

The Applicants have stated that costs and logistics associated with pipelines make a 10-mile radial distance from a beneficiation plant the practicable pumping distance to that plant. The concern has been raised that a 10-mile pumping distance is in place simply to limit potential mining alternatives around existing beneficiation plants. However, as high as the costs of pipelines may be, the costs of new beneficiation plants are at least as substantial. For example, construction costs alone for the CF Industries beneficiation plant in 2003 were approximately $135 million. Mosaic estimates that total costs for its proposed beneficiation plant would be as much as $900 million. The FIPR Institute has focused significant study on increasing the efficiency of transporting slurry from mine sites to beneficiation plants, which is in the mining companies' interests to do given that the plants cannot be moved once located and investment in a new plant is costly.

Ultimately, the greater the pumping distance around any one beneficiation plant, the more area that beneficiation plant has access to for mining and the less need there is for investing in a new plant. For example, a beneficiation plant with a 5-mile pumping distance would have a potential mining area of 78.5 square miles (50,240 acres), whereas a plant with a 10-mile pumping distance would have a potential mining area of 314 square miles (200,960 acres). It would require four beneficiation plants with a 5-mile pumping distance to cover the same area as the plant with the 10-mile pumping distance. A plant with a 15-mile pumping distance would have 706 square miles (452,100 acres) and would be equivalent to two plants with a 10-mile pumping distance (i.e., twice the area could be accessed if the pumping distance could be increased from 10 to 15 miles).

The ±20 CFPD mines that have operated in the last 30 years have typically mined reserves within a 10-mile radius from their beneficiation plant. Although there are rare exceptions, 10 miles is the industry

standard. Given the high quantities of material transported, the infrastructure and maintenance costs, the energy and water costs of transporting material, and the costs associated with beneficiation plants, the USACE has determined that the 10-mile pumping distance is the practicable pumping distance for a beneficiation plant given current technology.

3.2 MINE EXTENSIONS AND NEW MINES

The Applicants' Preferred Alternatives being evaluated in this AEIS consist of two similar categories of phosphate mines: mine extensions (South Pasture Extension and Wingate East) and new mines (Ona and Desoto).

Mine extensions are projects that represent continuations of existing mines. They consist of mining new land areas and conveying the mined material to existing beneficiation plants. At least some of the existing mining infrastructure, including infrastructure corridors and CSAs, supports the activities for the mine extensions' full life cycle. For both of the Applicants' mine extensions in their applications, the existing beneficiation plants at South Pasture and Wingate Creek would serve as the matrix sorting and product export locations for the duration of the extensions' life cycles. For these two mine extensions, existing CSAs and recirculation systems would support some of the new mining operations.

A new mine is independently developed and operated at a site requiring mostly (or completely) new mining infrastructure and operations plans. In the case of the Ona Mine, there would be initial integration with the adjacent existing Fort Green Mine's infrastructure, with an ultimate shift to the new mine's infrastructure and operations, including a new beneficiation plant. The Desoto Mine would require all new infrastructure and operations. With any new mine, there is a much greater focus on developing new CSAs, beneficiation plant infrastructure, and mine infrastructure such as utility and dragline corridors, water management systems, and other support systems than for a mine extension.

3.3 KEY NATURAL AND HUMAN RESOURCES OF CONCERN

3.3.1 Surficial Geology and Soils

This section summarizes the regional geology and soils characteristics. Effects on surficial geology and soils can influence localized water resources. The interaction of unconsolidated soil layers with lower rock-dominated layers affects soils storage of water, and infiltration to recharge the underlying aquifers. Because the CFPD ranges from higher elevation landscapes in the north and east with gradual land surface gradients dropping to the south and west toward the Gulf of Mexico, the intersection of some of these rock and soil layers with surface waters affects regional hydrology.

3.3.1.1 Regional Geologic Setting in Relation to Phosphate Resource Presence

Various agency reports on southwest Florida have characterized the general geologic characteristics of the AEIS study area. A report prepared by URS, Inc. (URS), on behalf of the Charlotte Harbor National Estuary Program (CHNEP) (URS, 2005), presented a typical section of rock layers and associated aquifer units (see Figure 3-2). The Bone Valley Member near the top of the Peace River Formation of the Hawthorn Group is the geologic unit where the highest quality phosphate deposits have been found.

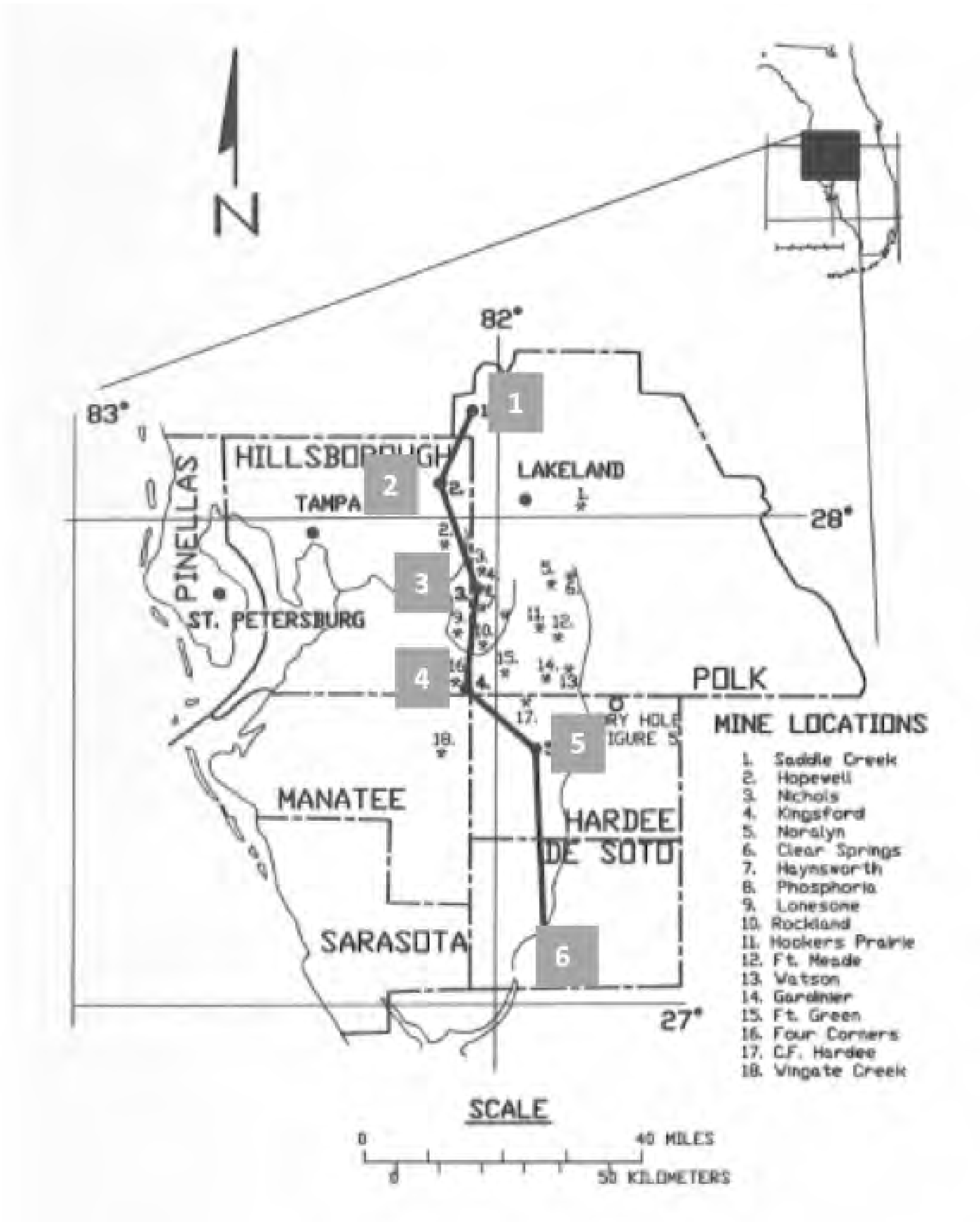
System	Series	Lithostratigraphic Unit	Hydrogeologic Unit	Generalized Lithology
Quaternary	Pleistocene	undifferentiated sand, shell, and clay	surficial aquifer	Highly variable lithology ranging from unconsolidated sands to clay beds with variable amounts of shell fragments, gravel-sized quartz grains and reworked phosphate
Tertiary	Pliocene; Miocene	Hawthorn Group: Bone Valley Member; Peace River Formation	intermediate aquifer system and/or intermediate confining unit	Interbedded sands, clays and carbonates with siliciclastic component being dominant and variably mixed; moderate to high phosphate sand/gravel content
Tertiary	Miocene; Oligocene	Hawthorn Group: Arcadia Formation; Tampa Member; Nocatee Member	intermediate aquifer system and/or intermediate confining unit	Arcadia formation is a fine-grained carbonate with low to moderate phosphate and quartz sand; variably dolomitic Tampa member is a sandy, low phosphate wackestone; Nocatee member is a clayey, carbonate, mud-bearing sand with low amounts of phosphate
Tertiary	Oligocene	Suwannee Limestone	Floridan aquifer system: upper Floridan aquifer	Fine-to-medium grained packstone to grainstone with trace organics and variable dolomite and clay content
Tertiary	Eocene	Ocala Limestone	Floridan aquifer system: upper Floridan aquifer	Chalky, very fine-to-fine grained wackestone/packstone varying with depth to a biogenic medium-to-coarse packstone grainstone; trace amounts of organic-grained material, clay, and variable amounts of dolomite
Tertiary	Eocene	Avon Park Formation	Floridan aquifer system: upper Floridan aquifer	Fine-grained packstone with variable amounts of organic-rich laminations near top; limestone with dolostone interbeds typical in upper part; deeper beds are continuous dolostone with sulfate near base

Source: URS, 2005

Figure 3-2. Generalized Stratigraphy and Hydrostratigraphy of Southwest Florida in the CFPD Study Area

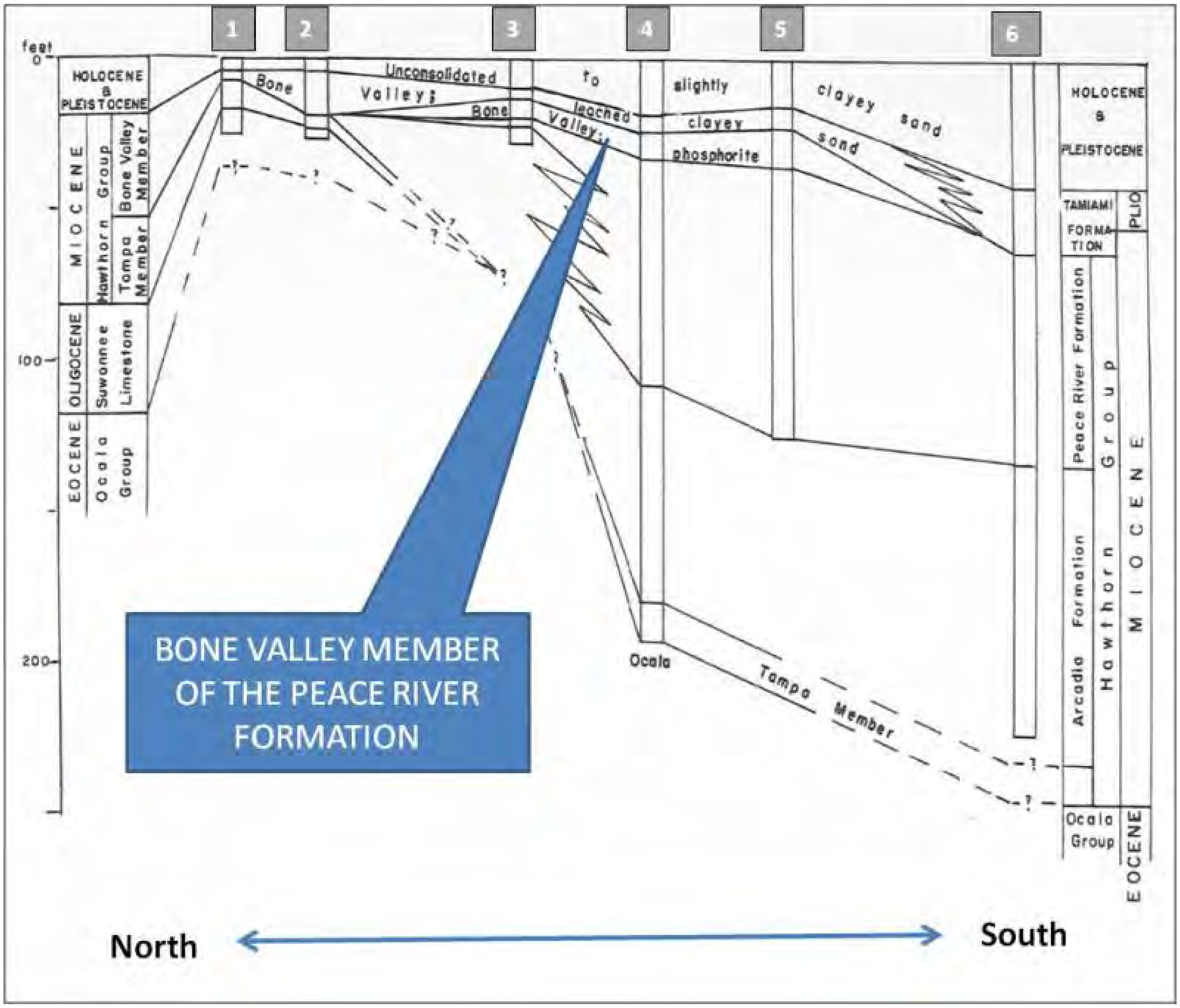
The approximate depth of the Bone Valley Member below the ground surface varies from north to south and east to west in the study area. In a Phosphate Deposit Field Guide (Scott and Cathcart, 1989), information on the estimated depths to economically mineable deposits in the CFPD was presented along a north to south transect through the study area. The approximate locations of the core borings are shown in Figure 3-3. The generalized lithologic diagram shown in Figure 3-4 indicates that the mineable ore tends to be found ever deeper when moving from north to south along the transect evaluated. This figure also reflects how the historical locations of phosphate mines in the study area have been concentrated in the vicinity of the area where the phosphate reserves were most likely to be accessible. The generalized cross section through the CFPD shown in Figure 3-5 indicates that the Peace River Formation is found deeper as one moves toward the eastern and western boundaries of the CFPD,

suggesting that mineable resources typically found at the uppermost portion of this formation would be less accessible to traditional mining technologies nearer to the CFPD boundaries.



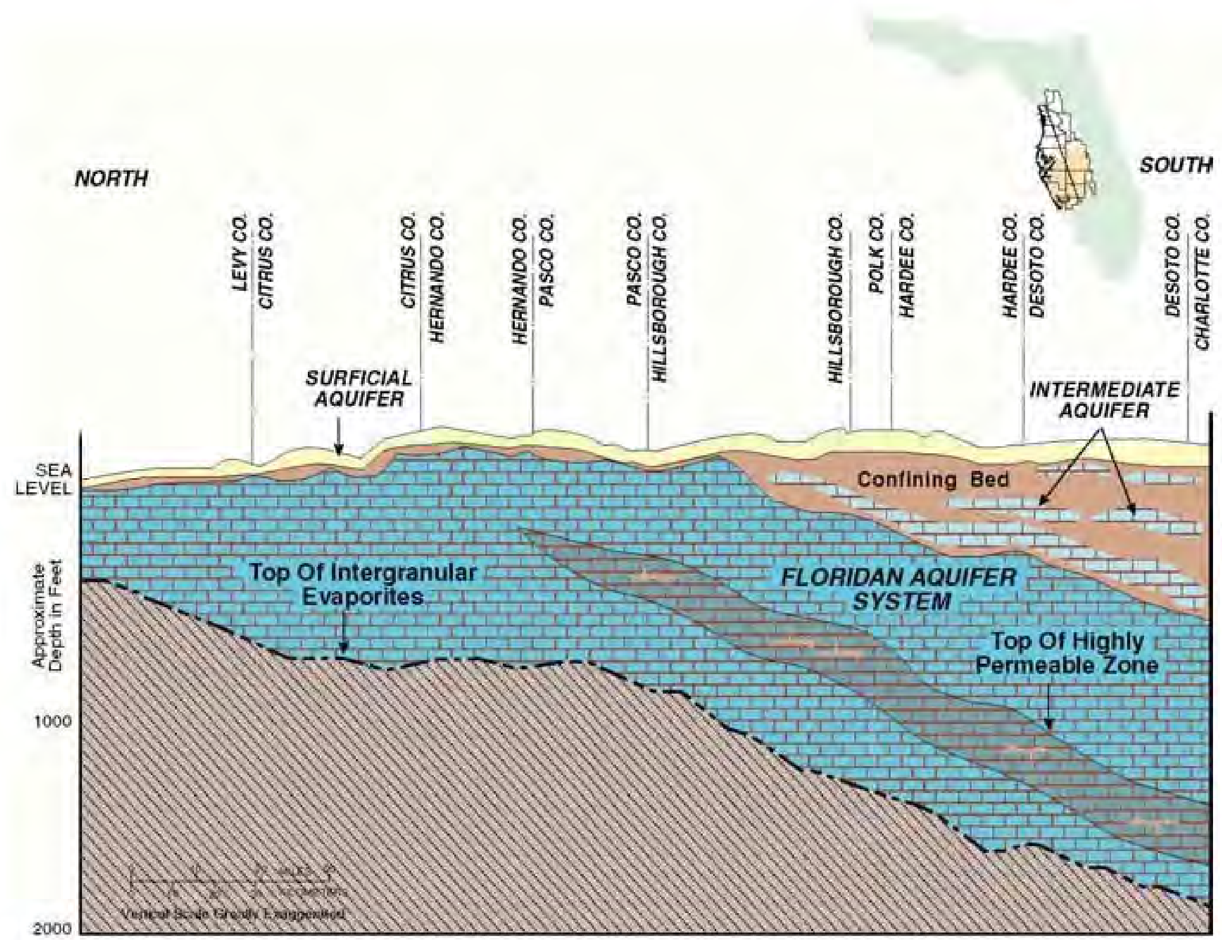
Source: Scott and Cathcart, 1989

Figure 3-3. Locations of Cores Evaluated on North – South Transect through the CFPD

1 

2 *Source: Scott and Cathcart, 1989*

3 **Figure 3-4. Phosphate Deposits and Depth Relationships in the CFPD**

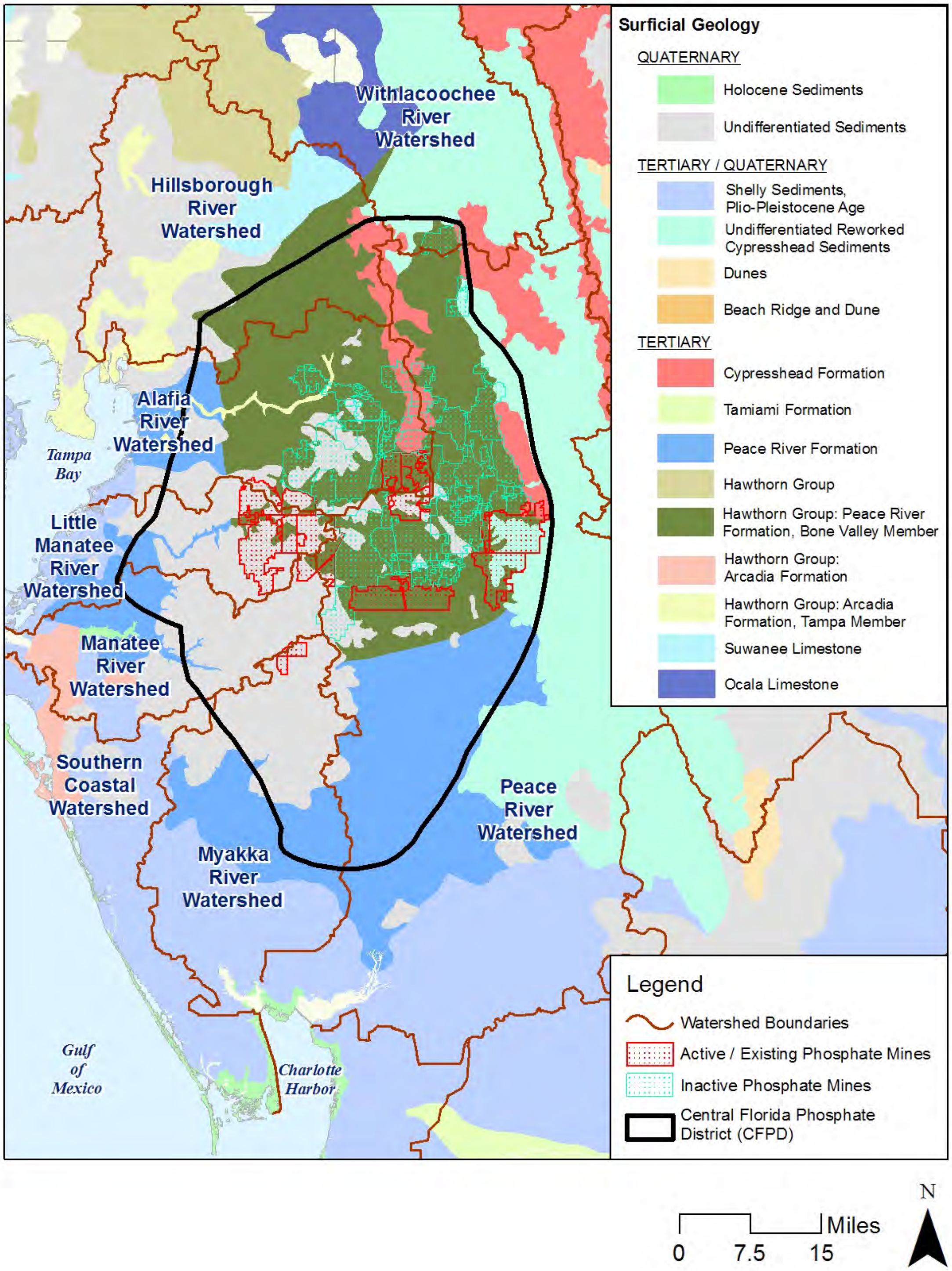


Source: SWFWMD, 2006a

Figure 3-5. Generalized Geologic Cross-Section of the AEIS Study Area

3.3.1.2 Locations of Historical Phosphate Mine Development

Figure 3-6 shows the locations of historical and ongoing phosphate mining in the CFPD relative to the various surficial geologic formations (as mapped by the Florida Geological Survey) and the major watersheds within and adjacent to the CFPD. Historically, phosphate mining has been most intensively conducted within the Alafia, Little Manatee, Manatee, and Upper Peace River watersheds in the northern and central portions of the CFPD. Surficial geology of the Alafia River watershed in the CFPD contains substantive deposits of phosphate in the Bone Valley Member of the Hawthorn Group/Peace River Formation. Surficial geology in the Little Manatee and Manatee River watersheds in the CFPD is characterized by undifferentiated Holocene sediments underlain by the Peace River Formation.



Source: Modified from Florida Geological Survey, 2008

Figure 3-6. Surficial Geology, Locations of Historical and Ongoing Phosphate Mining, and Major River Watersheds in the AEIS Study Area

In the CFPD, the northern half of the upper Peace River watershed's surficial geologic deposits include sand and clayey-sand sediments of the Pliocene Cypresshead Formation to the east and the sand, silt, and clay of the Bone Valley Member of the Miocene/Pliocene age Hawthorn Group to the west. Further to the south, the middle Peace River watershed includes the Cypresshead Formation on the east, and the sands, clays, and carbonates of the Miocene/Pliocene age Peace River Formation on the west in the CFPD. The lower Peace River watershed, most of which is outside of the CFPD, consists primarily of undifferentiated shelly sediments of Pliocene/Pleistocene age.

Surficial geological formations in the Myakka River watershed include undifferentiated Pleistocene/Holocene age sediments in the northern reaches. The central portion of the Myakka River watershed includes the Peace River Formation whereas the southern portion nearest to the coast is similar to the lower Peace River watershed, consisting primarily of shelly Pliocene/Pleistocene sediments.

The above geospatial relationships are relevant to this AEIS in that they help characterize where phosphate mineable ore reserves are most likely to be found in the CFPD. The reserves tend to be located deeper in the study area as one moves to the south and also to the eastern and western extremities of the CFPD. Because the traditional approach to phosphate mining in the CFPD is based on dragline excavation, there are depth limitations that must be factored into mine planning by the industry.

3.3.1.3 Soil Characteristics of the CFPD

The near-surface soils characteristics are critically important in relation to evaluating phosphate mining effects. Soil characteristics have a major influence on how rainfall infiltrates into the ground and how it drains as surface runoff to wetlands or associated surface water conveyances (streams and rivers) or to impoundment type water bodies (ponds or lakes). Native soils unimpacted by land clearing and use by man for agricultural, industrial, residential, or any other development-related activity allow for natural runoff and rainfall infiltration conditions. Once the land surfaces are modified to support any form of anthropogenic uses, those native soil characteristics are changed. This often leads to decreased infiltration and increased runoff, and ultimately to modified water balance conditions for the impacted land areas and downstream or downgradient surface water systems.

Understanding the range of soil characteristics of lands in the CFPD is a key element of describing the affected environment in the study area. The Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture (USDA) places soils in four hydrologic groups (A, B, C, or D) depending on two key factors:

- Their ability to transmit water
- The depth to a seasonal water table

These groups are described further as follows:

- Group A soils are characterized by having low runoff potential when thoroughly wet and transmitting water freely through the soil. Group A soils typically have less than 10 percent clay, more than 90 percent sand or gravel, and gravel or sand textures.
- Group B soils are characterized by having moderate to low runoff potential when thoroughly wet, and with unimpeded water transmission through the soil. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures.
- Group C soils are characterized by having moderate to high runoff potential when thoroughly wet, and with somewhat restricted water transmission through the soil. Group C soils typically have between 20 percent and 40 percent clay, less than 50 percent sand, and loam, silt loam, sandy clay loam, clay loam, or silty clay loam textures.
- Group D soils are characterized by having high runoff potential when thoroughly wet, and with restricted or very restricted water movement through the soil. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures.

Some soils have characteristics that are a blend of the above four groups. Such “dual hydrologic soil groups” are designated by a combination of the letters. For example, Group A/D soils are characterized by being wet soils and are placed in Group D based solely on the presence of a water table within 24 inches of the surface, even though the saturated hydraulic conductivity may be favorable for water transmission when unimpeded. If these soils could be adequately drained, they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the un-drained condition. By standard practice and convention, dual groups are assumed to be type D soils for design and permitting purposes. However, for characterizing long-term runoff, this assumption may be too conservative, particularly in a sub-basin where the interaction with groundwater is known to vary.

The “soil types by hydrologic group layer” GIS coverage was acquired from the NRCS databases (2000-2010). Soils data in these databases were mapped for the CFPD counties between 2000 and 2010. Table 3-1 presents the acreage and percent of area for each soil hydrologic group for the CFPD, with additional details on conditions in the Peace River basin and the Myakka River basin where the potential for future phosphate mining expansion in the CFPD appears to be the greatest. A soil hydrologic group map of the study area is presented in Figure 3-7. The CFPD is categorized by having mostly sandy poorly drained soils, which contribute less to runoff and surface water flows and more to infiltration and groundwater recharge depending on the groundwater levels. The predominant soil hydrologic groups in the CFPD are Group A and A/D, with 30 and 38 percent cover, respectively. Only 5 percent of the CFPD is of D type soils.

The coverages of B/D and C/D soils are 12 and 11 percent, respectively. These reflect the presence of wetlands that have high water tables.

Table 3-1. Acreage and Percent Soil Hydrologic Groups Coverage in the CFPD, Peace River Basin, and Myakka River Basin

Soil Hydrologic Groups	CFPD		Peace River Basin		Myakka River Basin	
	Acres	% Cover	Acres	% Cover	Acres	% Cover
A	403,326	30%	274,178	18%	21,824	6%
B	1,746	0%	9,605	1%	2,546	1%
C	868	0%	939	0.1%	0	0%
D	62,578	5%	36,763	2%	57	0%
A/D	514,292	38%	730,469	49%	238,021	63%
B/D	158,027	12%	227,008	15%	17,537	5%
C/D	150,002	11%	149,553	10%	92,909	25%
OTHER	58,044	4%	60,452	4%	4,433	1%

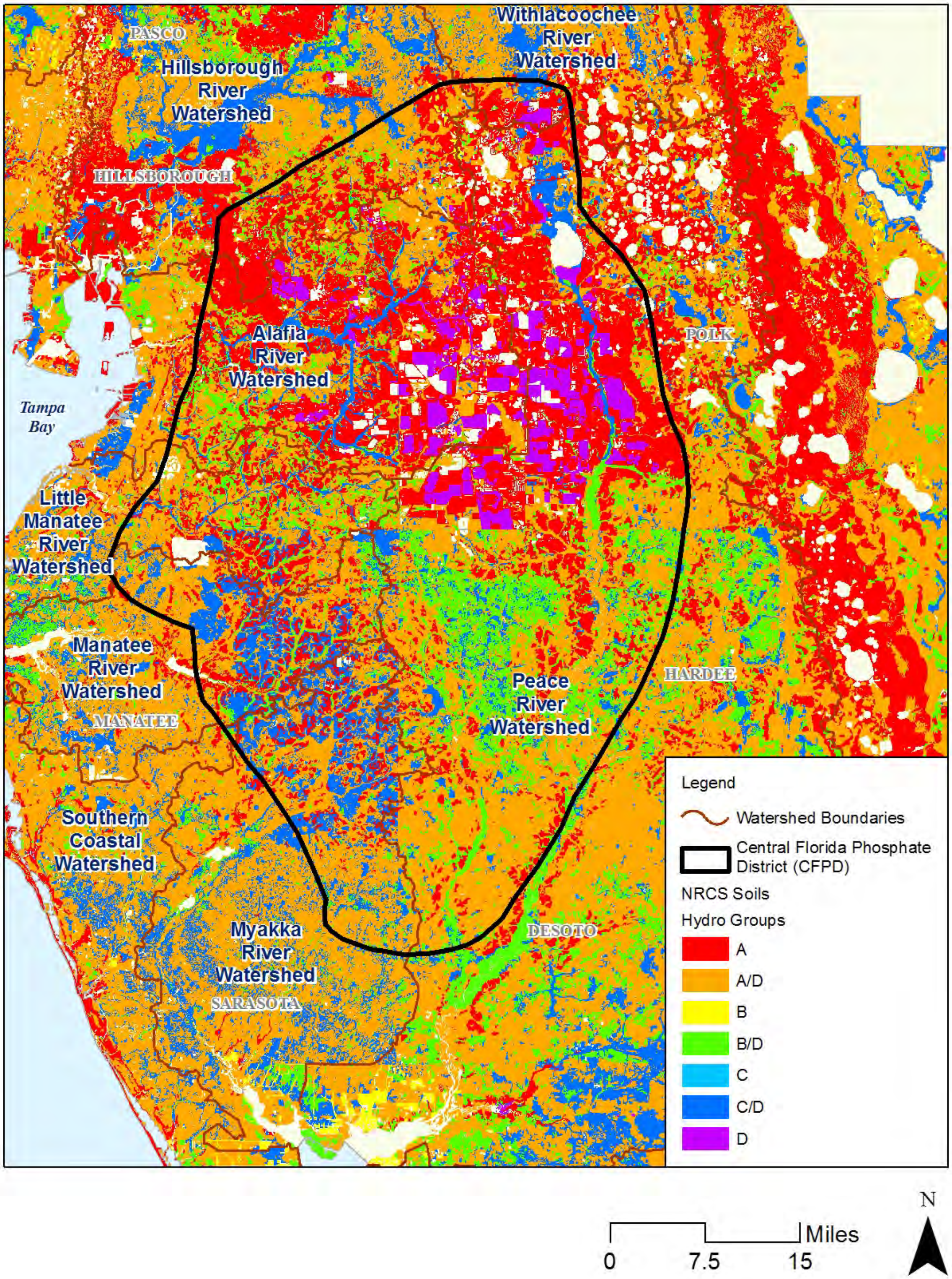
Source: NRCS, 2000-2010

The Applicants' Preferred Alternatives are located in the lower Peace River and Myakka River basins. Accordingly, these basins warrant particular mention.

In the Peace River basin, the predominant soil group is A/D, with a total cover of 49 percent. Although these are sandy soils, they are characterized by having high groundwater levels. Soil hydrologic group A covers approximately 18 percent of the Peace River basin. Soil groups B, C, and D cover only 1, 0.1, and 2 percent of the basin, respectively. Hydrologic groups B/D and C/D cover 15 and 10 percent, respectively. This basin is characterized as having high groundwater levels in most of the basin, especially in areas with dual hydrologic group soils, which means that the potential for runoff and the presence of wetlands can be significant.

In the Myakka River basin, the predominant soil group is A/D, with a total cover of 63 percent, followed by soil group C/D with a total cover of 25 percent. The next most common hydrologic group is A, with only 6 percent cover. With this distribution of hydrologic groups, this basin is also characterized as having a high groundwater table and a significant presence of wetlands. Runoff potential for this basin is high.

These characteristics are pertinent to future evaluation of the potential change in mine area runoff characteristics following mining and mine reclamation, as addressed in Chapter 4.



Source: NRCS, 2000-2010

Figure 3-7. Distribution of Surface Soil Hydrologic Groups in the CFPD

Among the tasks that are pertinent to understanding study area soil characteristics is identifying the potential presence of important agricultural soil types in the project area. For a NEPA evaluation of a proposed activity comparable to phosphate mines, where large acreages of agricultural lands would be impacted by a proposed action, the review of the study area soils information must also address the presence of soils of special value in terms of agricultural production. The following three categories are included: prime farmlands, unique farmlands, and soils of state-wide importance.

Prime farmlands are defined as agricultural soils that have a combination of physical and chemical characteristics that are highly suitable for producing food, feed, forage, fiber, and oilseed crops (7 CFR § 657.5(a)). Most of Florida's prime farmlands are in the north and western part of the state (Brown, 1992). There are no prime farmlands in the CFPD (NRCS, 2012a).

Soils classified as "unique farmland" by the USDA are those lands other than prime farmland that are used for producing specific high-value food and fiber crops (7 CFR § 657.5(b)). Most of Florida's unique farmlands occur in the central and southern part of the state (Brown, 1992).

Soils classified as "soils of statewide importance" by the USDA are those that are nearly prime farmland and economically produce high yields of crops when treated and managed according to acceptable farming methods (7 CFR § 657.5(c)).

Table 3-2 summarizes the inventory of soil characteristics in the overall CFPD based on an evaluation of the soil types categorized in the NRCS database for the counties in the study area. This review supports the finding that there are no prime farmlands in the study area that are likely to be impacted by the four mines in the Applicants' Preferred Alternatives. However, these data also indicate that in the study area, the unique farmlands designation applies to 3 percent of the DeSoto County acreage, 47 percent of the Manatee County acreage, and 50 percent of the Hillsborough County acreage.

3.3.2 Water Resources

Water resources in the AEIS study area are a critical element of the natural systems that could be impacted by phosphate mining. These resources fall into two major categories: surface waters and groundwater.

Surface water systems discussed span the spectrum of freshwater to estuarine systems because there is the potential for mining to affect surface waters from the sites of the Applicants' Preferred Alternatives downstream to Charlotte Harbor. These systems are described in Section 3.3.2.1.

Groundwater resources are also described, with particular focus on the surficial and Floridan aquifers. The generalized relationships between these aquifers in relation to the lithologic formations they represent are depicted in Figure 3-2; characteristics and conditions of the surficial and Floridan aquifers are reviewed in Section 3.3.2.2.

Table 3-2. Soil Map Units in CFPD Classified as Farmlands of Unique Importance

Map Unit Name	Map Unit Symbol	County	Acres	Percent of Total[a]
GATOR MUCK, DEPRESSIONAL	19	DeSoto	341	0.1
MYAKKA FINE SAND	24	DeSoto	6,116	1.5
TAVARES FINE SAND, 0 TO 5 PERCENT SLOPES	37	DeSoto	1,528	0.4
VALKARIA FINE SAND	40	DeSoto	46	0.0
ZOLFO FINE SAND	42	DeSoto	3,419	0.9
CANDLER FINE SAND, 0 TO 5 PERCENT SLOPES	7	Hillsborough	14,923	3.8
FORT MEADE LOAMY FINE SAND, 0 TO 5 PERCENT SLOPES	18	Hillsborough	7,031	1.8
IMMOKALEE FINE SAND	21	Hillsborough	9,789	2.5
LAKE FINE SAND, 0 TO 5 PERCENT SLOPES	25	Hillsborough	10,012	2.5
MALABAR FINE SAND	27	Hillsborough	7,513	1.9
MYAKKA FINE SAND	29	Hillsborough	66,249	16.7
ONA FINE SAND	33	Hillsborough	12,740	3.2
POMELLO FINE SAND, 0 TO 5 PERCENT SLOPES	41	Hillsborough	9,537	2.4
ST. JOHNS FINE SAND	46	Hillsborough	17,259	4.4
SEFFNER FINE SAND	47	Hillsborough	18,980	4.8
WABASSO FINE SAND	57	Hillsborough	814	0.2
ZOLFO FINE SAND	61	Hillsborough	24,495	6.2
CASSIA FINE SAND	11	Manatee	12,777	3.2
DELRAY-POMONA COMPLEX	18	Manatee	20,318	5.1
EAUGALLIE FINE SAND	20	Manatee	14,089	3.6
MYAKKA FINE SAND, 0 TO 2 PERCENT SLOPES	30	Manatee	56,922	14.4
MYAKKA FINE SAND, 2 TO 5 PERCENT SLOPES	31	Manatee	1,487	0.4
POMELLO FINE SAND, 0 TO 2 PERCENT SLOPES	42	Manatee	21,137	5.3
WABASSO FINE SAND	48	Manatee	2,369	0.6
WAVELAND FINE SAND	52	Manatee	55,680	14.1

[a] Percent of total farmlands of unique importance for all three counties or 395,570 acres.

Source: NRCS Survey Geographic (SSURGO) Data Set for 2010

The following descriptions focus on hydrologic relationships. Surface and groundwater water quality conditions and issues are addressed in Section 3.3.3.

3.3.2.1 Surface Water Hydrology

Surface water systems occur in nine watersheds in the CFPD, including seven river systems and two bays. These systems are the Hillsborough River (HUC 03100205), Withlacoochee River (HUC 03100208), Alafia River (HUC 03100204), Tampa Bay and Coastal (HUC 03100206), Little Manatee River (HUC 03100203), Manatee River (HUC 03100202), Myakka River (HUC 03100102),

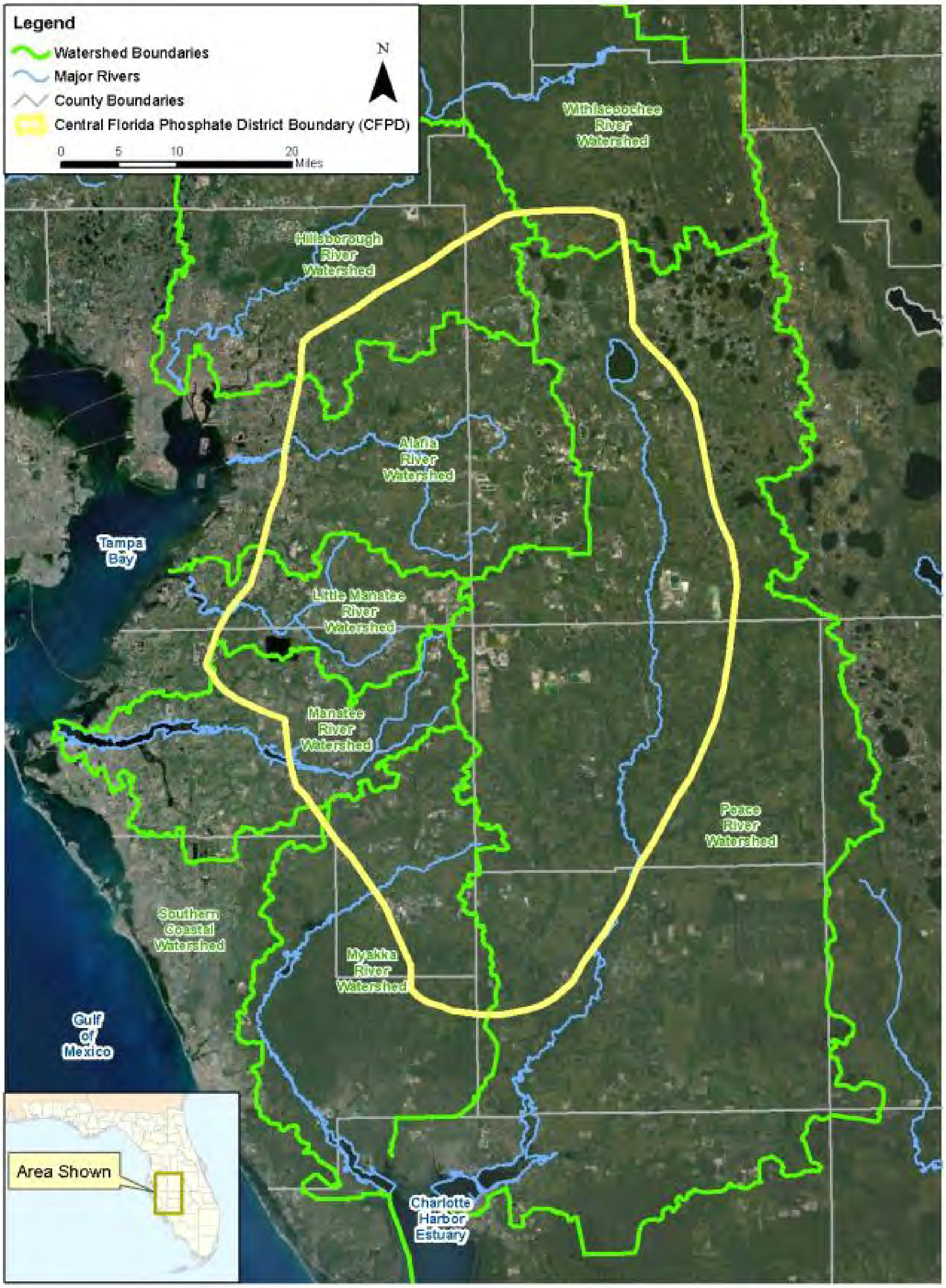
Peace River (HUC 03100101), and Sarasota Bay (HUC 03100201). The Sarasota Bay watershed is also referred to as the Southern Coastal watershed.

The watershed locations and boundaries are reflected in Figure 3-8. No recent phosphate mining has occurred in the Withlacoochee and Hillsborough River watersheds; these systems are acknowledged as part of the CFPD, but are not further addressed in detail in this AEIS. In contrast, significant phosphate mining has occurred historically in the Alafia, Little Manatee, and Peace River watersheds; ongoing mining is occurring in all three. Lesser amounts of mining have occurred in the uppermost portions of the Manatee and Myakka River watersheds. In the Applicants' Preferred Alternatives, three of the four new mines are primarily in the Peace River watershed (Desoto Mine, Wingate East Mine, South Pasture Mine Extension), and one is located in the uppermost portion of the Myakka River watershed (Ona Mine).

A small portion of the Ona Mine is also in the Myakka River Watershed). Detailed descriptions of the Peace and Myakka River watersheds are provided in reports generated by SWFWMD and FDEP. The brief excerpts provided here are for general orientation to the rivers' characteristics and geographic settings.

Peace River Basin: The Peace River basin encompasses approximately 2,350 square miles of land representing large portions of Polk, Hardee, DeSoto, and Charlotte Counties, as well as smaller portions of Hillsborough, Manatee, Highlands, Sarasota, and Glades Counties. The Peace River is approximately 105 miles in length. It flows south from the convergence of the Peace Creek Drainage Canal and Saddle Creek in central Polk County and empties into the Upper Charlotte Harbor estuary in Charlotte County. Multiple major tributaries feed into the mainstem of the river (PBS&J, 2007). Some of the tributaries discussed in this AEIS include: Horse Creek, Payne Creek, Charlie Creek, Joshua Creek, Shell Creek, and portions of the land that drains directly into the Peace River between flow monitoring gages on the mainstem (like Bartow, Zolfo Springs, and Arcadia) (SWFWMD, 2011a).

Myakka River Basin: The Myakka River basin is located just west of the Peace River basin and encompasses approximately 600 square miles. The Myakka River flows nearly 66 miles southwest from its headwaters in marshes near the community of Myakka Head, discharging into the Charlotte Harbor estuary near the City of North Port (SWFWMD, 2011a). The headwaters of the Myakka River basin are very near the headwaters of the Horse Creek watershed in the Peace River basin. Surface waters in the Myakka River watershed include numerous wetlands and several stream and slough systems. One of the most significant surface water features in the Upper Myakka River basin is the confluence of seven streams to form Flatford Swamp, which lies just upstream of State Road 70 near Myakka City in Manatee County (SWFWMD, 2004a). One stream system discussed in the AEIS is the Big Slough sub-watershed, which lies east of the main Myakka River and flows through North Port directly into Charlotte Harbor.

1 

2 **Figure 3-8. River Basins Draining Major Portions of the CFPD**

The other CFPD river basins where historical or ongoing phosphate mining has occurred are described as follows.

Alafia River Basin: Basic features of the Alafia River basin were described by SWFWMD and FDEP:

The Alafia River basin has an estimated drainage area of 422 square miles (270,000 acres). For the period 1933-1999, the river's yearly mean discharge was 340 cubic feet per second (cfs) at the Lithia station (USGS, 2000).

The Alafia River originates from several creeks that converge into a centralized riverine system flowing westward from Polk County through Hillsborough County to Tampa Bay. The two main creeks that feed the river include the North Prong, which is about 10 miles long, and South Prong, which is about 25 miles long. The Lower Alafia River lies downstream of the confluence of North Prong and South Prong, flowing 24 miles westerly in a well-defined channel to the Gulf of Mexico at Hillsborough Bay near Gibsonton. Approximately 5 miles upstream from the river's mouth, the channel widens and becomes tidally influenced (FDEP, 2013b).

The Alafia River watershed is bounded to the north by the Hillsborough River watershed, to the east by the Peace River watershed, to the south by the Little Manatee River watershed and to the southwest by the Tampa Bay watershed (FDEP, 2013b).

Little Manatee River Basin: In its Comprehensive Watershed Management Plan for the Little Manatee River Basin, SWFWMD described the basin's features as follows (SWFWMD, 2002a):

> "The Little Manatee River…drains approximately 222 square miles of land. For the period 1940-1999, the river's yearly mean discharge was 171 cfs at the U.S. 301 bridge (USGS, 2000). The watershed is bordered by the Alafia River watershed to the north, the Manatee River watershed to the south and to the east by the Peace River watershed."

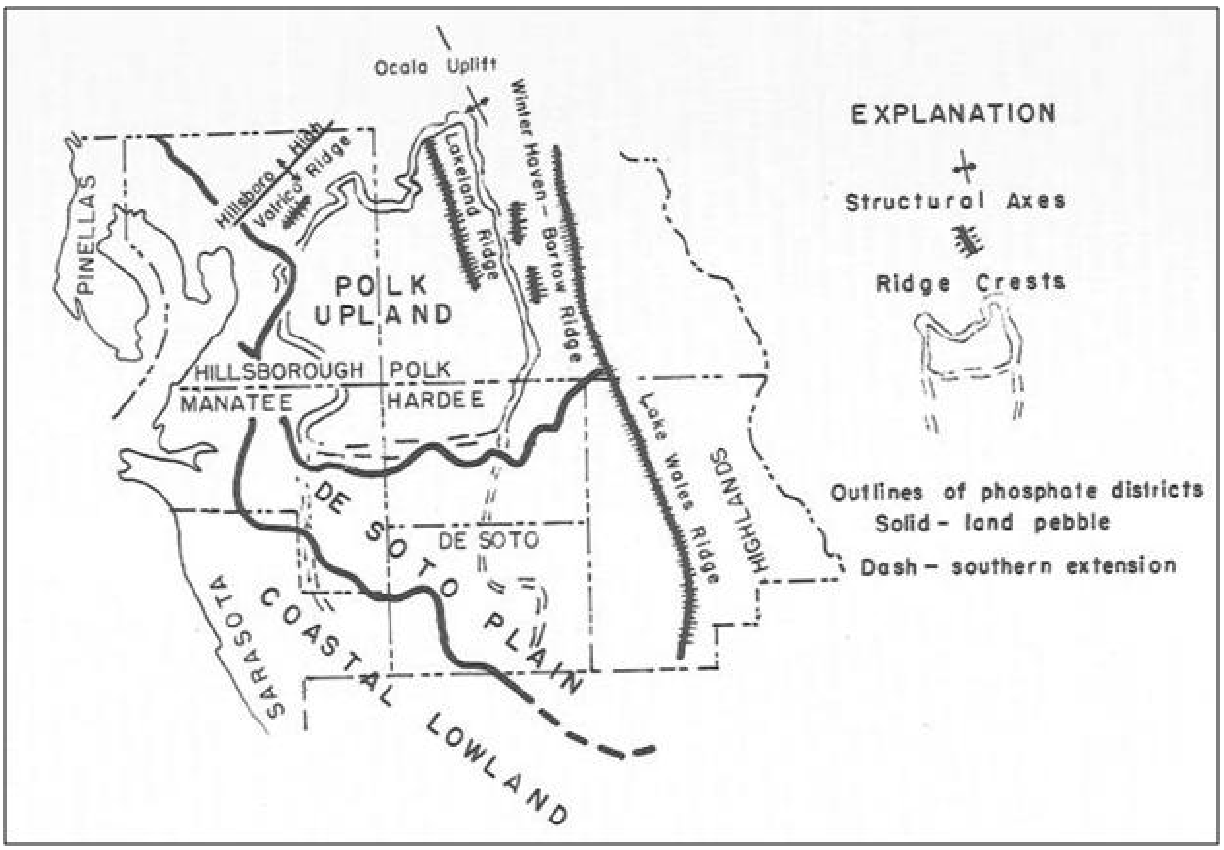
Manatee River Basin: In its Comprehensive Watershed Management Plan, SWFWMD (2001a) described the Manatee River Basin as follows:

> "The Manatee River Watershed…drains an area of about 360 square miles consisting mainly of Gulf Coastal Lowlands, hardwood swamps, marsh, and mesic flatwoods. The Manatee River…begins in marshes in the northeastern part of the County near Four Corners and flows approximately 45 miles in a westerly direction to southern Tampa Bay and the Gulf of Mexico. The Manatee River Watershed…is bounded to the north by the Little Manatee River watershed and coastal basins along Tampa Bay; to the east by the Peace River watershed and to the south and west by the Myakka River and Southern Coastal area watersheds, respectively."

The rivers that convey water out of the CFPD drain three physiographic regions identified by White (1970) as presented in Scott and Cathcart (1989): the Polk Upland, the DeSoto Plain, and the Coastal Lowland. The approximate areal coverage of these three physiographic regions is shown in Figure 3-9.

Topography

SWFWMD described the general topographic trends in each of the watersheds in the applicable watershed Comprehensive Water Management Plans (SWFWMD, 2001a, 2001b, and 2002a); additional descriptions of the area's topography were presented by FDEP and SWFWMD in the Peace River Cumulative Impacts Study (PBS&J, 2007). Land elevations in the Polk Upland generally range between 100 and 130 feet above mean sea level (MSL). All seven of the river watersheds in the CFPD drain some portion of the Polk Upland. The transition from the Polk Upland to the DeSoto Plain toward the south and west occurs at roughly 75 to 80 feet, MSL. The subsequent transition from the DeSoto Plain to the Coastal Lowland occurs at an elevation of approximately 40 feet, MSL.



Source: White, 1970, in Scott and Cathcart, 1989

Figure 3-9. Generalized Spatial Relationships between the Polk Uplands, DeSoto Plain, and Coastal Lowland Physiographic Regions in the Vicinity of the CFPD

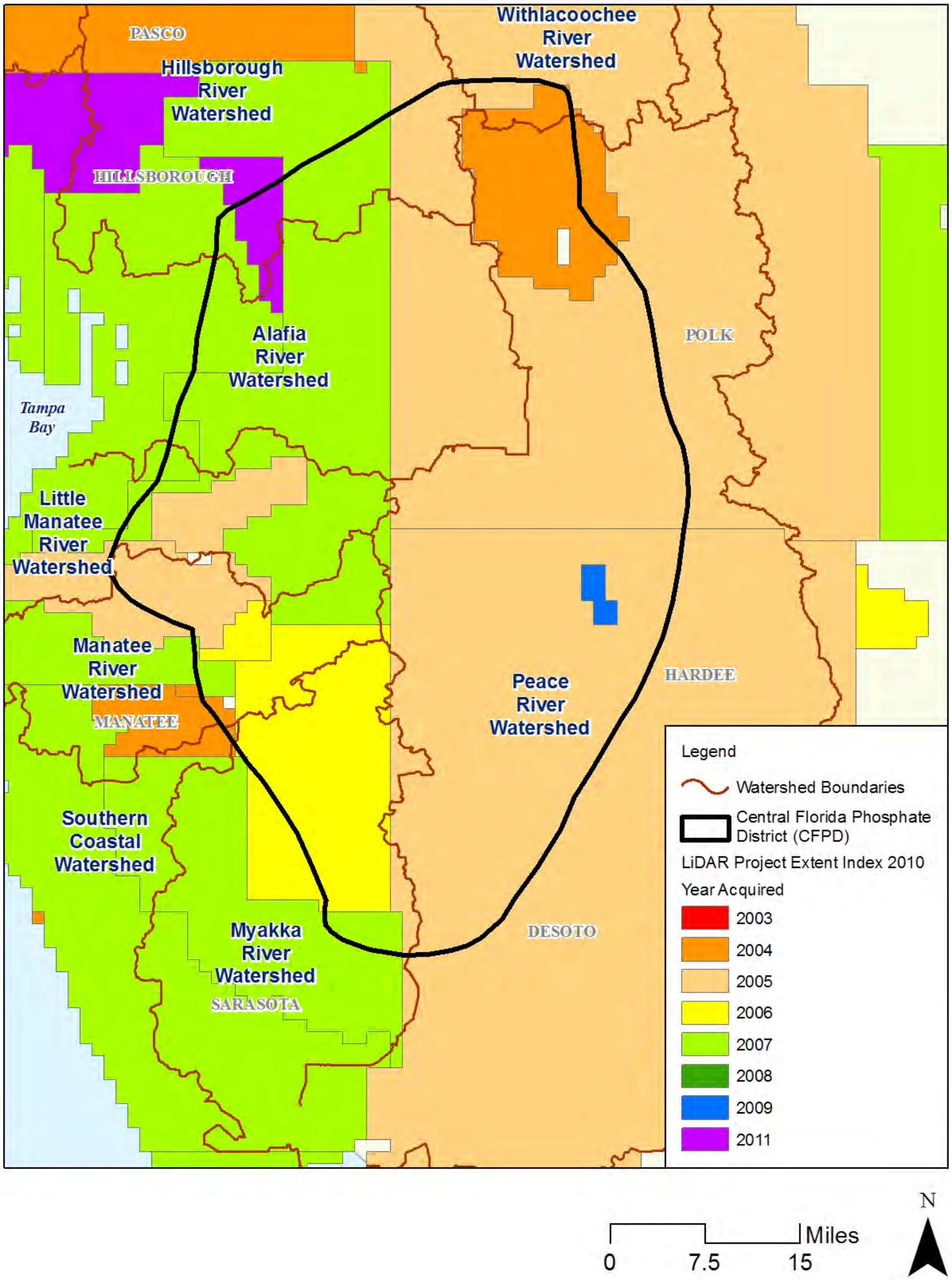
In the northern portion of the CFPD, the Alafia River watershed transitions rapidly from the Polk Uplands to the Coastal Lowlands. In contrast, the Little Manatee, Manatee, Myakka, and Peace River watersheds cross all three physiographic regions (White, 1970) and the relative topographic gradients are more gradual. Potential phosphate mining effects on the localized or regional surface water hydrology are linked to these topographic gradients for a given mine and its adjacent land areas. Topographic conditions of the unmined areas as compared to the post-mined and reclamation lands are a relevant factor in evaluating potential impacts of proposed actions. Generally, project actions in lands with greater topographic relief have a higher probability of affecting runoff flows and water quality conditions than those centered in low relief land areas.

The general flatness of Florida's terrain, especially towards coastal zones, has sometimes challenged scientists that use these data for determining flow patterns. The SWFWMD extensively uses topographic information to support regulatory, planning, engineering, land management and acquisition, and habitat restoration projects. To support these elements of its mission, it has collected Light Detection and Ranging (LiDAR) aerial survey data of most areas within its jurisdiction. Figure 3-10 illustrates the available LiDAR topographic data and the date they were obtained in the study area.

LiDAR data are often used to develop and apply detailed hydrologic and hydraulic models of relatively small domain sizes (Lee et al., 2010; Interflow, 2008a). LiDAR remote elevation data collection relies on precision global positioning system (GPS) and ground referencing (control survey) to obtain accurate results. While the laser sensor is highly accurate (less than or equal to 15 centimeters [cm]), the raw data need post-processing to determine ground elevations because the sensor reflects off all surfaces, including tops of buildings and trees. For example, CF Industries reported that some of the LiDAR data for herbaceous wetlands reported the top of the vegetation because of the dense foliage (BCI Engineers & Scientists, Inc.[BCI], 2010a). As part of the data collection effort, SWFWMD requires an accuracy report. For relevant portions of the AEIS study area, the reported accuracy of the LiDAR data and the spacing of the ground data are listed below:

- Peace River North: 6-foot spacing, 0.6-foot vertical accuracy
- Peace River South: 6-foot spacing, 1.2-foot vertical accuracy
- Upper Myakka River: 4-foot spacing, 0.3- to 0.6-foot vertical accuracy

As evident from the variable vertical accuracy of the data, LiDAR-derived terrain data and 1-foot contours primarily are useful for cartographic visualization and planning-level purposes because the results meet or exceed National Map Accuracy Standards for 2-foot contours. In general, LiDAR-derived topography information can be useful in evaluating existing conditions in a study area (e.g., wetland connections to streams, and stream lengths) in areas proposed as prospective future mines where the data accuracy has been confirmed through ground truthing of LiDAR interpretation. Such ground truthing is not available for all LiDAR-surveyed areas, making its use in support of this AEIS only possible in selected areas.



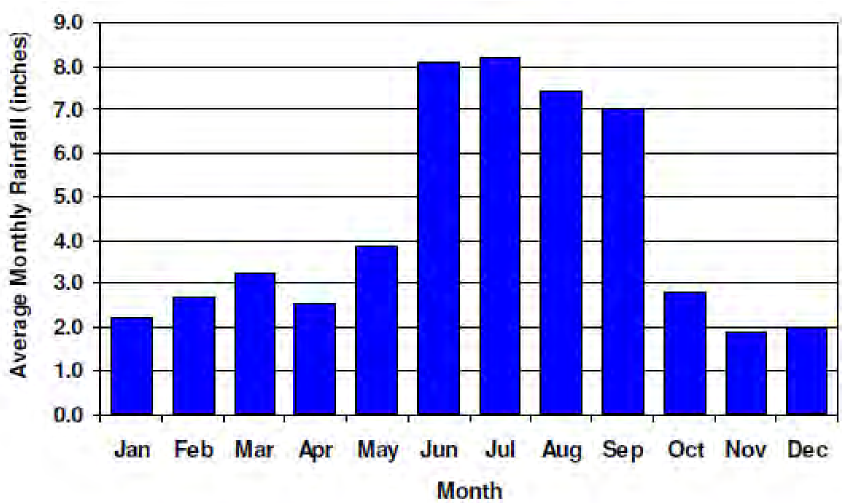
Source: SWFWMD

Figure 3-10. LiDAR Acquisition in the AEIS Study Area

Historical Rainfall Records

Evaluating the effects of phosphate mining on AEIS study area surface water hydrology requires a basic understanding of the meteorology of the region, with specific focus on rainfall. Rainfall is the driver most affecting the water balance of any study area in Florida, and it directly affects both the surface and groundwater resources. An understanding of the water resources in the CFPD must begin with an understanding of long-term rainfall patterns and short-term, seasonal relationships.

Rainfall patterns in the AEIS study area were characterized in FDEP's Peace River Cumulative Impacts Study (PBS&J, 2007); a summary of rainfall data is provided in Appendix G. Monthly Peace River watershed rainfall averaged for the Bartow, Wauchula, Arcadia, and Punta Gorda gages for the period of 1932-2004 was summarized graphically (Figure 3-11). The total average annual precipitation was 52 inches. However, a clear distinction between the wet season months (June through September) and dry season months (October through May) is evident.



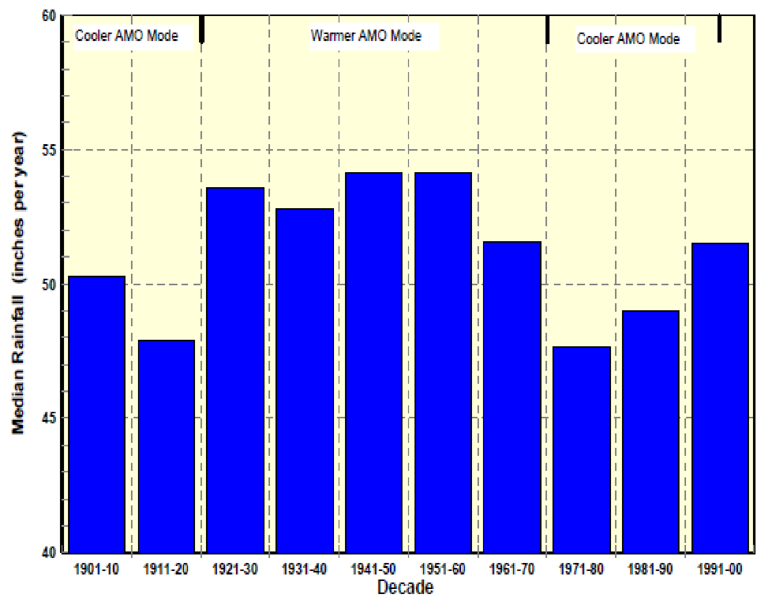
Source: PBS&J, 2007

Figure 3-11. Monthly Average Rainfall in the Peace River Watershed Based on Gages in Bartow, Wauchula, Arcadia, and Punta Gorda (1932-2004)

More than 60 percent of annual precipitation occurs during the summer wet season due to local convective-type thunderstorm activity (Basso and Schultz, 2003). During the late summer period, tropical storms may also affect the region with extremely heavy rain and wind. During the remainder of the year, weather patterns are dominated by mid-latitude frontal systems. On average, the wettest month in the region is July and the driest month is November. Because of the spatial scale and temporal duration of the phosphate mining projects under consideration, this AEIS is focused on long-term relationships rather than short-duration, storm event-based hydrologic responses of the natural system to mining activities.

Thus, no further discussion of tropical storms or frontal system rainfall conditions is required. Rather, the information presented is focused on long-term relationships at the basin or subbasin scale level.

A particularly relevant issue is whether there has been any regional trend in annual rainfall patterns that might be related to changes in hydrologic patterns over time. Plots of annual rainfall are provided in Appendix G. SWFWMD has concluded that over the last century, there has been no significant change in annual rainfall (Basso and Schultz, 2003). However, if the record is partitioned into shorter 10-year intervals, above-or-below average rainfall during multi-decade cycles is evident (Figure 3-12).



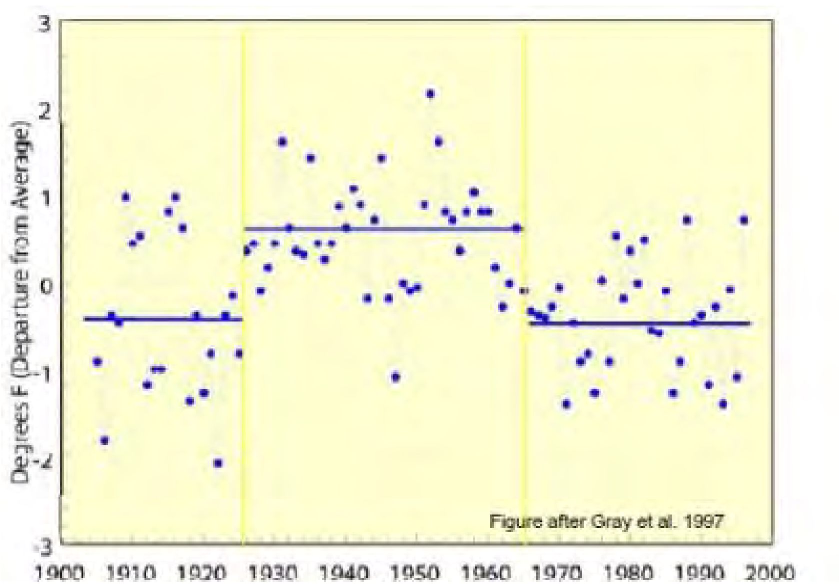
Source: Basso and Schultz, 2003

Figure 3-12. Median Rainfall by Decade Averaged from 27 Long-Term Rainfall Monitoring Stations in Western Central Florida

The Basso and Schultz (2003) analysis was based on both annual totals and seasonal totals for two 30-year periods (1936-1965 and 1966-1995) using rainfall records from long-term rainfall monitoring stations in Lakeland, Bartow, Haynesworth, Wauchula, Avon Park, and Arcadia – all in the Peace River basin. Based on averages from all six stations, there was a difference in rainfall of about 5 inches per year between these two 30-year periods. Similar results occurred if the time period shifted 5-years forward (1941-1970 and 1971-2000), suggesting that these periods have a transitional period of several years and are not sharply divided trends.

These cycles have been closely linked with what is now known as the Atlantic Multidecadal Oscillation (AMO), a naturally occurring variation in sea surface temperature in the North Atlantic Ocean that occurs every 20 to 50 years (Figure 3-13). Surface water flow increases and decreases in rivers in peninsular

Florida are consistent with the AMO and the reported relationship with rainfall (Kelly, 2004). These relationships are addressed further under the following section addressing rainfall and river discharge relationships.



Source: Kelly, 2004

Figure 3-13. Atlantic Ocean Sea Surface Temperature

Historical River Discharges

Recent historical patterns in river discharge are important in evaluating potential phosphate mining effects. Because a given mine's operations are designed to capture rainfall and associated runoff to support the mine's water supply in the recirculation system, that portion of the mine's footprint in the ditch and berm system is effectively removed from the applicable subbasin's watershed, with the exception of water discharged through the NPDES-permitted outfalls and groundwater contributions from the ditch and berm system to adjacent streams and wetlands. The annual contribution of the mine to downstream flows is not necessarily zero because at times, excess water accumulations in the recirculation system occur, resulting in off-mine discharges through the permitted NPDES outfalls. However, the annual quantity and timing of water contributions to downstream flows is not the same during active mining periods as it would have been if the lands remained in the un-mined condition.

The magnitude of the change in runoff quantity and timing depends on the relative relationship between the mine area in the ditch and berm system and the total area of the applicable subbasin. If the mine area is only a small portion of the total subbasin area, then the effect would not be expected to be large. Conversely, if the mine area represents a significant portion of the applicable subbasin area, it would be reasonable to anticipate a substantial effect. Should there be multiple mines operating that cumulatively

represent a substantial proportion of the applicable subbasin, the cumulative effects could be ecologically significant. For these reasons, it is essential to understand the river and major creek discharge patterns that prevail in the CFPD subbasins where phosphate mining expansion is proposed.

For river basins throughout Florida, land use changes caused by the collective activities of man over time have had substantial effects on surface water hydrology. Land use change over time includes converting native land to agricultural use, often followed by further transition to various forms of urbanization including residential, commercial, or industrial development. The net effect is loss of native upland and wetland habitats and gradual increase in the amounts of impervious surfaces because of infrastructure development. These actions modify the physical processes associated with rainfall accumulation and infiltration and also disrupt the natural quantity, timing, and distribution of water flows to downstream river reaches.

SWFWMD has conducted many studies on the major watersheds in the CFPD. Of the river systems in the AEIS study area, the historical flow record for the Peace River has been the most extensively studied. This is fortunate because this is the watershed where most of the Applicants' Preferred phosphate mining expansion would occur. The reduction of river flow deliveries to the Charlotte Harbor estuary has been the subject of extensive research, and the focal point of considerable debate. It appears likely that the change in river discharges over time can be attributed to a combination of the following factors:

- Change in land uses and associated natural water balance disruption
- Natural variation in rainfall conditions
- Regional effects of heavy use of the FAS for potable, agricultural, and industrial/mining water supply purposes

This conclusion is supported by a number of agency reports addressing hydrologic conditions in this river basin, a number of which are summarized here for general reference.

SWFWMD provided technical assistance to a detailed hydrologic assessment of the Peace River basin in the Peace River Basin Cumulative Impact Study, which was funded by FDEP (PBS&J, 2007). This document presents the agency's perspective on the relative impact of water sources and sinks to the Peace River basin as well as a detailed characterization of the flows from each subbasin in the Peace River watershed. A total of nine Peace River subbasins can be delineated and characterized in part by existing USGS flow gaging stations (the exception being the Lower Coastal Peace River subbasin, which is tidally influenced). The subbasins studied include four along the river's mainstem and five major creek subbasins tributary to the river (Figure 3-14). This AEIS and most of the studies reviewed base their analyses on these tributaries and USGS gage locations.

Source: PBS&J, 2007

Figure 3-14. Peace River Subbasins

River mainstem subbasins include:

- Peace River at Bartow
- Peace River at Zolfo Springs
- Peace River at Arcadia Payne Creek
- Lower Coastal Peace River

Major creek subbasins include:

- Payne Creek
- Charlie Creek
- Joshua Creek
- Horse Creek
- Shell (Prairie) Creek

A summary of characteristics of each subbasin is presented in Table 3-3. This table includes extrapolations and interpretations from data and charts presented in the Peace River Basin Cumulative Impact Study.

Table 3-3. Peace River Subbasin Summary

Peace River Subbasin	Sub-Basin Area (acres)	Percent of Peace River Basin (%)	Period of Record	Max Annual Median Flow (cfs)	Min Annual Median Flow (cfs)	Average Annual Median Flow (cfs)
Peace River at Bartow	233,761	17	1939 - 2004	341	142	246
Payne Creek	79,561	6	1979 - 2004	265	92	131
Peace River at Zolfo Springs	196,668	14	1933 - 2004	673	380	558
Charlie Creek	173,573	12	1959 - 2004	426	208	298
Peace River at Arcadia	128,186	9	1931 - 2004	1212	661	925
Joshua Creek	77,391	6	1950 - 2004	144	56	75
Horse Creek	128,435	9	1950 - 2004	249	106	147
Shell Creek	213,537	15	1966 - 2004	347	250	295
Lower Coastal Peace River	154,571	12	Tidally Influenced			
Source: PBS&J, 2007						

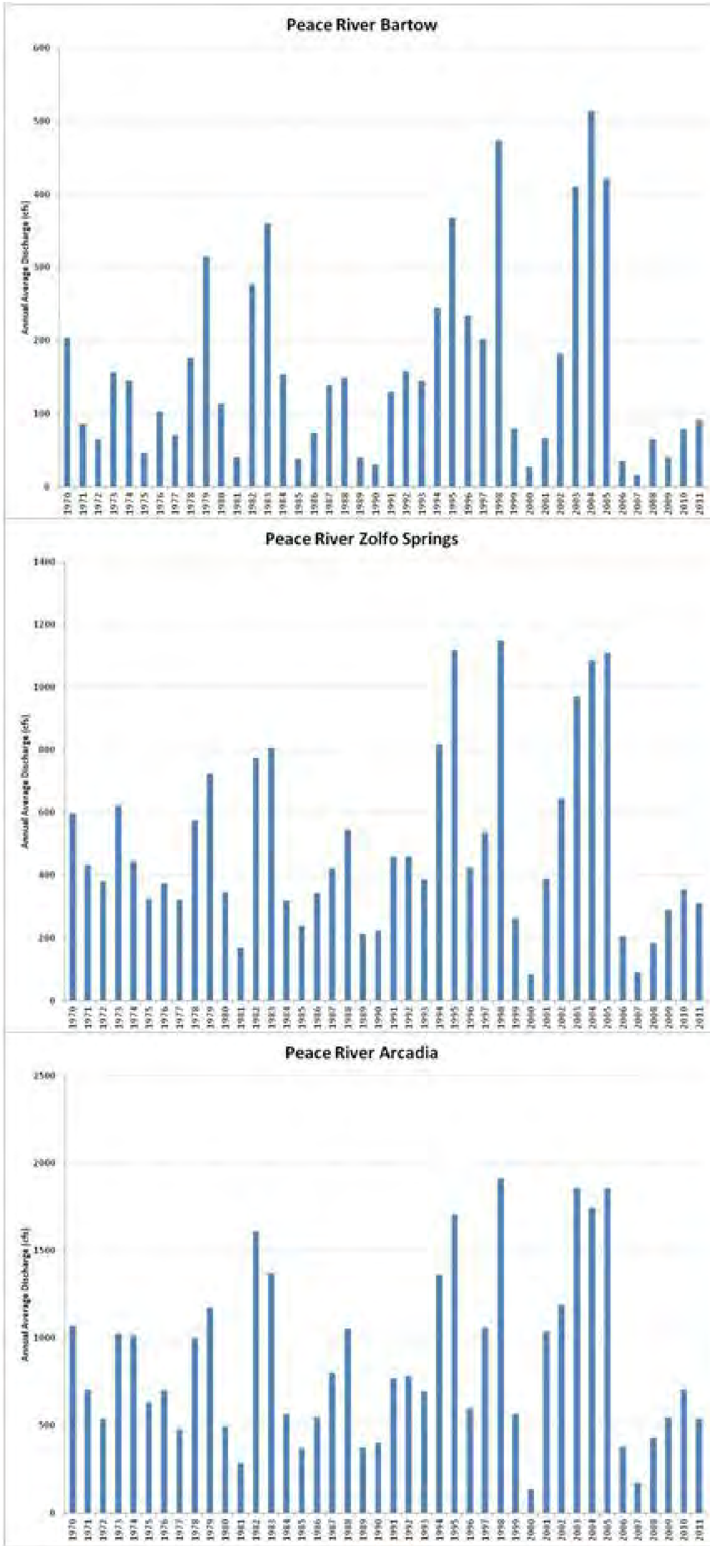
SWFWMD and others concluded that in the upper portion of the Peace River watershed, baseflows along the main river channel (i.e., low flows during dry periods) have declined because of historic groundwater withdrawals by multiple users and subsequent reductions in the potentiometric surface, in turn resulting in cessation of spring flows and reduced groundwater contributions to river baseflow (SWFWMD, 1993 and 2001b; Basso, 2003). The baseflow in several of the creeks, by comparison, is augmented by agricultural land drainage and irrigation water runoff (PBS&J, 2007).

Daily USGS gage records dating back to 1970 were used to calculate annual average discharge values for each year for 7 of the above locations; averages could not be calculated for the Lower Coastal Peace River subbasin because there is no downstream gage. The annual averages for the three river mainstem locations and four of the major creek tributaries are depicted in Figures 3-15 and 3-16, respectively. The graphs document the widely variable annual average flows experienced by the respective subbasins. River and creek annual average discharge reflects variability in annual average rainfall more than any other single factor (Schreuder, 2006). Review of the daily records further confirms that stream and river discharges in the AEIS study area are extremely variable from month to month and year to year; extreme fluctuations in stream flow conditions are the norm rather than the exception.

Long-term changes in river discharge trends throughout SWFWMD correspond with the AMO hypothesis, which suggests natural climate cycles or phases that can persist over decades are the major driver behind discharge trends. Warmer phases are associated with the periods 1869-1893, 1926-1969, and 1995 to date, while cooler phases predominated during 1894-1925 and 1970-94. During warmer phases, above average river flows and the cumulative total flow increases; during cooler phases, when flows are below the long-term average, the cumulative total declines. Long-term data from the Peace River at the Arcadia gage indicate that from the mid-1930s to approximately 1960, total annual flows were generally above the long-term average, while between 1960 and 1994 annual flows were generally below the long-term average. Over the past decade, annual flows in the Peace River near Arcadia have fluctuated above and below the long-term average of 1,084 cfs.

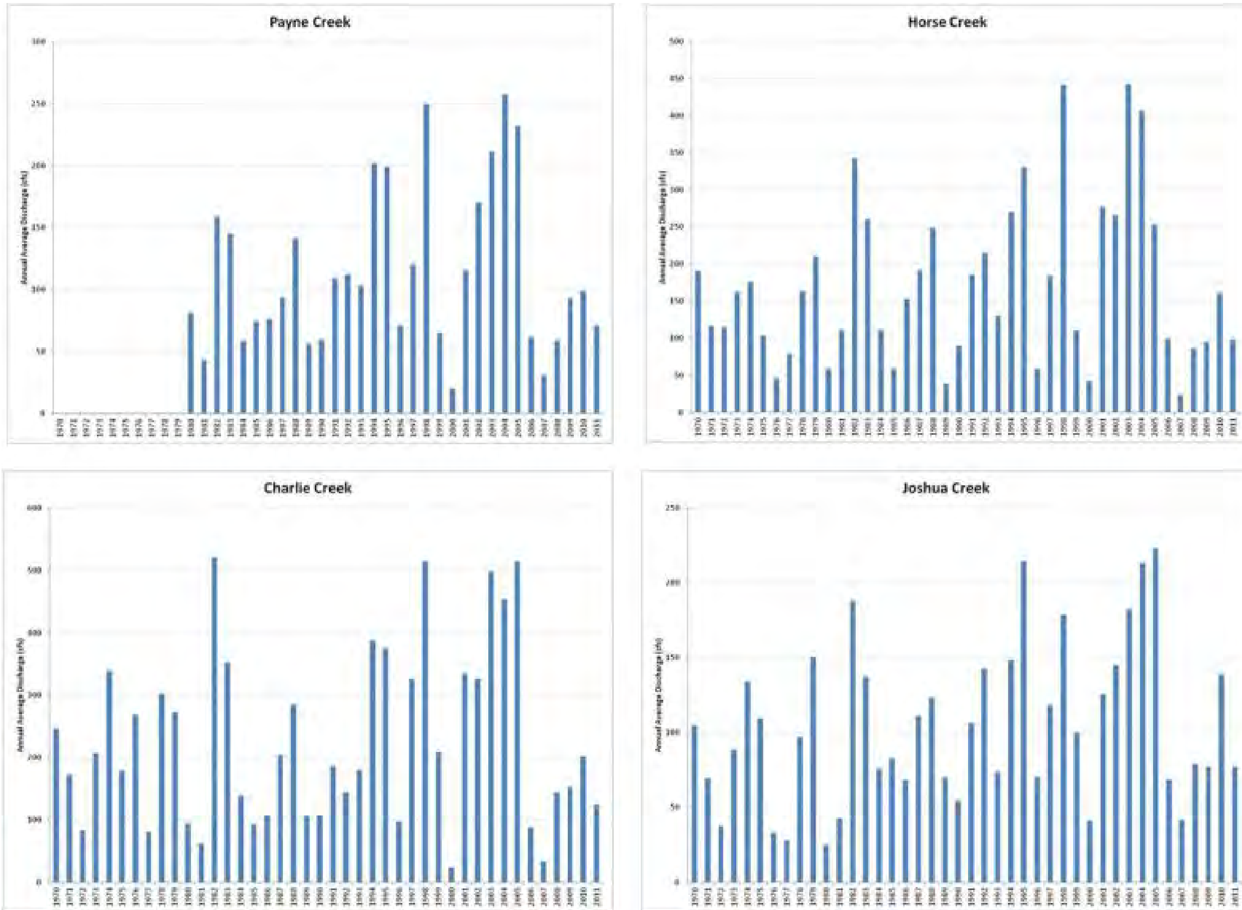
To address the potential factors contributing to the long-term trend of decreasing Peace River discharges to Charlotte Harbor estuary, Basso and Schultz (2003) performed regression analysis on river stage and rainfall records from the SWFWMD. USGS gaging stations reviewed in this analysis are reflected in Figure 3-17. Figure 3-18 presents the 5-year moving average of total annual flow per basin area from 1955 to 2005 (PBS&J, 2007) for the following three key gaging stations:

- *Peace River at Bartow and Peace River at Zolfo,* which represent flows for the upper reaches of the Peace River draining lands that were heavily impacted by historical phosphate mining operations
- *Peace River at Arcadia,* which represents flows for the lower reach of the Peace River
- *Withlacoochee River at Croom,* which represents a reference station with a relatively un-altered rural watershed



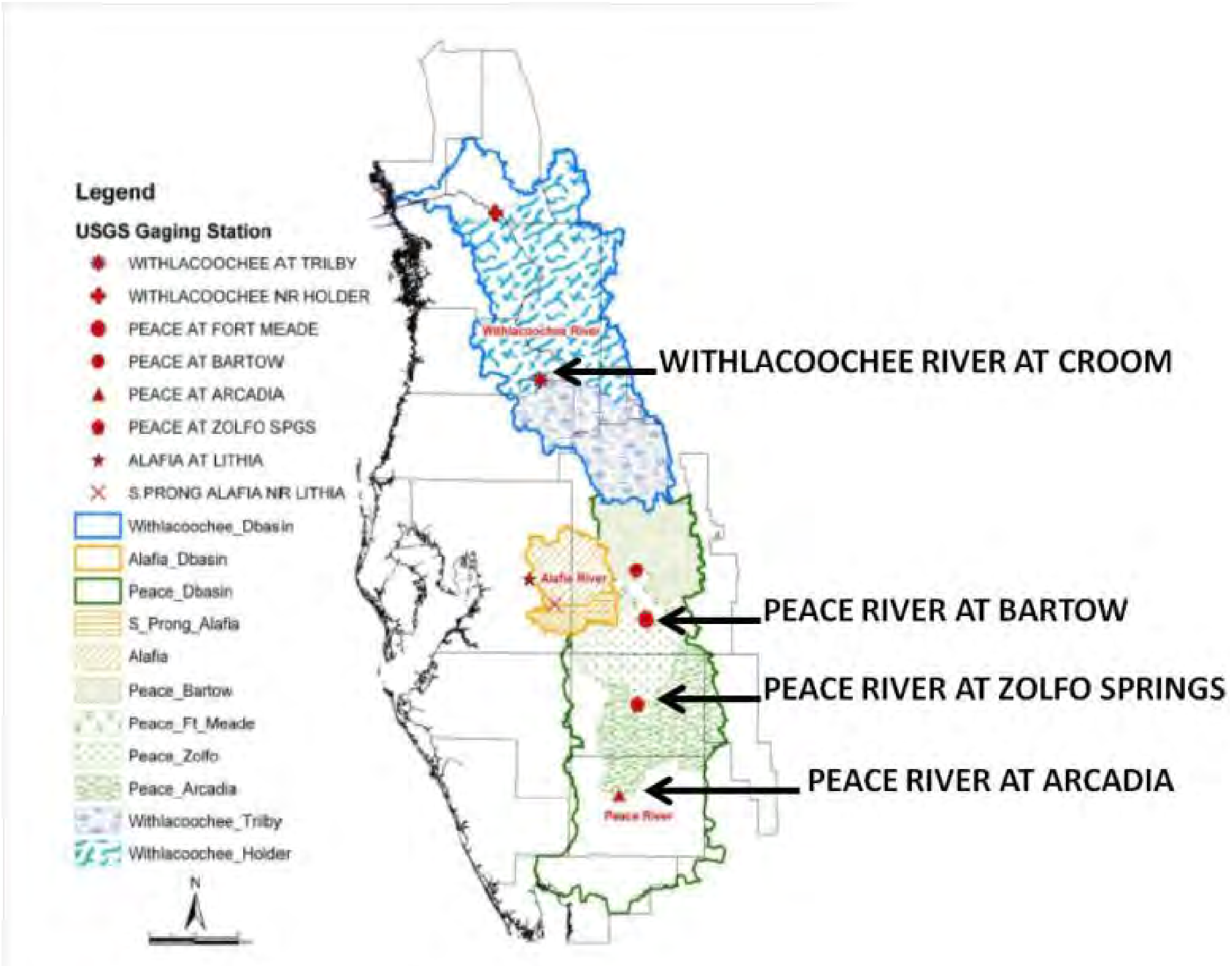
Source: USGS, 2012b

Figure 3-15. Annual Average Discharge Records for Three USGS Gage Stations on the Mainstem of the Peace River



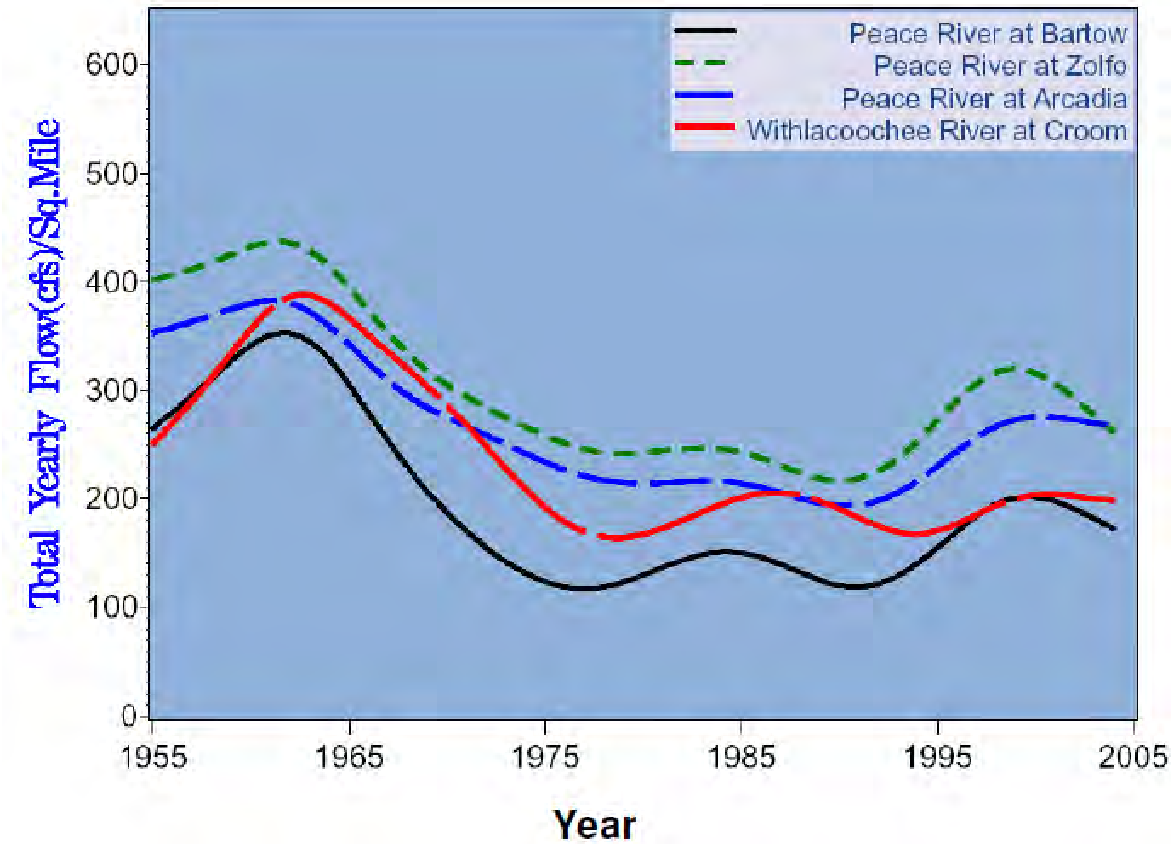
Source: USGS Website Data

Figure 3-16. Annual Average Discharge Records for USGS Gage Stations on Four Major Creeks Tributary to the Peace River



Source: Schreuder, 2006

Figure 3-17. Selected USGS Gages in the CFPD Region

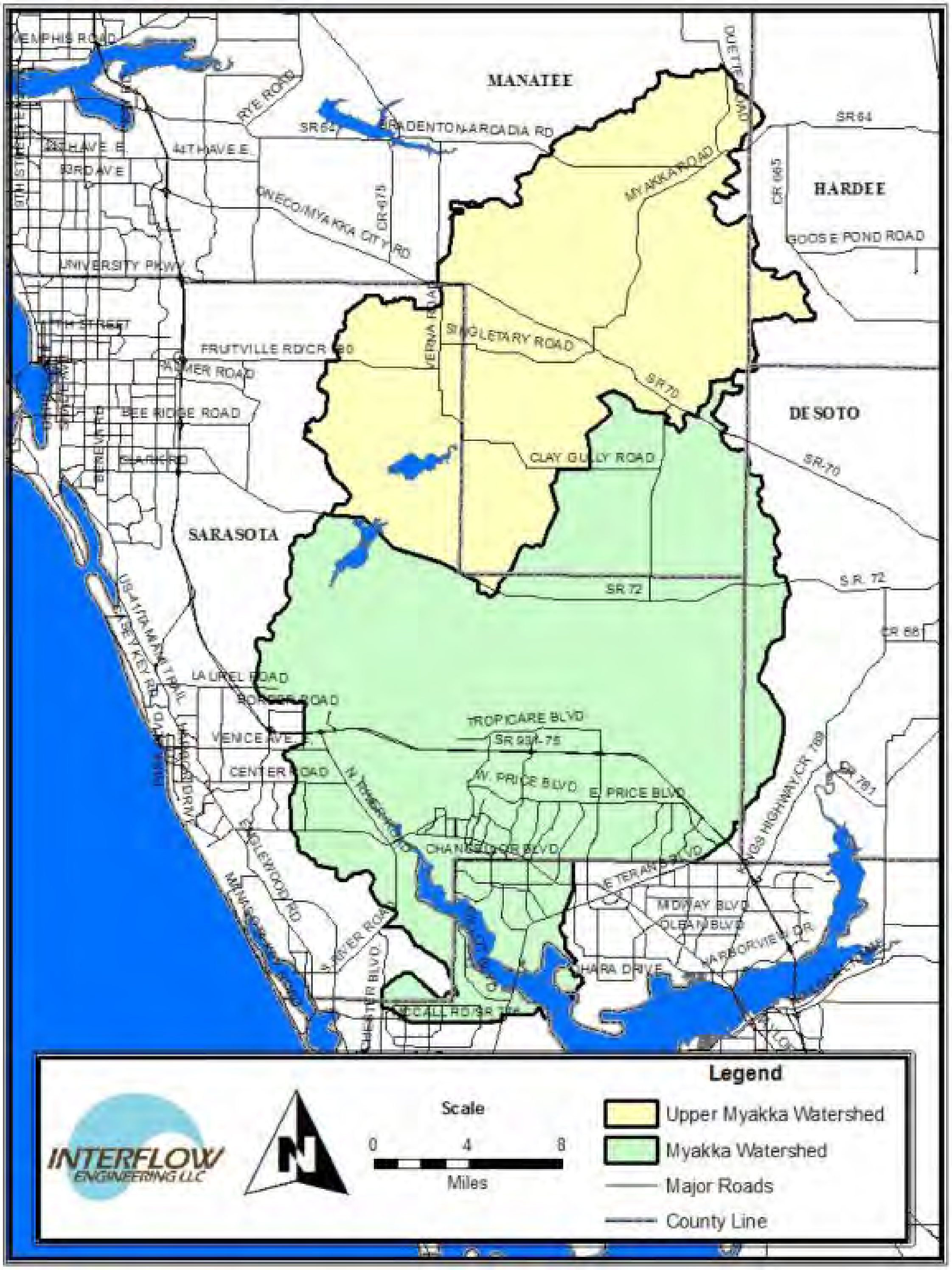


Source: PBS&J, 2007

Figure 3-18. 5-Year Moving Average Total Annual Flows Standardized by Basin Area (Square Miles)

Figure 3-18 illustrates that the patterns of declining flows at the three Peace River gages (*Bartow, Zolfo Springs*, and *Arcadia*) are very similar to the pattern seen at the un-altered reference basin *Withlacoochee River at Croom* gage. Results from this analysis showed that about 90 percent of the observed stream flow decline at the Zolfo Springs and the Arcadia gaging stations on the Peace River could be attributed to a post-1970 rainfall decline of 5 inches per year (Basso and Schultz, 2003). At the Bartow station of the Peace River, about 75 percent of the observed stream flow decline was correlated with long-term changes in rainfall (Basso and Schultz, 2003). Thus, there is strong evidence supporting the SWFWMD conclusion that the observed decline in regional river flows observed over the past decades is primarily driven by rainfall patterns (PBS&J, 2007; Kelly, 2004; Basso and Schultz, 2003).

Substantively less research has been invested to date on Myakka River basin discharge patterns. However, several focused investigations are now underway and SWFWMD has been studying water balance problems in the Upper Myakka River basin (Figure 3-19).



Source: Interflow, 2008a

Figure 3-19. The Upper Myakka River Watershed Study Area

The Upper Myakka River basin encompasses approximately 235 square miles of the overall 600–square-mile watershed. Effects from surface water imbalances have been attributed to the development of agricultural land uses in the areas draining to Flatford Swamp. Agricultural irrigation has led to increased surface water flows in a number of creeks (Howard Creek, Mossy Island Slough, Tatum Sawgrass Slough, Owen Creek, Ogleby Creek, Maple Creek, Long Creek, and Wingate Creek) draining to the swamp, resulting in seasonal flooding and wetland habitat degradation. SWFWMD is conducting investigations to evaluate whether excess water in the Flatford Swamp might be alleviated through surface water diversions to phosphate mine clay settling areas to the north at the Wingate Creek Mine or to other water users.

In a preliminary report on model development and calibration (Interflow Engineering, LLC [Interflow], 2008a), available USGS flow data at State Road 72 were reported in inches per year. Table 3-4 provides a summary of these discharge records based on the USGS gaging data for May 1994 through April 2006. These historical discharge records are potentially significant for this AEIS because the Upper Myakka River basin contains the lands where Wingate East, an extension of the Wingate Creek Mine is proposed. Therefore, Wingate East could potentially affect the upper watershed water balance.

Table 3-4. Summary of Myakka River USGS Flow Data

Myakka River Basin Station	USGS Station ID	USGS Remarks	Drainage Area (sq. mi.)	Measured Streamflow	
				(in/yr)	(cfs)
Myakka R. nr. Sarasota	2298830	poor	236.65	18.2	318
Myakka R. at Myakka City	2298608	fair	125.93	22.11	206
Myakka R. nr. Myakka City	2298554	poor	89.48	23.35	154
Myakka R. Upstream of Youngs Ck.	2298488	poor	28.45	21.17	44
Howard Creek	2298760	fair	19.68	22.37	32
Maple Creek	2298495	poor (flows)	4.5	29.91	10
Long Creek	2298492	poor	10.8	21.97	18
Ogleby and Coker Creek (combined)	02298527 OC/ 02298530 CC	poor (flows)	31.53	25.72	60

Notes:

sq. mi. = square mile
in/yr = inches per year

The USGS remark regarding the quality of data indicates that “fair” flow data have 95 percent of the data within 15 percent of being accurate and “poor” means that 95 percent of the data are less than 15 percent accurate.

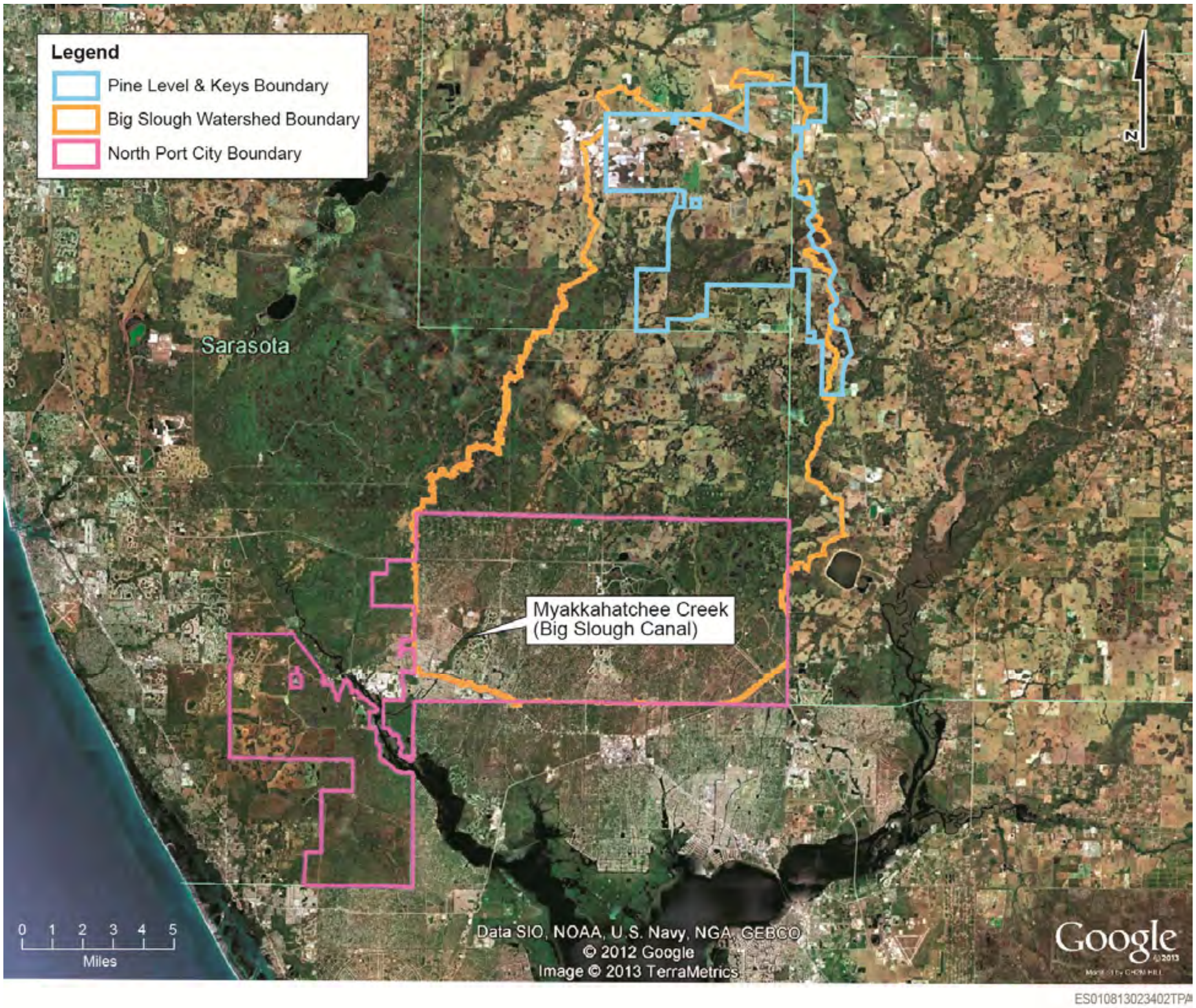
Source: Interflow, 2008a

Other ongoing SWFWMD investigations of hydrologic and hydraulic conditions in the Myakka River watershed are evaluating flood control objectives for areas in the Big Slough watershed, which covers a major portion of the eastern Myakka River watershed. In the Floodplain Justification Report provided to SWFWMD, Ardaman & Associates (Ardaman, 2011a) reported the following:

> "The Big Slough Watershed is located in southeastern Sarasota County, and is tributary to the Myakka River. Portions of the incorporated City of North Port (those areas east of the Myakka) are located within the southern portion of the watershed. The 195.5 square mile watershed encompasses numerous depressional features, including wetlands and water bodies, the most prominent of which is the Big Slough Canal (also called Myakkahatchee Creek in its lower reaches).
>
> The Big Slough Canal passes from north to south through the City of North Port, and receives inflows from an internal system of waterways which provide surface drainage throughout the City, before discharging beneath U.S. Highway 41 toward its confluence with the Myakka River.
>
> Big Slough Canal/ Myakkahatchee Creek begins in the southeastern part of Manatee County (near Edgeville) and flows approximately 21 miles through the City of North Port where it empties to the estuarine portion of the Myakka River."

The work is focused on developing a hydrologic analysis tool that can be used to estimate "…the extent of flooding that would result from storm event conditions, and for estimating rainfall-induced flood risk throughout the Big Slough/City of North Port Watershed" (Ardaman, 2011b). Evaluations are focused on short-term flood event conditions (5-day 100-year and 1-day 100-year storm event conditions). Thus, the focus of this investigation was on simulation of short-term rainfall – floodplain – water stage issues, which are divergent from the long-term perspectives of this AEIS.

The tools under development are expected to be useful to future SWFWMD modeling that will evaluate the range of infrastructure solutions for flood control in this specific portion of the Myakka River basin. They are not viewed as central to impact evaluations linked to the Applicants' Preferred Alternatives addressed in this AEIS; however, it is noted that one of the offsite alternatives in this subbasin is a mine extension project identified by Mosaic as the Pine Level/Keys Tract – conceptually representing the second "half" of the Desoto Mine. The location of this mine complex in relation to the Big Slough is depicted in Figure 3-20.



Source: Mine outline – Mosaic, 2011a
City and watershed boundaries - City of North Port, 2011

Figure 3-20. The Location of the Pine Level/Keys Tract in the Big Slough Watershed

Minimum Flows and Levels (MFLs)

The following information is drawn directly from the SWFWMD website addressing the setting of minimum flows and levels for the protection of water resources in the state of Florida (SWFWMD, 2013):

> “Florida law (Chapter 373.042, Florida Statutes) requires the state water management districts or the Department of Environmental Protection to establish minimum flows and levels (MFLs) for aquifers, surface watercourses, and other surface water bodies to identify the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area. Rivers, streams, estuaries and springs require minimum flows, while minimum levels are developed for lakes, wetlands

and aquifers. Minimum flows and levels are adopted into Southwest Florida Water Management District (District) rules (Chapter 40D-8, Florida Administrative Code) and used in the District's water use permitting program to ensure that withdrawals do not cause significant harm to water resources or the environment. Water bodies with adopted minimum flows and levels, and those the District is currently or planning to work on, are identified in the District's Minimum Flows and Levels Priority List and Schedule. The list and schedule, which is updated annually, is based upon the importance of the listed waters to the state or region and the existence of potential for adverse impacts associated with water use."

Establishing minimum flows and water levels is a complex technical process that involves extensive statistical evaluation of flows and/or water levels of the applicable water bodies. SWFWMD collects and analyzes the data for the available period of record and proposes the minimum flows and levels. The proposal then undergoes peer review by independent scientists and is made available for public review by all interested stakeholders. Following the review period, the proposal is revised as needed and codified into SWFWMD rules. If the water body does not meet the established minimum flow limit or is projected to be below its MFL within the next 20 years, SWFWMD re-evaluates the water body and implements a prevention or recovery strategy to bring it above the established MFL as per Chapter 40D-80, F.A.C. Failure to establish an MFL for a water body does not prevent SWFWMD from issuing or renewing water use permits (WUPs). However, permits normally have an opener clause that allows the permit to be modified in the event that an MFL is established during the permit duration. Compliance with the established minimum flows and water levels is monitored through monthly reports required in the WUP.

In the AEIS study area, MFLs have been established for the Alafia River, Myakka River, and Peace River. MFL development has been conducted for the Little Manatee River, with rule establishment planned for 2012. MFL considerations for the Manatee River were planned for 2012. Table 3-5 summarizes how some of the rivers have been segmented for MFL evaluations, as well as the status of formal MFL adoption (i.e., by rule). The tables presented in this section were drawn directly from the SWFWMD Minimum Flows and Levels Report database (SWFWMD, 2012a) and from Chapter 40D-8, F.A.C.

Because of the spatial heterogeneity of a given river's characteristics, MFLs are in some cases established for different watershed/river reaches (example: upper and lower basins). Additionally, because of temporal heterogeneity of flows, minimum flows in some cases are set for different seasons of the year in terms of "blocks" of the year.

Table 3-5. River Reach Definition and Summary of MFL Establishment for AEIS Surface Water Bodies

River Reach	MFL Status as Approved by the SWFWMD Board (Fiscal Year 2013)[a]	Applicable Rule
Alafia River - Upper Freshwater Segment (at Lithia Gage)	Adopted as a Rule	40D-8.041(10)
Alafia River - Lower Estuary (includes Lithia and Buckhorn Springs)	Adopted as a Rule	40D-8.041(11)
Alafia River – North Prong	To be assessed in 2015	
Alafia River – South Prong	To be assessed in 2015	
Little Manatee River (upper and lower segments)	Rule to be finalized in 2014	
Manatee River (includes Braden Estuary)	To be assessed in 2013	
Myakka River – Upper (near Sarasota Gage)	Adopted as a Rule	40D-8.041(6)(a)
Myakka River - Lower	Adopted as a Rule	40D-8.041(6)(b)
Peace River – Upper	Minimum Low Flows Adopted as a Rule Minimum Middle and High Flows to be assessed in 2016	40D-8.041(7)
Peace River – Middle (at Arcadia Gage)	Adopted as a Rule	40D-8.041(5)
Peace River – Lower	Adopted as a Rule To be reevaluated in 2015	40D-8.041(8)
Horse Creek	To be assessed in 2015	
Charlie Creek	To be assessed in 2015	
Prairie Creek and Shell Creek (upper and lower segments)	To be assessed in 2015	
Myakkahatchee Creek	Staff recommended it to be assessed in 2015 with Lower Peace River, but not on board-approved list	

[a] *Source: SWFWMD, 2012a*

In these basins, the following blocks apply:

- Block 1 represents April 20 to June 25.
- Block 2 represents October 17 to April 19 of the following year.
- Block 3 represents June 26 to October 26.

Blocks 1, 2, and 3 are classified as having low, middle, and high average seasonal flows in the southern CFPD. Each block is assigned a minimum flow accordingly. The supporting MFL documentation also considers the surface water withdrawal by utilities; these reports present important background information about the ability to provide water (e.g., North Port and the Peace River Manasota Regional Water Supply Authority [PRMRWSA]). Because the Applicants' Preferred Alternatives are in the Myakka and Peace River basins, only these two rivers' MFLs are discussed in detail below.

MFLs for the Myakka River

The Upper Myakka River boundary is the location of the USGS gage near Sarasota (Gage No. 02298830). Minimum flows for the Upper Myakka River system have been developed for annual and the three seasonal flow conditions, as summarized in SWFWMD Table 8-10 (shown below, as included in Chapter 40D-8.041(6)(a), F.A.C.). This table includes potential withdrawals when the monitored flow is above given threshold rates. In addition to the minimum flow in SWFWMD Table 8-10, there is a target wet season high flow rate measured at the Sarasota Gage of 577 cfs. Compliance is measured for the Myakka River at the USGS Sarasota Gage, as summarized in SWFWMD Table 8-11 (also shown below).

40D-041(6)(a)2, F.A.C., Table 8-10. Minimum Flow for Myakka River at USGS Myakka River near Sarasota Gage

Period	Effective Dates	Where Flow on Previous Day Equals:	Minimum Flow Is:
Annually	January 1 to December 31	0 cfs	0 cfs
		0 cfs	Seasonally dependent see Blocks below
Block 1	April 20 to June 25	0 cfs	0 cfs
		>0 cfs	previous day flow minus 15%
Block 2	October 27 to April 19	0 cfs	0 cfs
		>0 cfs	previous day flow minus 5%
Block 3	June 26 to October 26	0 cfs	0 cfs
		>0 cfs and >577 cfs	previous day flow minus 16%
		>577 cfs	previous day flow minus 7%

40D-041(6)(a)2, F.A.C., Table 8-11. Compliance Standards for Myakka River at USGS Myakka River near Sarasota Gage		
Minimum Flow	**Hydrologic Statistic**	**Flow (cfs)**
Annual Flow	10-Year Mean	172
	10-Year Median	12
	5-Year Mean	149
	5-Year Median	5
Block 1	10-Year Mean	23
	10-Year Median	0
	5-Year Mean	4
	5-Year Median	0
Block 2	10-Year Mean	28
	10-Year Median	4
	5-Year Mean	15
	5-Year Median	3
Block 3	10-Year Mean	324
	10-Year Median	181
	5-Year Mean	241
	5-Year Median	133

It was determined by the SWFWMD that the Upper and Lower Myakka River segments were impacted by human activities such that excess flow is delivered to Flatford Swamp and other riverine wetlands. These excess flows were attributed primarily to irrigation return flow, although other contributors probably exist in the basin. The adopted MFL points to the need for flow reductions because recent flows are in excess of the naturally occurring flows (Chapter 40D-8.041(6)(b), F.A.C.). SWFWMD plans to use its regulation process to reduce the excess flows at rates between 0 and 130 cfs in the Upper Myakka River basin to restore the natural flow range. Therefore, the rule establishes that minimum flow for the Lower Myakka River at the Myakka River Sarasota Gage is 90 percent of the adjusted flow (the estimated natural flow) when the adjusted flow exceeds 400 cfs. The adjusted flow at the USGS gage is calculated by adding the flows measured at the Myakka Gage and the excess flows removed by SWFWMD from the Upper Myakka River.

MFLs for the Peace River

The Upper Peace River currently has a rule for only minimum low flows, as outlined in Rule 40D-8.041(7) – see the SWFWMD Table 8-8 below. The flow must exceed the recommended flow at the corresponding USGS gage location for 95 percent of the year, or 350 days. Minimum middle and high flows are not yet established; they were scheduled to be assessed in 2012. Compliance is achieved when the measured

flow rate is at or above the minimum low flow for 3 consecutive years. Once this is attained, the compliance measures will change (the rules do not include this criterion for other locations).

40D-041(7)(c), F.A.C., Table 8-8. Minimum Flows for the Upper Peace River	
Location/Gage	**Minimum Flow (cfs)**
Bartow / USGS Bartow River Gage No. 02294650	Annual 95% exceedance flow of 17 cfs
Fort Meade / USGS Fort Meade River Gage No. 02294898	Annual 95% exceedance flow of 27 cfs
Zolfo Springs / USGS Zolfo Springs River Gage No. 02295637	Annual 95% exceedance flow of 45 cfs

Minimum flows for the Middle Peace River at the USGS Arcadia Gage are presented in SWFWMD Table 8-6 (included below). Compliance standards for this river reach are summarized in SWFWMD Table 8-7 (also shown below) and this table includes the potential withdrawals.

40D-041(5)(b), F.A.C., Table 8-6. Minimum Flow for Middle Peace River at USGS Peace River at Arcadia Gage			
Period	**Effective Dates**	**Where Flow on Previous Day Equals:**	**Minimum Flow Is:**
Annually	January 1 to December 31	≤67 cfs >67 cfs and <1,362 cfs >1,362	67 cfs Seasonally dependent – see Blocks below Previous day flow minus 8%
Block 1	April 20 to June 25	≤67 >67 cfs and <75 cfs >75 cfs and <1,362 cfs >1,362	67 cfs 67 cfs previous day flow minus 10% previous day flow minus 8%
Block 2	October 27 to April 19	≤67 >67 cfs and <67 cfs >82 cfs and <1,362 cfs >1,362	67 cfs 67 cfs previous day flow minus 18% previous day flow minus 8%
Block 3	June 26 to October 26	≤67 cfs >67 cfs and <1,362 cfs >73 cfs and <73 cfs an >1,362	67 cfs 67 cfs previous day flow minus 13% previous day flow minus 8%

40D-041(5)(b), F.A.C., Table 8-7. Compliance Standards for Middle Peace River at Arcadia Gage

Minimum Flow	Hydrologic Statistic	Flow (cfs)
Annual Flow (January 1 through December 31)	10-Year Mean	547
	10-Year Median	243
	5-Year Mean	534
	5-Year Median	196
Block 1 (April 20 through June 25)	10-Year Mean	219
	10-Year Median	121
	5-Year Mean	160
	5-Year Median	64
Block 2 (October 27 through April 19)	10-Year Mean	359
	10-Year Median	182
	5-Year Mean	300
	5-Year Median	122
Block 3 (June 26 through October 26)	10-Year Mean	977
	10-Year Median	631
	5-Year Mean	790
	5-Year Median	382

MFLs for the Lower Peace River were established by the SWFWMD and are codified in 40D-8.041(8), F.A.C. The targeted minimum flow in the Lower Peace River is 130 cfs. No surface water withdrawals are permitted that would cumulatively cause the flow to be reduced below the minimum low flow threshold of 130 cfs based on the sum of the mean daily flows for the three gages listed in the table. This is enforced by allocating a daily allowable withdrawal limit in the WUP (PRMRWSA, listed in Table 8-20 below) based on the previous day’s flow (see Appendix G for a review of low flow at this location). Compliance standards for this river reach are summarized in SWFWMD Table 8-21 (also shown below).

40D-8.041(8), F.A.C., Table 8-20. Minimum Flow for Lower Peace River Based on the Sum of Flows from Horse Creek, Joshua Creek, and the Peace River at Arcadia Gages

Period	Effective Dates	Where Flow on Previous Day Equals:	Minimum Flow Is
Annually	January 1 through December 31	≤130 cfs >130 cfs	Actual flow (no surface water withdrawals permitted) Seasonally dependent – see Blocks below
Block 1	April 20 through June 25	≤130 cfs >130 cfs	Actual flow (no surface water withdrawals permitted) previous day's flow minus 16% but not less than 130 cfs
Block 2	October 28 through April 19	≤130 cfs >130 cfs and <625 cfs ≥625 cfs	Actual flow (no surface water withdrawals permitted) previous day's flow minus 16% but not less than 130 cfs previous day's flow minus 29%
Block 3	June 26 through October 27	≤130 cfs >130 cfs and <625 cfs ≥625 cfs	Actual flow (no surface water withdrawals permitted) previous day's flow minus 16% but not less than 130 cfs previous day's flow minus 38%

40D-8.041(8), F.A.C., Table 8-21. Minimum Five-Year and Ten-Year Moving Mean and Median Flows for the Lower Peace River Based on the Sum of Flows from Horse Creek, Joshua Creek, and the Peace River at Arcadia Gages

Minimum Flow	Hydrologic Statistic	Flow (cfs)
Annual Flow	10-Year Mean	713
	10-Year Median	327
	5-Year Mean	679
	5-Year Median	295
Block 1	10-Year Mean	284
	10-Year Median	264
	5-Year Mean	204
	5-Year Median	114
Block 2	10-Year Mean	429
	10-Year Median	383
	5-Year Mean	330
	5-Year Median	235
Block 3	10-Year Mean	1260
	10-Year Median	930
	5-Year Mean	980
	5-Year Median	595

Estuarine Reaches of the Peace and Myakka Rivers

A major hydrologic and ecological feature of the AEIS study area is found at the downstream reaches of the Peace and Myakka Rivers, where their freshwater discharges mix with the estuarine waters of the Gulf of Mexico in an area known as the Charlotte Harbor estuary. The following excerpt from the CHNEP Comprehensive Conservation and Management Plan (2000) describes this system:

> "The CHNEP study area is a special place. Three large rivers — the Myakka, Peace and Caloosahatchee — flow westward to the Gulf of Mexico. These rivers start as headwater wetlands, lakes, creeks and ground water that combine and meander until they become substantial rivers. The rivers flow through cities and towns, cattle pastures and citrus groves, pine flatwoods and cypress swamps. When these rivers meet the salty water of the Gulf of Mexico, they form estuaries that are one of the most productive natural systems on earth. Coastal bays such as Lemon Bay and Estero Bay are influenced by smaller streams and are spectacular havens for fish and wildlife. The CHNEP study area is defined by subtle topography, subtropical climate and subtropical plant communities."

Over many years, various studies have sought to define the boundaries of the estuary. Estuary segmentation is viewed as relevant to defining estuarine system segments most impacted by upstream watersheds. The goal of the segmentation is to identify factors influencing estuarine system physical, chemical, and biological integrity so that management plans can be developed to optimize how the applicable estuary segments meet designated uses associated with natural and human needs. CHNEP evaluated Charlotte Harbor estuary segment definition during review of existing water quality conditions in relation to prospective water quality criteria development. These alternative segmentation approaches were documented on behalf of CHNEP by Janicki Environmental, Inc. (2007).

Figure 3-21 reflects the segmentation approach advocated by CHNEP during development of its water quality monitoring program. This figure depicts the areas viewed where most of the river flow from these rivers is concentrated: the tidal reaches of the Peace and Myakka Rivers, "East Wall," and "West Wall" areas. These three estuarine segments appear to be the most relevant to AEIS evaluations in that they generally correspond to those identified by FDEP in impairment evaluations performed in accordance with the Clean Water Act (CWA), Section 303 water quality reviews (see Water Body Identification [WBID] Nos. 1991A and B; 2056 A, B, and C; and 2065A and B in Figure 3-22). For this AEIS, this portion of the Charlotte Harbor estuary serves as the focal area for evaluation of Peace and Myakka River discharge effects on the estuary's water quality and biological integrity.

Figure 2. Segmentation scheme used by the Coastal Charlotte Harbor Water Quality Monitoring Network.

Source: Janicki Environmental, 2007

Figure 3-21. Charlotte Harbor Estuary Segmentation Scheme, Coastal Charlotte Harbor Water Quality Monitoring Program

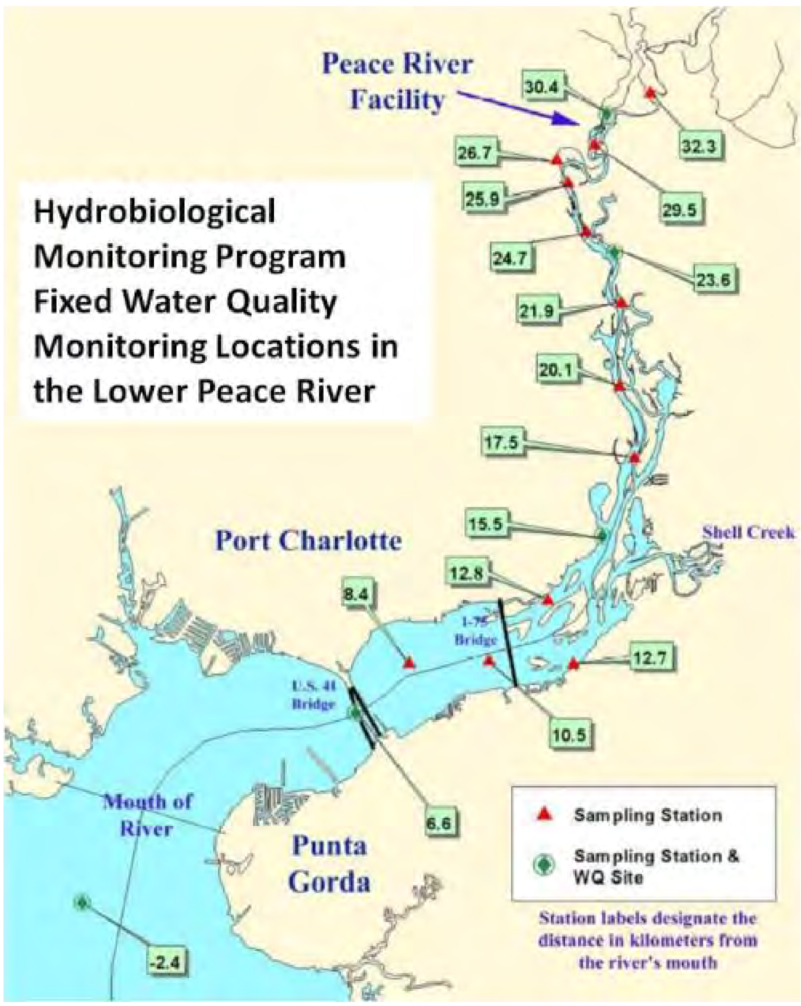
Figure 5. Florida Department of Environmental Protection Waterbody Identifiers.

Source: Janicki Environmental, 2007

Figure 3-22. Charlotte Harbor Estuary Segmentation Scheme, FDEP Water Body Segments for Water Quality Assessment under the Total Maximum Daily Load Program

A long-term Hydrobiological Monitoring Program (HBMP) has been conducted in the Lower Peace River since 1975 by the PRMRWSA with the objective of assessing the potential effects of freshwater withdrawals on the estuarine communities of the Upper Charlotte Harbor estuary (PBS&J, 2010). The monitoring records from the fixed water quality monitoring stations shown in Figure 3-23 document that the salinity regime in this reach of the river is dramatically impacted by variations in river inflow, which are

linked to precedent rainfall patterns in the overall Peace River basin. During dry years characterized by low rainfall and correspondingly low river discharge, bottom salinities approaching 20 parts per thousand (ppt) can occur as far upriver as river kilometer 23.6. Under more normal flow patterns, however, the freshwater condition persists much farther downstream, closer to the mouth of the river at Punta Gorda. The annual reports summarizing monitoring and associated modeling results have generally supported the conclusion that PRMRWSA water supply withdrawal effects on downstream salinity are small, particularly when considered in relation to the documented natural variation in the system caused by the interaction of tidal exchange and river flows. These perspectives are relevant in that the AEIS evaluations address the potential influence of phosphate mines on river flows in relation to whether any such influences would be of sufficient magnitude to result in ecologically meaningful changes in salinity regimes.



Source: PBS&J, 2010

Figure 3-23. Hydrobiological Monitoring Program Water Quality Monitoring Locations in the Lower Peace River

Full characterization of the existing conditions in the Lower Peace River and in the Charlotte Harbor estuary cannot be adequately covered in this brief section of the AEIS. Rather, interested parties are encouraged to review the extensive body of work consisting of technical reports and management plans generated by PRMRWSA for the river, and by the CHNEP in collaboration with USEPA, the Southwest Florida Regional Planning Council, the SWFWMD, the FDEP, and many other local, state, and federal agencies that have supported natural and human environmental resource management planning for the Charlotte Harbor estuary.

3.3.2.2 **Groundwater Systems**

The AEIS study area includes three hydrostratigraphic units (Fernald and Purdum, 1998a):

- The Surficial Aquifer System (SAS)
- The Intermediate Aquifer System/Intermediate Confining Unit (IAS/ICU)
- The Floridan Aquifer System (FAS)

These aquifers have been described as "…not uniformly permeable throughout their thickness. Each aquifer contains zones of higher permeability (flow zones) that are partially separated from one another by semi-confining, lower permeability zones. The aquifers are also hydrologically separated from each other by confining beds that strongly restrict movement between the aquifers" (SWFWMD, 1993). Despite these confining beds, which help differentiate the three aquifers from each other, there is vertical water movement through the system. This result in recharge of the SAS by infiltration of rainfall accumulated on the land surface and variable interaction between the SAS and the underlying aquifers, depending on the geological formation characteristics and water level differences in a given area.

The upper Floridan aquifer is a principal source of water in the SWFWMD used for major industrial, mining, public supply, domestic use, and agricultural irrigation (SWFWMD, 2009b). Other withdrawals include use of the pumped water to support brackish water desalination in some coastal communities. Historical heavy reliance on the FAS to support these water supply uses by the user categories listed above resulted in significant cumulative aquifer level drawdown in the northern Peace River watershed and adjacent areas in the overall AEIS study area in central Florida. In this sub-watershed of the Peace River system, and adjacent land areas, FAS drawdown contributed to impacts on surface water bodies in the form of lake level decreases and reduced groundwater contributions to Peace River baseflows. Along the Gulf coast, FAS drawdown impacts led to increased magnitude and spatial extent of salt water intrusion into the freshwater portions of the aquifer, and increasing risk of permanent impacts to the usability of coastal water supply wellfields.

As described by SWFWMD in a 2002 report on saltwater intrusion (SWFWMD, 2002b):

> "Major uses of ground water have historically been for agricultural irrigation and mining of phosphate ore. Locations of agricultural withdrawals tend to be distributed throughout the basin, whereas, phosphate mining has been concentrated in the areas of southeast Hillsborough, southwest Polk, and northern Hardee Counties. Since the 1970s, there has been a shift in water use from the mining industry to other water use types in other areas of the basin. As described in Beach et al. (2002b), the 1990s was a period of water level recovery in the northern portion of the basin and continued water level decline in southern portions of the basin. This, in large part, was due to the migration of agriculture into the area. Decreased water use in the northern portion of the basin was largely due to increased water conservation practices by the phosphate mining industry since the 1970s and other changes within the industry that occurred."

The AEIS study area is in a SWFWMD water supply planning area defined as the Southern Water Use Caution Area (SWUCA). SWFWMD applied this designation based on concerns that cumulative reliance on withdrawals from the upper FAS through well systems to meet potable, agricultural, and mining water supply demands has resulted in a decline of the potentiometric surface of the Floridan aquifer. This has led to saltwater intrusion into the FAS along the Gulf coast and changes to aquifer flow gradients in the Upper Peace River and adjacent watersheds, leading to changes in groundwater contribution to river baseflows and wetland stages. SWFWMD and many other agencies are working together toward implementing the SWUCA Recovery Strategy (SWFWMD, 2006b). This is designed to stabilize the FAS and prevent further lowering of FAS water levels. The long-term goal is for FAS recovery to higher water levels that will reduce the rate of saltwater intrusion and help maintain surface water systems.

A key SWUCA recovery strategy goal is limiting current FAS allocations for all users at 650 million gallons per day (mgd); it also sets a goal of reducing this total to 600 mgd by the year 2025 to meet Salt Water Intrusion and Minimum Aquifer Level (SWIMAL) requirements. To reach that goal, SWFWMD's strategy anticipates a reduction in groundwater use by agriculture of 50 mgd between 2005 and 2025 (SWFWMD, 2006b). Allocations for groundwater withdrawals for other users would be held at their current levels. Agricultural water use has decreased and is expected to continue to decrease due to land use transition coupled with SWFWMD's investment in irrigation, conservation, and alternative water supply projects. The SWUCA rules and cooperative funding programs are encouraging future reductions through conservation practices by all user groups.

Figure 3-24 summarizes the FAS water use allocations in permits issued by SWFWMD as of 2009 in the SWUCA Planning Area; these values were reported in the water management district's estimated water use report for that year, which was completed in June 2011 (SWFWMD, 2011b). Table 3-6 shows the same information. Agricultural allocations represented 57.4 percent of the total allocations in the SWUCA planning area. The aggregate of all public water supply users represented 22.3 percent of the total. The

industrial/commercial and mining/dewatering categories represented 8.1 and 8.5 percent of the total, respectively. Recreational/aesthetic water users (golf courses, parks, etc.) represented the smallest user group at 3.8 percent of the total. While actual water usage totals are variable depending on the interaction of factors such as antecedent rainfall, variations in market conditions affecting industrial/commercial/mining operational levels, and varying population levels and use of conservation methods, these relative allocation levels generally reflect the historical usage relationships between the user categories.

From a water management district-wide perspective, review of historical usage trends compared to the 2009 FAS allocations demonstrates the relative relationships between allocations and actual usage. From 2001 through 2009, actual water use from the FAS for the various user categories was relatively consistent for the agricultural, industrial/commercial, public supply, and recreational/aesthetic user categories (Table 3-7). The collective mining/dewatering user category use has shown a decreasing trend over this time period.

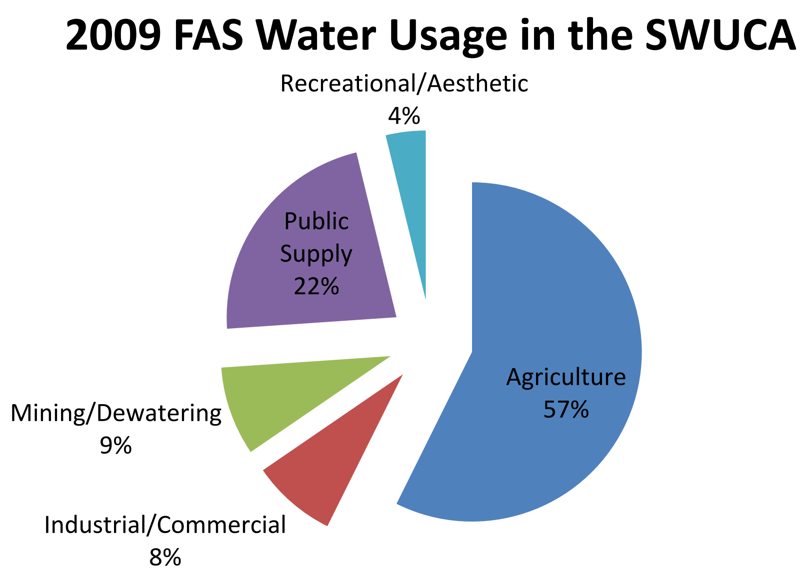


Figure 3-24. 2009 Floridan Aquifer Water Use Allocations in the SWUCA Planning Area

Table 3-6. 2009 FAS Water Allocations for All Water User Categories in the SWUCA		
Water User Category	**2009 FAS Water Use Allocation, in mgd**	**% of Total Allocations**
Agriculture	575	57.4
Industrial/Commercial	81	8.1
Mining/Dewatering	85	8.5
Public Supply	223	22.3
Recreational/Aesthetic	38	3.8
Totals	**1,002**	**100.0**
Source: SWFWMD, 2011b		

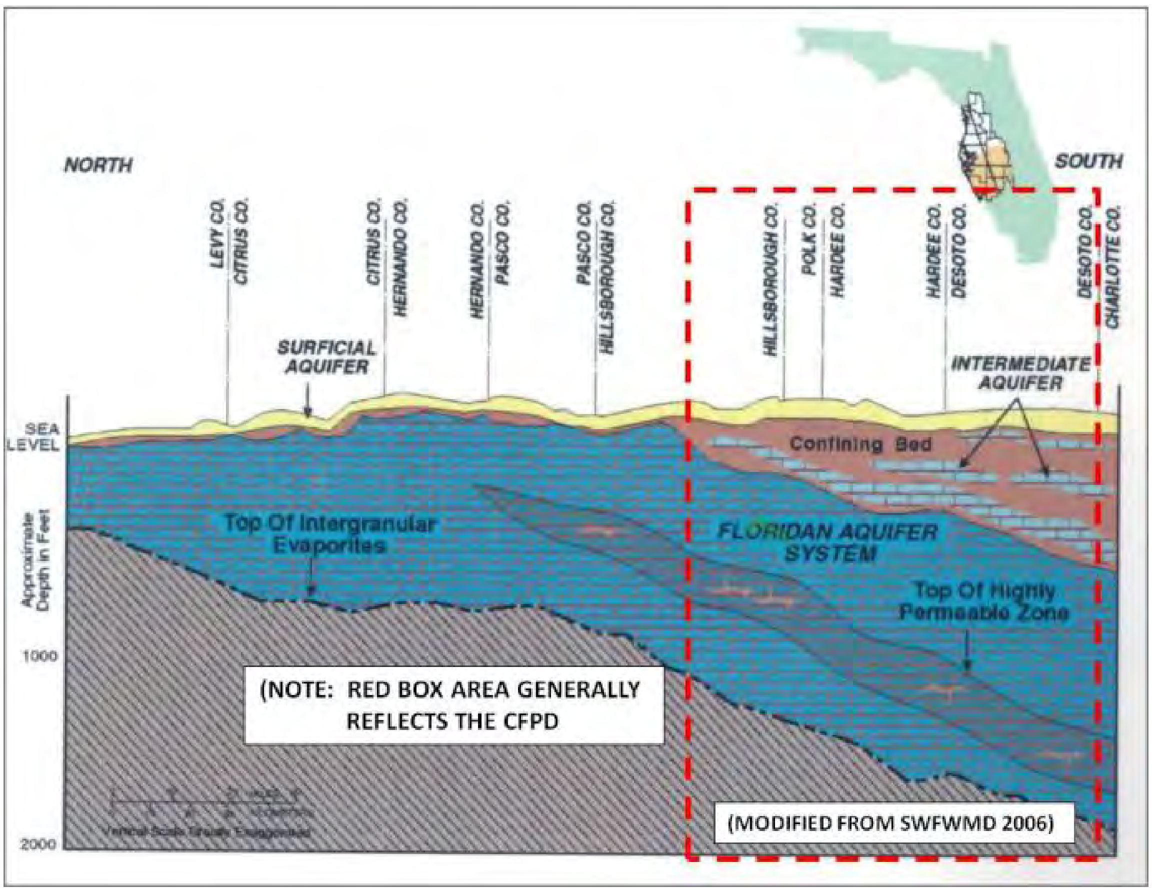
Table 3-7. Comparison of 2009 FAS Water Allocations and Historical Water Use for All Water User Categories District-Wide										
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2009 Total**
Category	**Reported Pumpage (mgd)**									**2009 Total Permitted Quantity for All Permits (mgd)**
Agriculture	318	273	227	246	199	298	273	240	291	773
Industrial/Commercial	66	69	64	55	51	61	57	57	57	160
Mining/Dewatering	65	47	58	64	46	37	45	37	31	103
Public Supply	503	497	481	513	562	522	472	492	522	771
Recreational/Aesthetic	32	32	28	33	28	37	33	30	33	124
District Totals	**984**	**918**	**858**	**911**	**886**	**955**	**880**	**856**	**934**	**1931**
Source: SWFWMD, 2011b										

As described above, impacts on the Floridan aquifer associated with historical phosphate mining-related water withdrawals in the CFPD have been substantially reduced compared to the types of impacts that occurred in the 1970s and 1980s. Water conservation measures and increased reliance on surface water capture and reuse have contributed to the reduced reliance on the FAS for water supply.

Descriptions of the three aquifers are found in the SWUCA Recovery Strategy document. The SWUCA generally includes southwestern Polk County, southeastern Hillsborough County, all of Hardee, Manatee, Sarasota, and DeSoto Counties, and northwestern Charlotte County – essentially including all lands in and immediately adjacent to the CFPD. In this area, the SAS represents a relatively consistent thin layer overlying the IAS. The IAS becomes thicker and deeper from north to south and the FAS correspondingly is found deeper below the land surface along a north/south gradient. The generalized relationships

among the aquifers in the AEIS study area are reflected in Figure 3-25, reproduced from the Recovery Strategy document (SWFWMD, 2006b).

In areas where the intermediate aquifer is very thin or otherwise penetrated by solution cavities through the limerock (karst features), the SAS may interact directly through the IAS with the FAS, recharging the FAS if there is a downward hydraulic gradient or alternatively being recharged by upward flow from the FAS if there is an upward pressure gradient. Both the Pine Level/Keys and Pioneer Tract offsite alternatives are in areas where the formations comprising the IAS and associated confining beds are thicker and where the FAS is not connected to the SAS. The top of the FAS is also much deeper than in the northern parts of the study area, resulting in less karst activity and few sinkholes in the areas of these offsite alternatives.



Source: SWFWMD, 2006a

Figure 3-25. General North – South Hydrogeologic Cross Section through SWFWMD Including the CFPD

All three aquifers are evaluated in this section and in the groundwater modeling evaluations in Chapter 4 and Appendix F. Descriptions of each aquifer and the possible phosphate mining impacts on them are described below.

Surficial Aquifer System

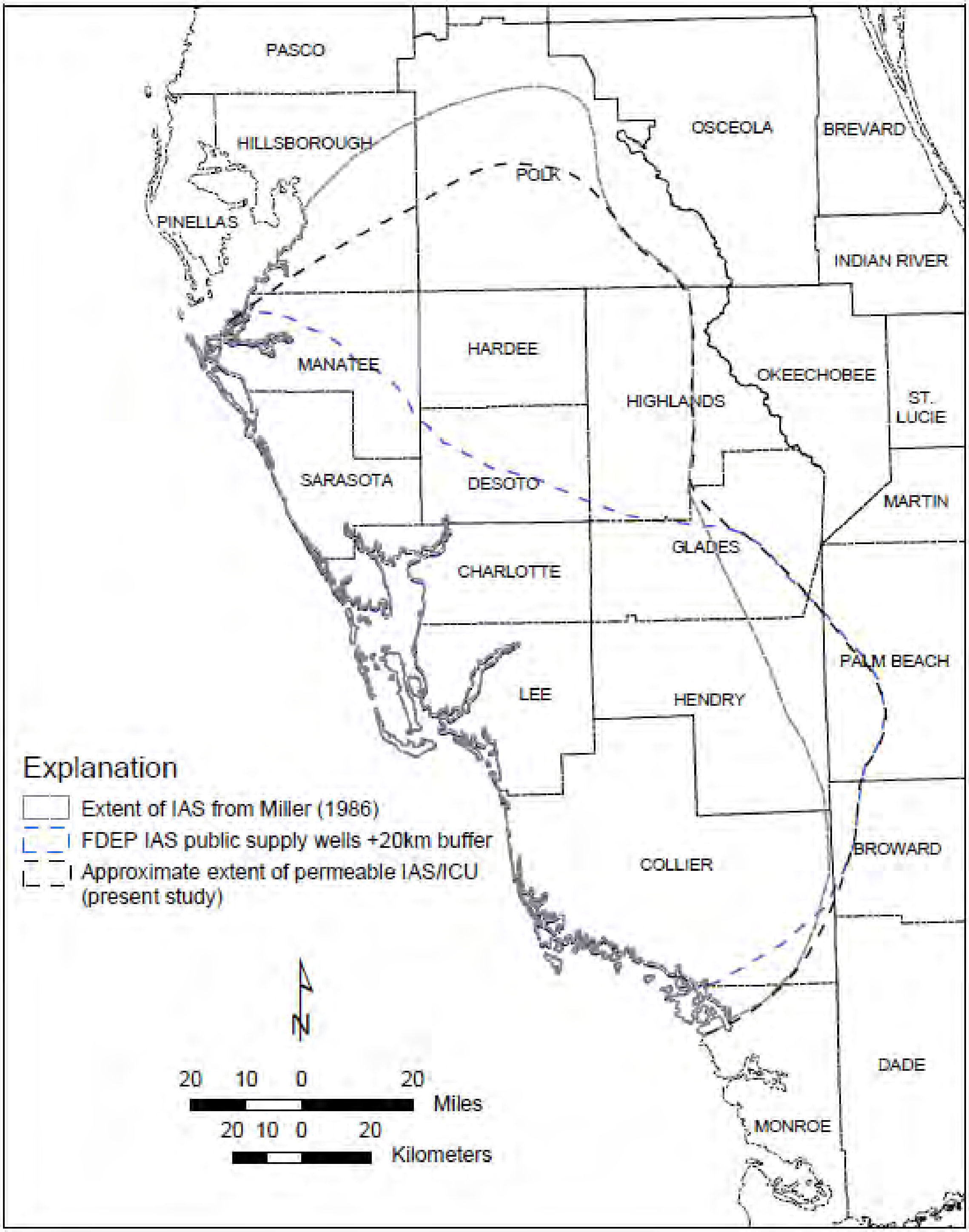
The SAS includes unconsolidated quartz sand, shell, clay, and phosphate from the Late Pliocene to the Holocene periods (Florida Geological Survey [FGS], 2008). Regionally, it is an unconfined aquifer that extends from land surface to depths of up to several hundred feet. In the CFPD, its thickness is on the order of 30 to 60 feet and semi-confining clay layers are variably present within the aquifer thickness. SWFWMD indicated that “Seasonal fluctuations in the water table are generally less than five feet. Water levels are typically lowest in the spring and highest in late summer” (SWFWMD, 1993). These natural seasonal fluctuations in the depth to the top of the SAS are natural reflections of water table response to variations in infiltration of rainfall from the land surface.

The surface of the water table typically is found within approximately 10 feet of the land surface, and generally follows the surface topography (Sepúlveda, 2002). Local discharges to wetlands, lakes, and rivers occur where the water table and land surface intersect. SAS contributions to baseflow of surface water bodies are an important linkage between surface water and groundwater conditions.

Intermediate Aquifer System

The IAS consists of low-permeability Oligocene-Pliocene sediments interbedded with discontinuous permeable layers that serve as small-scale water supply sources. The lower-permeability clays that comprise portions of the IAS result in differing water levels in each permeable unit (FGS, 2008 [page 62]). Figure 3-26 depicts the extent of the permeable zones within the IAS (FGS Bulletin 68, Figure 23).

In the northern portions of the CFPD, where historical mining was most intensively conducted, the IAS is thinner and more permeable than in the southern portions of the CFPD. Duerr et al. (1988) reported that in the vicinity of the northern boundary of the CFPD, the IAS is on the order of 100 to 200 feet thick in contrast with areas to the south near the southern border (mid-DeSoto County) where it varies between 400 and 500 feet thick. Karst geologic formations, consisting of limerock with extensive solution cavities, in the Polk County area provide conveyance routes between the SAS and the IAS, but such features are sparse to the south in the Peace River watershed.



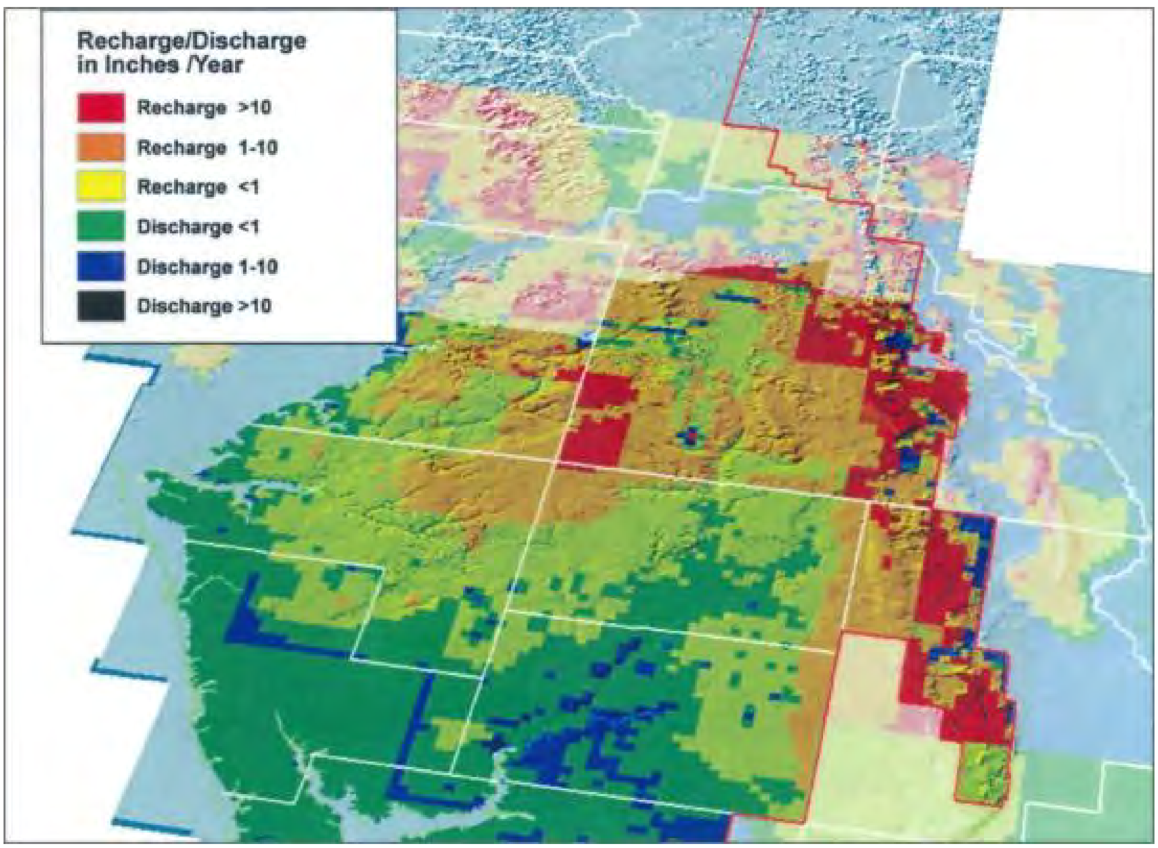
Source: FGS, 2008

Figure 3-26. Approximate Extent of the Intermediate Aquifer System/Intermediate Confining Unit in the AEIS Study Area

Floridan Aquifer System

The FAS is composed of the Lower Oligocene Suwannee Limestone, the Upper Eocene Ocala Limestone, and the Middle Eocene Avon Park Formation. The FAS is defined by permeability and hydraulic connection with other units (Bush and Johnston, 1988), such as basal portions of the Hawthorn Group. The FAS is a regionally extensive aquifer that is present beneath nearly the entire Florida peninsula. The hydraulic gradient in the FAS in the study area is generally from the east to the west, towards the Gulf of Mexico.

Water level differences between the FAS and the overlying IAS and SAS vary in the AEIS study area. Historically, these pressure gradients favored downward recharge of the aquifers in the northern portions of the CFPD, generally in the vicinity of Polk and Hillsborough Counties. In the central portion of the CFPD, the gradients were lower and could reverse seasonally with higher water levels in the FAS than in the IAS during the dry season, but lower water levels in the FAS than in the IAS during the wet season. In the southernmost portions of the study area, historical water level gradients have generally been higher in the FAS than in the IAS, as reflected in Figure 3-27.



Source: SWFWMD, 2006b

Figure 3-27. Areas of Recharge to and Discharge from the Floridan Aquifer in the SWUCA

With respect to conditions in the Peace River basin, the following general statements are believed to be applicable (SWFWMD, 2001b).

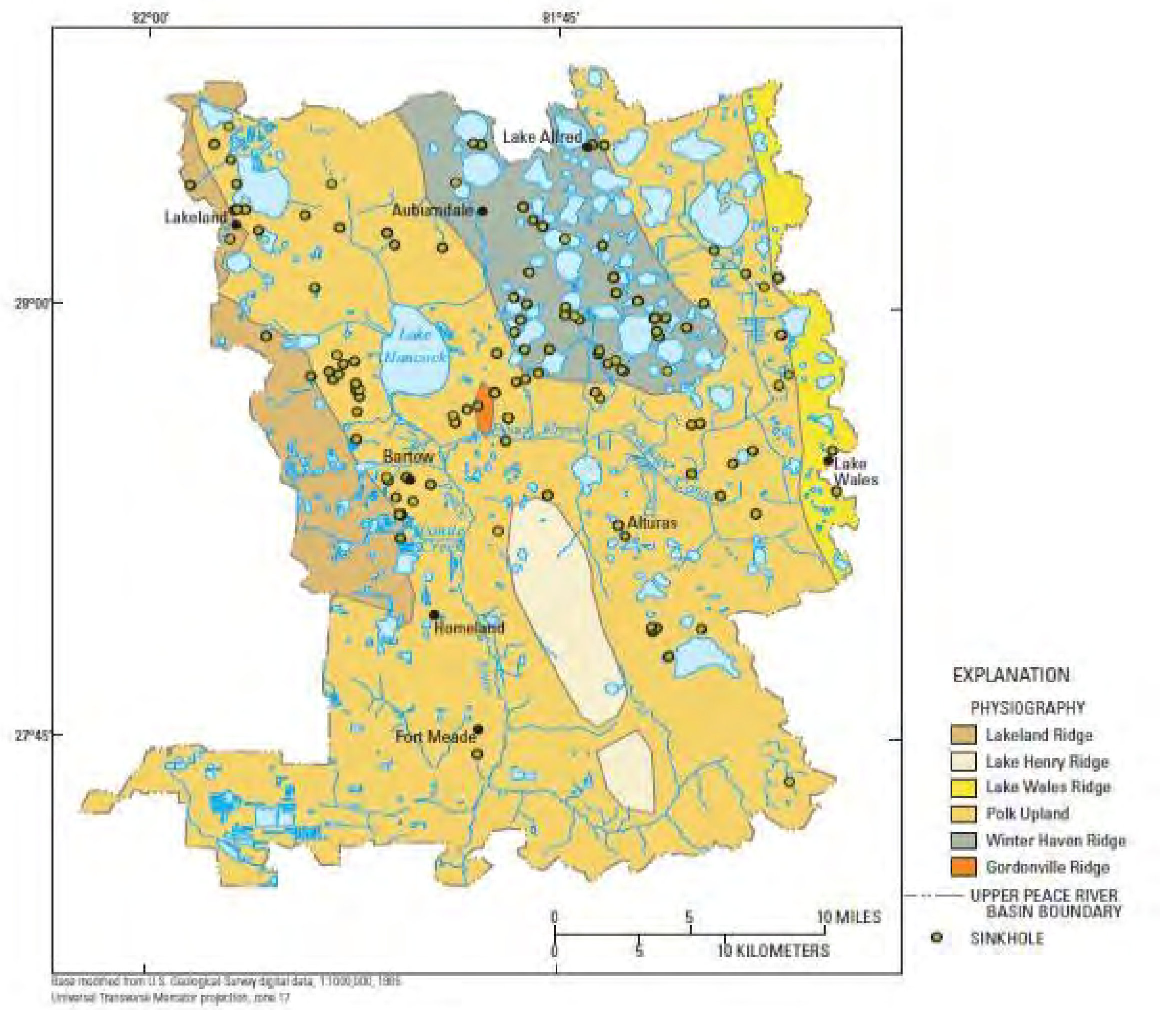
- The Peace River from Bartow to Fort Meade historically served as a net groundwater recharge area.
- The Peace River between Fort Meade and Zolfo Springs is a transition area where changing groundwater levels create seasonal, alternating groundwater recharge and discharge conditions.
- The Peace River from south of Zolfo Springs to Arcadia and beyond is an area of upward groundwater discharge.

Direct Sinkhole and Spring Connections

Several investigations have focused on the prevalence of near-surface karst geological formations in the Upper Peace River watershed, with particular focus on the Peace River at Bartow subbasin (areas north of Bartow). Karst geological formations are limestone layers characterized by extensive solution cavities that provide pathways for groundwater flow. The potential for sinkhole formation is greater where such formations are naturally prevalent near the ground surface than where the formations are deeper.

Metz and Lewelling (2009) documented that the Upper Peace River basin north of Fort Meade is an area where there are a significant number of sinkholes (Figure 3-28). In this area, FAS drawdown from the regional water uses by all water well users has occurred. Because of the prevalence of karst formations and aquifer interconnections in the river bed, there are now some locations where river water disappears during dry periods and the streambed goes dry. Metz and Lewelling (2009) indicated that the effects of these sinkholes are less obvious downstream of Dover, approximately 1-2 miles south of Bartow.

USGS and others have documented that in some locations spring discharges historically were significant contributors to river baseflow. The case of Kissengen Spring is well documented. Kissengen Spring was a second magnitude spring that once contributed an average of 20 mgd to the Peace River basin in Polk County (Metz and Cimitile, 2010). Kissengen Spring is now inactive; it stopped flowing regularly in February 1950; the major cause of flow cessation is attributed to regional groundwater withdrawal from FAS wells (SWFWMD, 2011a). USGS indicated that phosphate mining use of FAS wells for water supply was a contributing factor to the regional FAS drawdown that resulted in the cessation of flow from this spring (Metz and Lewelling, 2009).



Source: Metz and Lewelling, 2009

Figure 3-28. Locations of Known Sinkholes in the Upper Peace River Basin

3.3.2.3 Past Mining Effects on Water Resources

Although phosphate mining water use has been dramatically reduced since the 1970s, phosphate mines continue to use FAS withdrawals to provide supplemental water on an as-needed basis. Evaluation of potential effects of continued phosphate mining in the CFPD on the FAS will need to address the potential for aquifer drawdown impacts similar to those documented in the upper Peace River basin. Typically in the past, each existing mine's WUP provided a maximum annual average as well as either a maximum daily or a peak month withdrawal allocation, and through conservation and alternative water supply management strategies, the existing mines have succeeded in operating well below their permitted withdrawal limits. An evaluation of continued use of the FAS to supply the necessary water to continue mining in the future is evaluated in Chapter 4.

This discussion examines the effects of past mining (including dewatering and reclamation) on existing conditions of surface water and groundwater resources, as well as linkages among these factors. Because of these linkages, each of the four parts of this discussion addresses relationships between surface water and groundwater:

- Past Effects of Phosphate Mine Operations on Surface Water Hydrology
- Past Effects of Phosphate Mine Operations on the Aquifer System
- Historical Effects of Phosphate Mining on Water Budgets
- Historical Effects of Phosphate Mine Reclamation on Surface Water Hydrology

Past effects provide not only an indication of how water resources have been affected by mining historically, but also provide an indication of the influence on current conditions. From a hydrologic perspective, most concerns raised about phosphate mining effects on local and basin level water resources have been focused on water supply withdrawals from the FAS for historical phosphate mining use. Prior to July 1975, there were no regulations constraining phosphate mining water use in the CFPD, and one of the unregulated effects was the widespread and large-scale use of FAS wells for mining water supply. Particularly in the Upper Peace River watershed, where the oldest mines were located, mining water supply withdrawals from the FAS contributed to regional FAS drawdown, which also contributed to lowered aquifer water levels in the overlying IAS and SAS. Other FAS users also contributed to this regional lowering of the FAS, but USGS has suggested that because phosphate mining was such a major water user, it historically had a major influence on regional drawdown of the aquifer (Metz and Lewelling, 2009). In contrast to this historical pumping, SWFWMD’s 2010 report of water usage in the CFPD shows that the combined withdrawals for mining and dewatering uses represent less than 10 percent of the total withdrawals from the upper FAS (SWFWMD, 2010a).

Past Effects of Phosphate Mine Operations on Surface Water Hydrology

The SWFWMD has conducted several comprehensive analyses of the river basins in the region in support of development of targeted MFLs for prioritized water bodies and aquifers. One of those investigations focused on the Alafia River basin (SWFWMD, 2005a). Historically, there has been substantial phosphate mining in this basin. For example, the areas classified as mining in the state’s land use cover data in the South Prong of the Alafia basin increased from less than 10 percent in 1972 to over 60 percent in 1999. During this same period, reduced river flows were documented. In the Alafia River Minimum Flows and Levels assessment, the SWFWMD (2005a) stated:

> “Although there has been considerable phosphate mining in the Alafia watershed (especially in the watersheds of the North and South Prongs) and substantial groundwater withdrawals

> from the Floridan aquifer, comparison of river flow declines with neighboring watersheds suggests a similar causative factor for flow declines. Our analyses indicate that flow declines attributed by Stoker et al. (1996) to groundwater withdrawals, and by SDI Environmental Services (SDI, 2003) to increasing area of mined land are due to another factor, namely the removal or reduction of discharges from the phosphate mining industry. These flow declines actually represent an increase in water use efficiency by the mining industry such that the large volumes of groundwater historically used for ore extraction and processing have been substantially reduced. In response to work done by SDI (2003), we have compared discharge volumes from the watersheds of the South and North Prongs of the Alafia River to demonstrate that similar amounts of water are being discharged from both basins and thus increasing area of mined lands has not lead to substantial nor quantifiable reductions in flow."

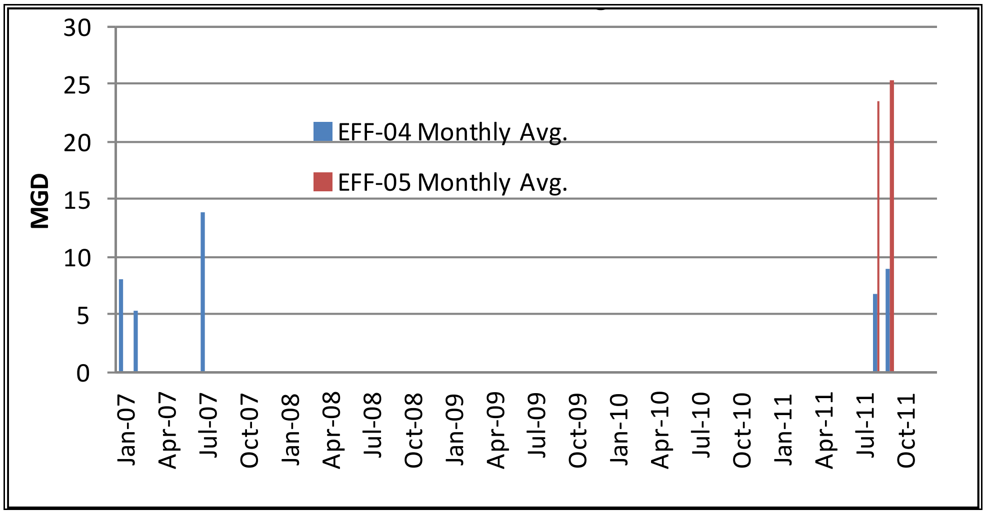
The SWFWMD analysis of the Alafia River used recorded water quality constituents of phosphorus and dissolved fluoride as corroborating evidence that the reductions in mine discharges are correlated to flow reductions. SWFWMD noted that the flow rates did not trend up or down significantly after the 1970s, even though the percentage of land used for mining increased significantly in the Alafia River basin. Thus, at least in this watershed, SWFWMD concluded that reduction in river flows was at least in part attributable to the fact that the mining industry had reduced its net use of water and decreased its offsite discharges, with those reductions contributing to the lowered flow rates in the river.

A more recent USGS investigation evaluated how groundwater levels and storage and overflow of water from headwater wetlands contribute to streamflow in an unmined portion of Charlie Creek (Lee et al., 2010). An integrated surface water and groundwater computer model (MIKE SHE) simulation was used to simulate daily streamflow observed over 21 months in 2004 and 2005, and to quantify the monthly and annual water budgets for the five subbasins of Charlie Creek, including the changing amount of water stored in the wetlands.

Recent state of Florida regulatory review of proposed mines includes hydrologic evaluation to confirm that the water management system will provide adequate stormwater runoff control to meet the state's requirements. Longer-term perspectives on how a mine's operations affect a given watershed or subbasin's water balance are also relevant. With the current ditch and berm systems, the contained portions of active mines become hydrologically isolated from the rest of the watershed, with outflows being highly managed. To evaluate the current surface water discharges from active mines, NPDES reports from the current CF Industries and Mosaic facilities were reviewed.

Past discharge monitoring records provided by CF Industries to FDEP in accordance with the South Pasture operations permit indicated that discharges through the two NPDES outfalls occurred during only 5 months over a 60-month period between 2007 and 2011 (Figure 3-29). These data confirmed that during this period of record, the South Pasture Mine's ditch and berm system contained the accumulated stormwater. This time

period also had low to normal rainfall (see Appendix G for data by county). Depending on the phase of activity in a mine, there may be a need to retain more stormwater to fill settling areas, or to feed the ditch and berm systems to keep adjacent streams and wetlands moist. Runoff data need to be evaluated over the entire mine life to determine typical discharge totals.



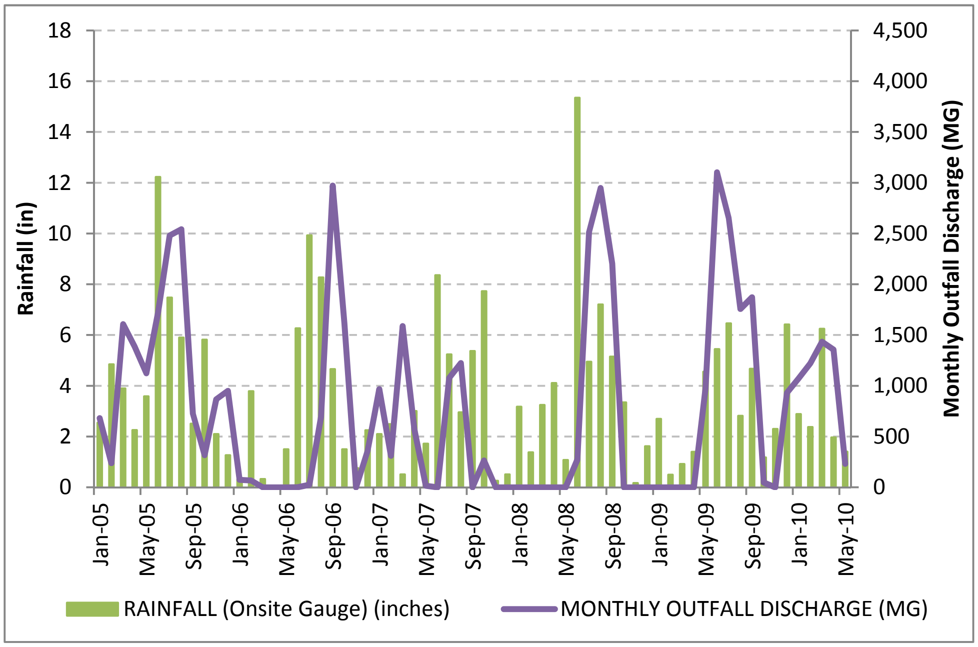
Source: CF Industries, 2012a

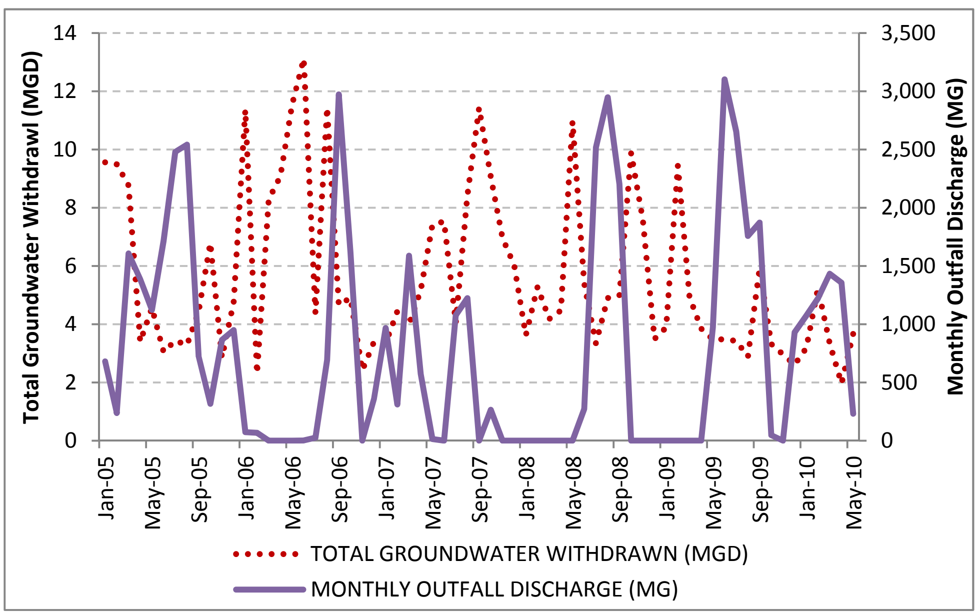
Figure 3-29. NPDES Discharge Records from the CF Industries South Pasture Mine

Recent NPDES data from representative Mosaic mines were also reviewed. Figure 3-30 depicts the NPDES discharges from the Four Corners Mine from 2004 through 2010. Figure 3-31 reflects the NPDES discharge records for the South Fort Meade Mine from 2005 through 2010. For the graphical summary of the Four Corners Mine, the discharge data shown are the total discharge per month from the mine's two outfalls combined, in million gallons (MG), and the rainfall records are shown in inches per month. The South Fort Meade Mine data reflect the discharge data for the mine's single outfall. These NPDES discharge records demonstrate that the mine recirculation systems are operated to retain accumulated rainfall, resulting in extended periods of no surface discharge during dry conditions. Surface discharges occur during or following periods of heavy rainfall if the recirculation systems' capacity to store the water is exceeded. The supporting figures relating discharge periods to groundwater withdrawals from the FAS water supply wells further indicate that surface discharges offsite are inversely correlated with use of the wells for water supply augmentation.

These figures reflect the mining industry's current onsite water management practices, which are the result of conservation strategies designed to reduce reliance on the FAS water supply wells for water supply augmentation. In addition to reducing the FAS usage, stormwater may be slowly released downstream through seepage from the ditch and berm system, designed to offset dewatering effects. Through these practices, reduction in phosphate mining effects on the FAS has been accomplished;

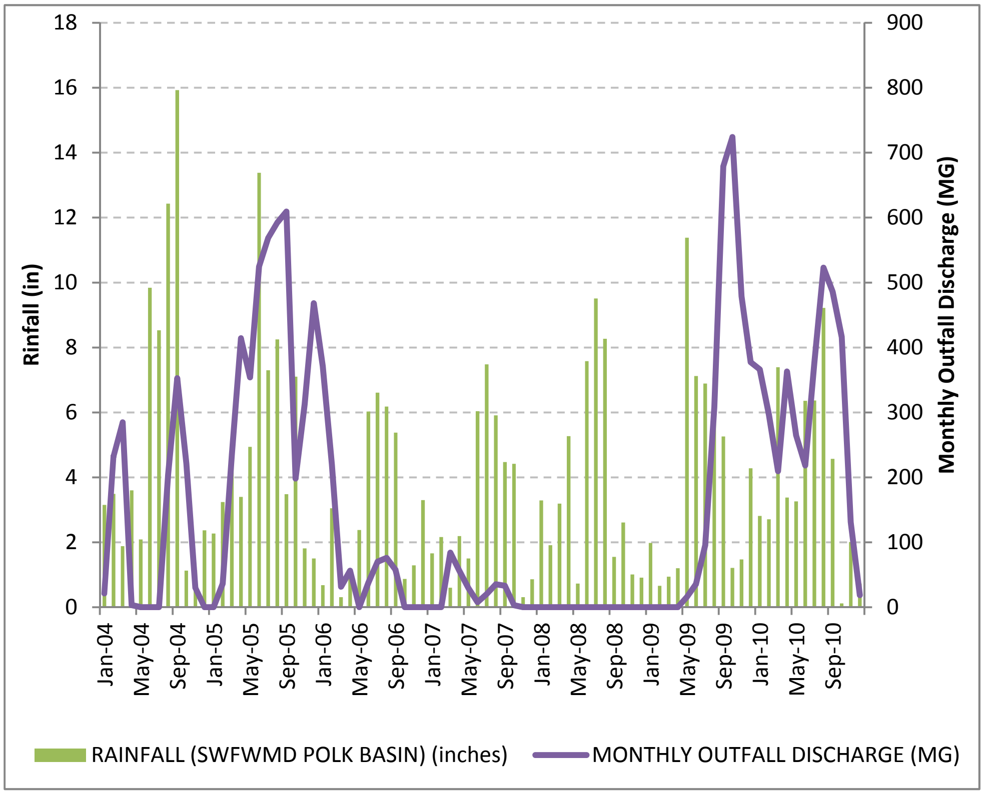
however, in the process the impacted mine areas could potentially contribute less to the impacted watershed's seasonal runoff accumulations during the life of the mine. These relationships are addressed further in Chapter 4.

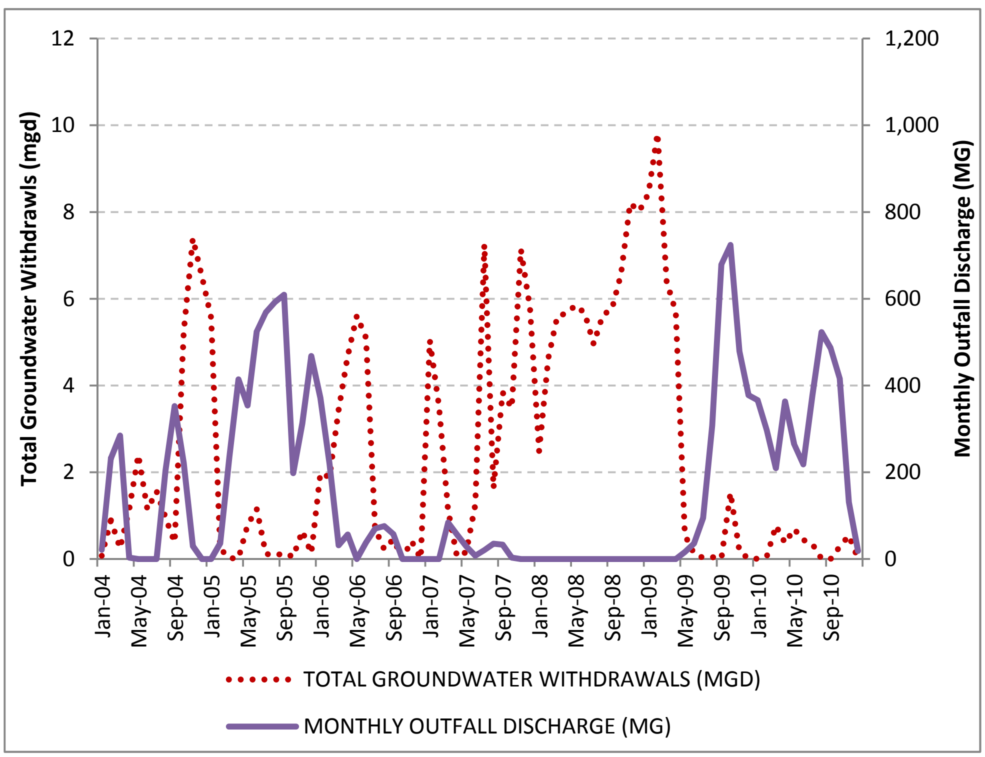




Source: Mosaic, 2011d

Figure 3-30. Mosaic Four Corners Mine NPDES Discharges





Source: Mosaic, 2011d

Figure 3-31. Mosaic South Fort Meade Mine NPDES Discharges

Past Effects of Phosphate Mine Operations on the Aquifer System

As with surface water resources, past effects of phosphate mine operations on the aquifer system provides not only an indication of how the system has been affected by mining historically, but also provides an indication of the influence of mining on current aquifer conditions. Region-wide lowering of FAS water levels has occurred as a result of the combined withdrawals of the region to meet water supply demands of agricultural, potable water, and industrial users (including phosphate mining). From the 1940s through the mid-1970s, phosphate mining was one of the largest groundwater users in the Upper Peace River watershed. By implementing water conservation practices, including greater reliance on capturing and recycling onsite surface waters for use in the mining and beneficiation activities, groundwater use at phosphate mines has been greatly reduced since the mid-1970s (PBS&J, 2007). Garlanger (2002) reported that current practices recycle as much as 95 percent of the water used at mining and beneficiation plants from the water retained and stored onsite.

Several USGS studies have documented the close hydrologic linkage between Peace River flows and underlying aquifer conditions. In 1990, USGS reported on an analysis of flows entering Charlotte Harbor (Hammett, 1990). Hammett documented the potentiometric levels in the region between 1934 and 1984. A statistically significant decline in flows was found using Peace River flow records available from the 1930s though 1984. This report attributed the reduction of surface water flows to the reduction in groundwater levels in the basin, although Hammett did not find similar reductions in stormwater flow in the Myakka River basin. Garlanger (2002) hypothesized that other factors like return flow from an increase in agriculture in the Myakka River basin helped maintain flow rates in that system.

Phosphate mine operations can impact the SAS in a number of ways. The most direct impact is extensive earthwork in the SAS itself in the mine blocks. Groundwater dewatering is accomplished through pumping of the SAS from a network of shallow wells or through excavating pits and pumping from the pits. Dewatering lowers the local water table and if environmentally sensitive habitats are within the dewatering zone of influence, hydrologic impacts may occur. This potential dewatering effect is why the ditch and berm systems were implemented; that is, to provide a boundary with a controlled water table in the SAS.

Other potential phosphate mining effects on the SAS are related to changes in surficial soil conditions following mine reclamation. The reclamation efforts seek to establish a surficial soil horizon that emulates the hydrologic characteristics of unmined lands. However, the relative success of these efforts has been long debated. There are concerns that soil condition alterations on reclaimed land lead to modified rainfall infiltration rates and runoff conditions that, in the aggregate, modify the local site water balance conditions. Mine cuts reclamation typically involves filling the cuts with sand pumped from the beneficiation plant site or from a stockpile site. Overburden stockpiled during the dragline operations is used to cover the sand-filled cuts. Current reclamation practices use a mixture of overburden and sand tailings to provide a better media for plant growth (related to water holding capacity). Care is taken that

the soils are not over-compacted by heavy equipment, which also may reduce soil productivity. For targeted wetland reclamation areas, stockpiled muck is used to improve hydric conditions and to add a seed bank. Similarly, topsoil removed from an active mine may be used to restore topsoil in upland areas. The CSAs have clayey soil that can be highly productive on its own if it is properly drained (that is, no need for additional soil amendments). The resulting reclamation area soils represent a modified surface substrate compared to that of unmined land. However, the hydrologic response from the whole mine area, considering the mixture of sandy soils and CSAs, averages out to approximate unmined conditions (see Appendix G).

As noted above, Metz and Lewelling (2009) investigated hydrologic conditions that influence streamflow losses in the Upper Peace River in Polk County. A historical summary of hydrology, climate, land use, and groundwater use in the Upper Peace River basin was included in this report, and the hydrogeology and water chemistry of the aquifers underlying the basin were described. Additionally, the report provided an inventory of the prominent karst features along the Upper Peace River. A detailed flow monitoring program was used to characterize streamflow losses to karst features for the period of 2002 through 2007. These analyses documented the hydraulic connection between the Upper Peace River and the underlying aquifers.

USGS and SWFWMD reports indicate that, beginning in the 1950s, this portion of the Peace River watershed changed from being a groundwater discharge area, through springs providing flow to the Peace River, to being an aquifer recharge area where flow moves downward from the surface into the underlying aquifers. This change was attributed to increases in Floridan aquifer use for water supply purposes, which created about a 40-foot decline in groundwater levels. According to the 2009 Metz and Lewelling USGS document, the declines observed in river streamflow are attributed to a combination of factors, including:

- Rainfall deficits
- Regional FAS groundwater withdrawals
- Changes to natural drainage patterns of Peace River tributaries
- Altered surface sediments that affect runoff, infiltration, and baseflow characteristics
- Karst features found in low-water channels that contribute to loss of streamflow

Metz and Lewelling (2009) stated in their report that phosphate mining contributed to reductions in stream flow through the following:

- Pre-1975 groundwater withdrawal from which the underlying aquifers have not fully recovered

- Changes in natural drainage patterns through the construction of CSAs, construction of ditches, and canalization of natural streams
- Land reclamation practices that leave large tracts of land filled with clay-waste, which decreased the natural hydraulic conductivity of the landscape, in turn decreasing the natural aquifer recharge in the area

Although the first observation is accurate, the mining industry has greatly reduced overall withdrawals since 1975, while at the same time other users such as public supply and agriculture have increased withdrawals. The net effect of these combined changes in the regional groundwater use has been a small recovery of water levels in the FAS, though not to pre-1975 levels (SWFWMD, 2001a).

Modeling results (Lee et al., 2010) demonstrated the linkage between the IAS water levels, the upward groundwater discharge, baseflow contributions, and Charlie Creek streamflow. It was found that artesian head conditions (i.e., pressure from groundwater) in the IAS were an important source of upward flow to the surficial aquifer in the vicinity of headwater wetlands and stream channels. Artesian head conditions in the IAS were consistently associated with wetland-dominated headwater regions, which prevent water in the surficial aquifer and wetlands from recharging downward. It was concluded that a reduction in artesian head pressure in the IAS would result in reduction of streamflow by lowering wetland water levels, increasing depression storage, and reducing the frequency with which water stored in the wetlands spills over to streams.

The authors concluded that there is a dynamic balance between wetland storage, rainfall-runoff processes, and groundwater-level differences in the upper parts of the Charlie Creek basin. It was estimated that these processes account for approximately half of the streamflow from Charlie Creek to the Peace River. The conclusion relevant to potential effects of phosphate mining on subbasin and overall watershed water balance was that alterations to this part of the basin that include changes in the hydraulic connectivity to wetlands during high flow conditions or reduce groundwater levels could substantially affect streamflow in Charlie Creek. Under extreme conditions, this could reduce streamflow contributions to the Peace River during dry conditions and thus affect the ability of the Peace River to remain in compliance with MFLs.

It is noted that none of the Applicants' Preferred Alternatives, including the offsite alternatives, are in the Charlie Creek watershed. The water levels in the IAS and the FAS in the Upper Horse Creek and Upper Myakka subbasins are lower than the groundwater levels in the SAS and, consequently, upward flow from the IAS to the SAS is not a normal source of water for these stream systems.

Groundwater dewatering operations are conducted in advance of mine cut excavation through pumping from the SAS with the goal of lowering the localized water table to allow dragline operations "in the dry." When conducted, dewatering typically precedes the dragline operations by several months; the duration

of pre-mining dewatering is variable and dependent on site-specific conditions as well as seasonal factors. Historically, where mining operations approached mine site property boundaries or habitat preservation areas, ditch and berm systems were installed in advance to protect ecological systems in need of protection and/or adjacent land owners' use of their lands from dewatering impacts.

Information provided by Mosaic for a typical dewatering process at a new mine area includes the following:

- A grid of dewatering wells is installed in an area representing two to three mine cut widths and pumps are operated to draw down the SAS. The number of wells for a dewatering grid can range from 30 to 70 or more, depending on the level of dewatering being maintained. Dewatering at a given well occurs for periods of up to 4 months.

- The dragline operations proceed. Dewatering operations stay ahead of the dragline by several mine cut widths (approximately 1,000 feet). Pumps in the dewatering wells are pulled and moved ahead of the active mine cut operations.

- As the dragline moves away from the applicable dewatered mine cut area, water is allowed to re-accumulate in the completed mine cuts.

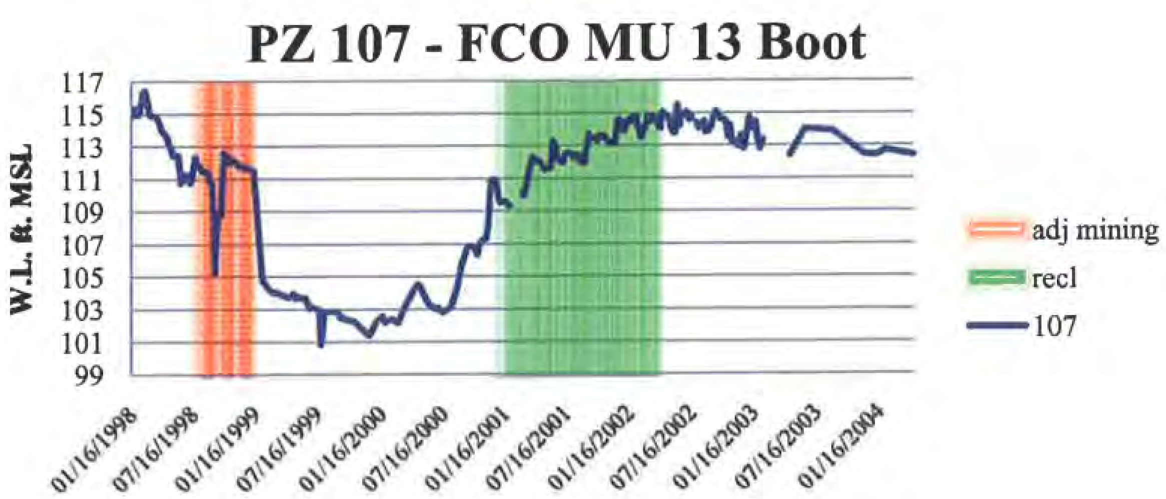
Thus, the progression of dewatering system installation, operation, and removal and relocation ahead of the dragline operations occurs in a rolling fashion in the immediate vicinity of the dragline operation. For this reason, dewatering is viewed as a temporary and localized SAS impact.

Ditch and berm systems have been reasonably effective in mitigating offsite drawdown effects; however; localized vertical drawdown of up to 20 feet during mining have been measured in some monitoring wells. An example of this type of localized effect is shown in Figure 3-32, which provides a water table elevation time series plot for a specific piezometer associated with Mosaic's Four Corners Mine, along with notes on when dewatering occurred associated with nearby mine cut excavations. This type of drawdown (approximately a 10-foot effect in this example) could occur in areas adjacent to dewatering in spite of water table management efforts. In some portions of the AEIS study area, sufficient semi-permeable hardpan or clay layers are present such that recharge of the SAS in the perimeter ditch system does not result in a corresponding increase in groundwater levels outside the perimeter ditch system (see example for CF Industries shallow and deep piezometers associated with the South Pasture Mine, Figure 3-33).

Figure 3-33 shows water levels in two piezometers; one 10 feet deep and the other 40 feet deep. While the 10-ft deep piezometer water level is stable, the deeper piezometer shows greater than 12 feet of drawdown when mining occurs within 1,800 feet of the well. In this case, 1,800 feet is a site-specific SWFWMD-approved compliance monitoring distance called the hydrologic impact distance (HID). This difference in monitoring well water levels is assumed to be the result of a low-permeability hardpan or

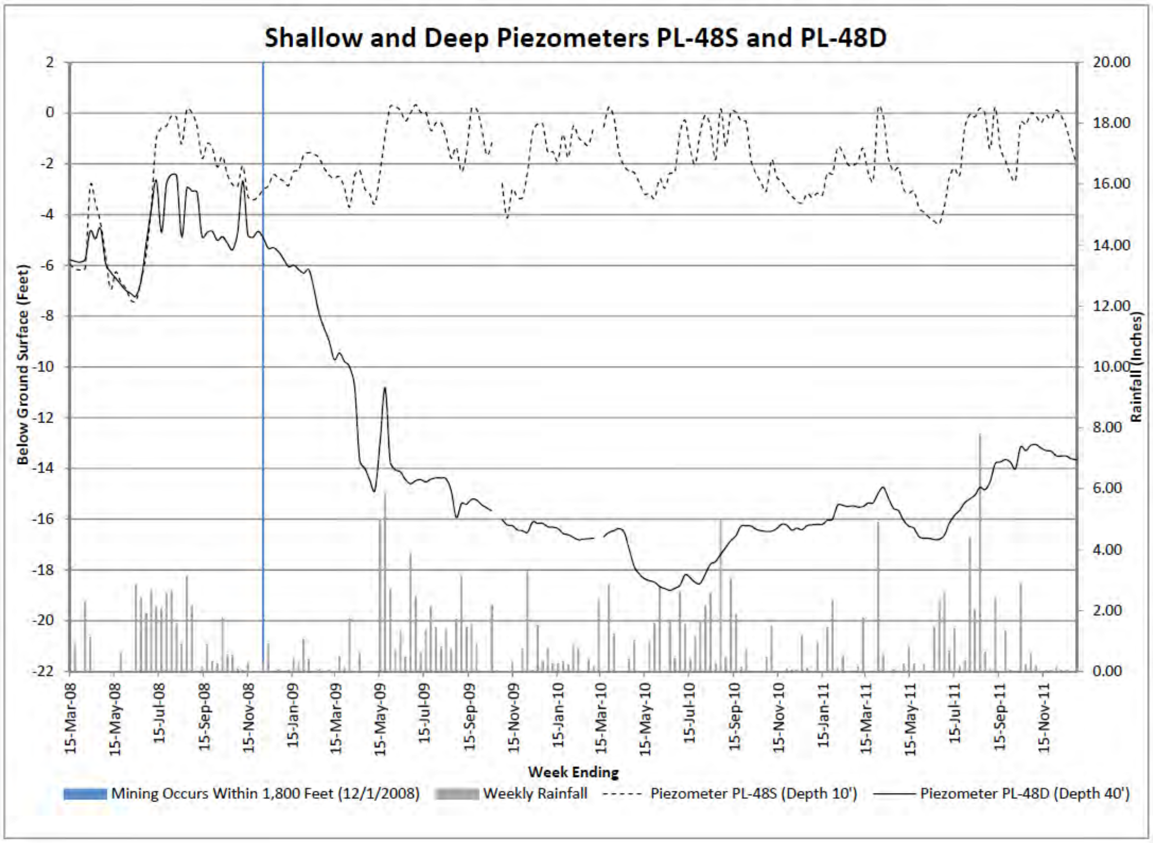
clay layer between the 10-foot and 40-foot depths that prevents efficient recharge of the aquifer from the perimeter ditch system. Site-specific conditions can affect the potential offsite effects of dewatering on adjacent land areas that are the subject of protective management efforts.

Because of the potential for localized and site-specific drawdown effects, SWFWMD has been working with the phosphate industry to ensure advanced spatial and temporal installation of SAS recharge systems prior to mining. In WUPs now in place, SWFWMD requires the industry to develop Environmental Management Plans (EMPs) to address dewatering impact minimization. EMP elements include site-specific hydrogeologic evaluations supported by groundwater flow modeling. The objective is to determine the need for special ditch and berm system design features that may be required to protect water levels outside of the mine property boundaries and within preservation areas inside the mines from potential dewatering effects.



Source: Mosaic, 2011d

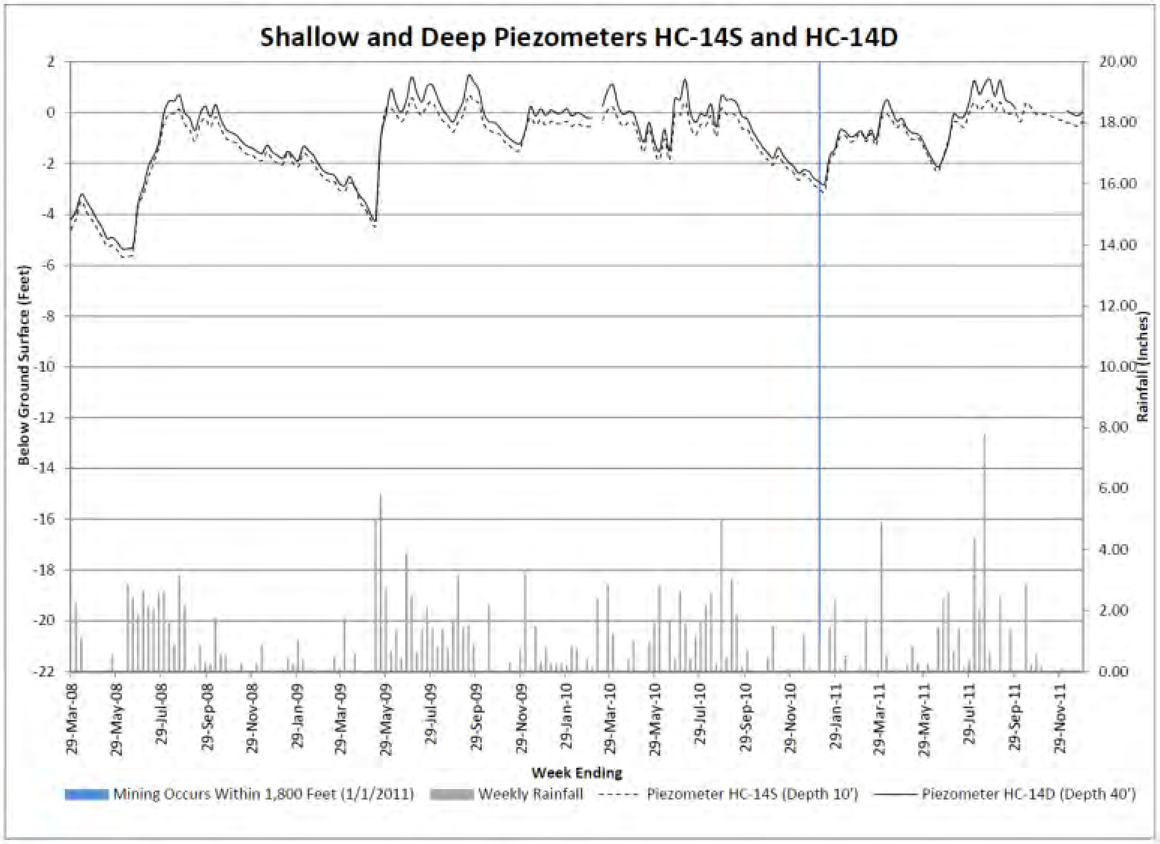
Figure 3-32. Example of Dewatering Effects on Water Table Levels in an Adjacent Monitoring Well



Source: CF Industries, 2011

Figure 3-33. Example of Dewatering Effects on Shallow vs. Deeper Water Table Levels of Paired Monitoring Wells

While various pilot studies of special design features have been required for WUP renewal, the most effective recharge method identified to date is modifying recharge ditch features to promote hydrologic barrier effectiveness and prevent water table drawdown impacts on the protected preserve areas or offsite properties. Pilot studies have documented that recharge ditch design features can effectively reduce drawdown effects in the preservation areas and maintain water table levels within the range of normal seasonal variations. An example of the effectiveness of a CF Industries recharge ditch system in controlling dewatering effects on an adjacent preserve area (Horse Creek) is reflected in Figure 3-34. Both shallow and deeper piezometer water levels remained consistent with historical patterns before and after the approach of mining activities within the 1,800-foot HID.



Source: CF Industries, 2011

Figure 3-34. Shallow and Deep Piezometer Monitoring Records for Water Levels in a Preserve Area with Recharge Ditch Designs Included

Historical Effects of Phosphate Mining on Water Budgets

The potential effects of future expansions of phosphate mining in the AEIS study area can best be related to regional environmental conditions by evaluating watershed or applicable subbasin water budgets. As outlined above, developing a new mine gradually places portions of the impacted mine footprint inside the ditch and berm system containing the mine's recirculation system. Thus, this area is taken out of a given watershed or subbasin's surface water contributions to the watershed or subbasin's water budget except through discharges from the permitted NPDES outfalls and seepage from the ditch and berm system to adjacent streams and wetlands. Over time, as portions of the mine are reclaimed and released from within the recirculation system, the total mine capture area is available to contribute to a watershed or subbasin's water budget. The relevance of a given mine's effects on the impacted watershed or subbasin can be assessed through a sequential water budget analysis approach. Cumulative effects of multiple mines in the same watershed or subbasin, with overlapping periods of operation, can be evaluated by aggregating the individual mines' effects.

Water budgets are used to represent long-term hydrologic responses and include the hydrologic components of rainfall, evapotranspiration (ET), runoff and/or streamflow, and recharge to the groundwater. The term “baseflow” represents the near-surface groundwater that seeps back into the surface water during dry periods. Because the water cycle is considered a closed system, the water budget is also referred to as the “water balance” because all components in the system must add up. Components of water balances are often expressed as inches per year, to compare the unit rates between basins to understand the different responses from rainfall. There can be great variation in water budgets from year to year, so most values are expressed as an average over a period of record.

Not every component of the water budget can be measured. ET is normally computed and the storage and recharge components are inferred from the remainder of the other components when observed data are used. Some researchers have used computer simulations to estimate each component more explicitly. For example, Lee et al. (2010), Interflow (2008b), SDI (2004), and BCI (2010b) have applied sophisticated models that integrate surface water hydrology with the groundwater hydrology to better evaluate the interdependencies of the interface between these systems. However, the level of effort to model these areas is substantial, so such modeling is normally done only for limited domains (i.e., limited spatial extents).

PBS&J prepared detailed water budgets for the nine Peace River subbasins as part of the Peace River Cumulative Impact Study (PBS&J, 2007). Water budgets for each subbasin were evaluated based on the available observed data records and land use characteristics and groundwater models of the region. In their report, the water balance for four 3-year periods was reported (1941-1943, 1976-1978, 1989-1991, and 1997-1999) to show the difference in rainfall and land use. Three-year periods were used to lessen the variability from annual differences in rainfall.

Table 3-8 summarizes reported water budgets for a number of subbasins in the Peace and Myakka River watersheds. The period of record for each study is listed and the general location of the study identified. Despite the different time periods and locations evaluated, and methods applied, the results do not differ substantially. The water budgets derived in the Peace River Cumulative Impact Study (PBS&J, 2007) appear to be particularly relevant for comparisons of surface water runoff conditions as they may be altered by the Applicants’ Preferred Alternatives. This study reported that the Payne Creek subbasin, which contains extensive mining activity, had much greater baseflow (groundwater seepage). These reference subbasin water budgets are important for characterizing the potentially impacted environments of the areas that may be impacted by the Applicants’ Preferred Alternatives.

Table 3-8. Reported Water Budgets for the Peace and Myakka River Basins

Location/Study	Period of Study	Rainfall (in/yr)	ET (in/yr)	Irrigation (in/yr)	Runoff (in/yr)	Baseflow (in/yr)	Recharge (in/yr)	Method
Peace River Basin (Geurink et al., 2001)	1989-1998	52.1	36.5	1.7	10.2	1.3	6.7	Simulation
Peace River above Arcadia (Garlanger, 2002)	1969-1998	50.9	37.8	1.95	8.75	NR	6.3	Based on Data
Horse Creek (SDI, 2004)	1978-1988	49.8	36.9	NA	9.8	in above	3.1	Simulation
Charlie Creek, Total listed below (Lee et al., 2010)	2003-2005	53.36	37.52	3.05	9.86	8.29	0.9	Simulation
CF Industries South Pasture Area, Pre-Mining (BCI, 2010a)	2000-2005	53.68	35.49	NR	13.27	0.22	2.02	Simulation
Upper Myakka River Basin (Interflow, 2008a)	1993-2005	58.7	40.6	2.3	19	in above	0.9	Based on Data
Peace River at Bartow Gage (PBS&J, 2007)	1997-1999	54	36	NR	7.8	0.9	10	Based on Data and Simulations
Peace River at Zolfo Gage (PBS&J, 2007)	1997-1999	56	36	NR	8.7	2.3	12	Based on Data and Simulations
Peace River at Arcadia Gage (PBS&J, 2007)	1997-1999	55	37	NR	9.3	2.3	8	Based on Data and Simulations
Payne Creek Basin (PBS&J, 2007)	1997-1999	57	35	NR	3.4	12.9	9	Based on Data and Simulations
Charlie Creek Basin (PBS&J, 2007)	1997-1999	58	37	NR	13.2	1.2	8	Based on Data and Simulations
Joshua Creek Basin (PBS&J, 2007)	1997-1999	52	37	NR	11.8	1.9	3	Based on Data and Simulations
Horse Creek Basin (PBS&J, 2007)	1997-1999	55	37	NR	14.3	1	3	Based on Data and Simulations
Shell Creek Basin (PBS&J, 2007)	1997-1999	52	37	NR	12.3	1.7	3	Based on Data and Simulations

Table 3-8. Reported Water Budgets for the Peace and Myakka River Basins

Location/Study	Period of Study	Rainfall (in/yr)	ET (in/yr)	Irrigation (in/yr)	Runoff (in/yr)	Baseflow (in/yr)	Recharge (in/yr)	Method
	AVG	**54.1**	**36.9**	**2.3**	**10.8**	**3.1**	**5.4**	
	MEDIAN	**53.8**	**37.0**	**2.1**	**10.0**	**1.7**	**4.7**	
	MAX	**58.7**	**40.6**	**3.1**	**19.0**	**12.9**	**12.0**	
	MIN	**49.8**	**35.0**	**1.7**	**3.4**	**0.2**	**0.9**	

Notes:

in/yr = inches per year

NR = Not reported, sometimes baseflow is in the streamflow.

NA = Not applicable, for example not every study or location has irrigation return flow.

sq. mi. = square mile

The PBS&J (2007) report listed water balances for four time periods, 1997-1999 was reported to be closer to normal conditions. Recharge in this report may include some baseflow to streams.BCI (2010a) reported recharge to intermediate aquifer system is used for net recharge. Some authors reported deep recharge only.

Historical Effects of Phosphate Mine Reclamation on Surface Water Hydrology

State and federal regulations have changed substantially over time and the current reclamation practices evolved as methods to minimize impact or to improve reclamation effectiveness were developed. As discussed above, the characteristics of the water resources change across the CFPD. Consequently, one must consider the time-frame, location(s), and type of mining and reclamation practices in effect when evaluating literature reports. The relationship between the interactions of surface waters with the underlying aquifer is addressed by the USGS in multiple studies in the Peace River basin (Lewelling and Wylie, 1993; Lewelling et al., 1998; Metz and Lewelling, 2009; and Lee et al., 2010). SWFWMD has conducted several comprehensive analyses of the river basins in the region, including the Alafia River, Peace River, and Upper Myakka River. The Alafia and Peace River studies (SWFWMD, 2005a, and PBS&J, 2007, respectively) led SWFWMD to conclude that river flows prior to the 1970s were impacted by phosphate mine discharges. After water conservation measures were implemented by utilizing more stormwater onsite (since 1980s), the mines' effects on downstream flows have changed. In many areas, phosphate mining has substantially altered local surface drainage patterns and the surface water/groundwater relationships, and contributed to altered flow patterns further downstream. However, while there is general agreement among studies regarding the interaction mechanisms and the fact that changes have occurred over time, there is disagreement on the extent to which these impacts are attributable solely to phosphate mining.

Multiple factors, including changed rainfall patterns; municipal, (non-mining) industrial, and agricultural consumptive water use and discharges; and altered reclamation and conservation practices all affect observed flow data. SWFWMD has indicated "*Though it is clear low flows in the upper Peace River have been affected by groundwater withdrawals, the affect of withdrawals on the river lessen as you go downstream."* It cited a series of investigations relating change in river flows within SWFWMD to rainfall records, and concluded that "…*most of the declines in flow are related to long-term deficit rainfall throughout central Florida from the 1960s through the 1990s."* (SWFWMD, 2006a).

Several investigations have addressed the hydrologic differences between reclaimed phosphate mine lands and unmined areas. Studies by Schreuder (2006) compared the streamflows from the highly mined Payne Creek basin (about 70 percent mined) to other Peace River subbasins where little to no mining has occurred. Schreuder (2006) quantified the difference between Payne Creek and Joshua Creek streamflows over a 16-year period (1984 to 2000) at about 5 percent higher, even though recorded rainfall was 3 percent higher in the Joshua Creek basin over the same period. The data indicate a somewhat higher baseflow from Payne Creek; one possibility is that land reclamation may have created more storage, allowing for increased streamflow post-mining. However, differences could also be related to differences in the landscape in each basin and/or how the aquifer levels interface with the streams in each basin. Payne Creek is located substantially higher in the overall Peace River watershed than Joshua Creek.

USGS examined the effects of mine reclamation by comparing the hydrology of individual mined and unmined areas ranging from 47 to 420 acres (Lewelling and Wylie, 1993). The findings of this study generally do not support the hypothesis that the lower hydraulic connection of mined lands reduces overall discharge. Considering both low and high intensity rainfall events, this study concluded that mined and reclaimed areas may have somewhat greater runoff than unmined areas, and can exhibit higher peak runoff.

The study also evaluated reclamation effects on groundwater conditions, and found that the depth to the water table in the surficial aquifer for unmined basins and basins reclaimed using native overburden or overburden-capped sand tailings was similar, ranging from near ground surface to approximately 5 feet below land surface. The depth to the water table for basins reclaimed using clay or sand-clay mixtures was deeper, ranging from approximately 4 to 13 feet below land surface, primarily because the land surface at these reclaimed CSAs is higher than pre-mining topography. Aquifer tests at the various basins studied indicated that hydraulic conductivities varied in relation to the reclamation methods applied. Hydraulic conductivities measured by USGS at these basins are summarized as follows:

- Three unmined reference basins
  - IMC-Agrico Company (IMC) Creek – three surficial wells tested with values ranging from 0.3 to 2.0 feet per day (ft/d)
  - Grace Creek – three surficial wells tested with values ranging from 2.2 to 17.9 ft/d
  - CFI-3 Creek – three surficial wells tested with values ranging from 0.1 to 3.2 ft/d
- One basin reclaimed by contoured overburden
  - Agrico-1 Creek – two wells tested with values of 0.2 and 0.5 ft/d
- One basin reclaimed by overburden capped sand tailings
  - Agrico-4 Creek – two wells tested with values of 8.4 and 57.8 ft/d (but USGS reported that the latter value was potentially for a well screened in the sand tailings)
- One basin reclaimed by sand/clay settling method
  - CFI-1 Creek – three wells tested with values ranging from 1.2 to 11.0 ft/d
- Two basins reclaimed by clay settling method
  - Mobil Creek – three surficial wells tested with values ranging from <0.1 to 0.4 ft/d
  - Agrico-9 Creek – two surficial wells tested with values of 0.8 and 1.2 ft/d

The lowest hydraulic conductivities were demonstrated at one of the clay settling area reclaimed basins, and at the basin reclaimed using contoured overburden material. However, values demonstrated at wells

in the other reclamation basins were comparable to those measured at the wells located in the reference unmined basins.

3.3.3 Water Quality

Phosphate mining has the potential to affect the water quality of surface waters draining off of, or downstream from, mined or reclaimed lands. It also has the potential to affect groundwater quality, with the greatest potential effects on the shallow aquifer underlying such lands. As discussed in prior sections of this chapter, in the northern portions of the CFPD, where a well-defined intermediate confining unit/intermediate aquifer system is not present, the surficial aquifer directly interacts with the upper Floridan aquifer in some locations (e.g., sinkholes). However, in the southern areas of the CFPD where the intermediate aquifer system is well developed, the potential for water quality effects to penetrate to the Floridan aquifer is low. As in any transitional physical system, exceptions exist and the relative communication between the surficial and the underlying intermediate aquifer varies as the depth to the intermediate system increases and semi-permeable layers of hardpan and/or clay occur in the AEIS study area. These conditions are described in the hydrogeology section (see Section 3.3.2.3), and are summarized here to explain the rationale for focusing the following descriptions of the impacted water quality environment on surface water and shallow water table conditions.

In the AEIS study area, surface water and surficial aquifer systems are hydraulically interconnected. Thus, mining influence on surface water quality can also affect the water table's water quality. Conversely, where mining directly affects the water quality of the water table, and hydrologic relationships result in groundwater contributing to stream baseflows, surface water quality can reflect the water quality influence of such groundwater inflows. As addressed elsewhere in this chapter, the SAS interchange of water with deeper aquifers varies depending upon localized hydraulic gradients and the presence of clay layers or rock formations, which may reduce the vertical migration of water. Alternatively, if karst geologic formations are prevalent in a particular area (such as near Bartow and northward), the intercommunication between the different aquifers can be increased. Historically, in evaluations of phosphate mining effects on water quality, the greatest emphasis has been placed on surface waters and the SAS.

Issuance of a CWA Section 404 permit by the USACE does not occur without receipt of the state's certification that the subject project will meet Florida's surface water quality standards. This certification occurs in the form of a CWA Section 401 state certification issued as an element of Florida's Environmental Resource Permit (ERP) permitting process. In Florida, evaluations of the potential effects of mining on water quality primarily have been conducted by FDEP through inclusion of permit conditions requiring monitoring of compliance of offsite mine discharges with applicable surface and groundwater standards. Monitoring requirements are incorporated into the industrial operations permits that phosphate mine operators must obtain from FDEP; the permits define discharge limitations under the NPDES

permits that are issued. Monitoring is required to confirm that the mining operations do not cause or contribute to violations of water quality standards.

This section provides a brief overview of the existing water quality standards. It also summarizes some example ambient water quality monitoring records and similar studies in the CFPD and describes watershed-level water quality improvement programs and emerging regulatory drivers that could influence future regulatory reviews of proposed phosphate mining projects. More detailed water quality focused information is provided in Appendix D.

3.3.3.1 Surface Water Quality

Surface waters in Florida are classified in "designated use" categories defined in Chapter 62-302, F.A.C. (Table 3-9). Each category has numerical and narrative criteria for physical, chemical, or biological parameters that are intended to protect the designated uses. These criteria, in conjunction with applicable implementation protocols allowed under the F.A.C., comprise the surface water standards used by FDEP to prevent discharges from regulated facilities like phosphate mines from causing or contributing to violations of the applicable standards.

Table 3-9. Surface Water Classifications in Florida per Chapter 62-302, F.A.C.

Category	Designated Uses
Class I	Potable Water Supply
Class II	Shellfish Propagation or Harvesting
Class III (Fresh Waters)	Fish Consumption; Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife
Class III (Marine Waters)	
Class III Limited	Fish Consumption; Recreation or Limited Recreation; and/or Propagation and Maintenance of a Limited Population of Fish and Wildlife
Class IV	Agricultural Water Supplies
Class V	Navigation, Utility, and Industrial Use

Certain water bodies receive a higher level of regulatory protection against water quality degradation. Chapter 62-302.700, F.A.C., identifies specific water bodies in the state that are designated as either Outstanding Florida Waters or Outstanding National Resource Waters. There are only two formally defined Outstanding National Resource Waters in Florida:

- Everglades National Park
- Biscayne National Park

It is noted, however, that the National Estuary Program (NEP) was established in 1987 by an amendment to the CWA to protect and restore the water quality and ecological integrity of estuaries of national

significance. There are now 28 “estuaries of national significance” in the NEP. The CFPD river watersheds are tributary to 3 of the 4 estuaries of national significance in Florida:

- In 1989, the Sarasota Bay Estuary Program (SBEP) was established by an act of Congress. The management plans to protect this receiving water is developed in partnership with Manatee County, City of Sarasota, City of Bradenton, Town of Longboat Key, SWFWMD, FDEP, and the USEPA. The primary tributaries include Bowlees Creek, Whitaker Bayou and Hudson Bayou (Sarasota Bay proper), Phillippi Creek (Roberts Bay), Catfish Creek and North Creek (Little Sarasota Bay), and South Creek (Blackburn Bay). Generally, the CFPD boundary only touches a small portion of the Southern Coastal watershed (Figure 3-8) and this estuary would not be impacted by the alternatives.
- In 1991, the Tampa Bay National Estuary Program (TBNEP) was established as a partnership of Hillsborough, Manatee, and Pinellas Counties; the Cities of Tampa, St. Petersburg, and Clearwater; SWFWMD; FDEP; and the USEPA. The Hillsborough, Alafia, Little Manatee, and Manatee River watersheds are tributary to the TBNEP planning area.
- In 1995, Governor Lawton Chiles submitted an application to USEPA to designate the Charlotte Harbor estuary as an estuary of national significance under the NEP. The application was accepted by USEPA and the CHNEP was established. The Peace and Myakka River watersheds are two of the major tributaries contributing inflow to the CHNEP planning area.

Protection strategies for these estuaries include prevention of water quality degradation and, where applicable, measures to improve water quality conditions through pollutant load reductions from tributary basins.

Water bodies designated by the state as Outstanding Florida Waters (OFWs) include national parks, wildlife refuges and wilderness areas, waters in the state park system, many waters in areas acquired through the state’s environmental land acquisition programs, rivers designated as wild and scenic, Florida’s aquatic preserves, and other specially designated waters listed in Chapter 62-302, F.A.C. While all surface waters are regulated using standards defined in this chapter of the F.A.C., these specially designated waters are afforded extra protection under the antidegradation provisions of the rule. The following water bodies in CFPD watersheds have been given additional protection through designation as OFWs:

- Hillsborough River State Park
- Little Manatee River State Recreation Area
- Lake Manatee State Recreation Area
- Paynes Creek State Historic Site

- The estuarine portion of the Peace River (downstream of U.S. Highway 41), designated as an OFW due to its location in the Charlotte Harbor Aquatic Preserve.
- Myakka River State Park
- The entire portion of the Myakka River that flows through Sarasota County and the estuarine portions of the river, designated as OFWs because they lie, respectively, in a segment designated as a Wild and Scenic River and the Gasparilla Sound–Charlotte Harbor Aquatic Preserve
- Becker Tract (Manatee County)
- Certain segments of Hillsborough River (Chapter 62-302.700(9)(i)4, F.A.C.)
- Certain segments of Myakka River (Chapter 62-302.700(9)(i)22, F.A.C.)
- Certain segments of Little Manatee River (Chapter 62-302.700(9)(i)20, F.A.C.)

Other than the above designations, most of the streams, rivers, and associated water bodies in and downstream of the CFPD are Class III waters. Exceptions identified by FDEP in the Tampa Bay Tributaries Water Quality Assessment Report (FDEP, 2005) and the Sarasota Bay and Peace and Myakka Rivers Water Quality Assessment Report (FDEP, 2006a) include the following:

- The portion of the Hillsborough River between Flint Creek and the city of Tampa dam, as well as Cow House Creek, is a Class I water.
- Segments of the Manatee River above the Rye Road Bridge, including Lake Manatee; tributaries entering Lake Manatee, and tributaries entering the upstream reaches of the river are Class I waters because they supply drinking water for Manatee County.
- The Braden River, from the Bill Evers Reservoir upstream to State Road 675, and most of the length of all its tributaries entering the Manatee River above the reservoir dam, are Class I waters.
- Portions of the Peace River watershed, including the lower portion of Horse Creek from the northern border of Section 14, T38S, R23E southward to the Peace River, the headwaters of Prairie Creek to the Charlotte County line, and the headwaters of Shell Creek to the Hendrickson Dam are Class 1 waters. These tributaries (or portions of them) serve as drinking water supply sources for the cities of Punta Gorda and North Port, and several surrounding counties (Charlotte, Sarasota, and DeSoto).
- Portions of the Myakka River watershed including the river reach that extends south from the Manatee County line through Upper and Lower Myakka Lakes to Manhattan Farms (north line of Section 6, T39S, R20E) and Big Slough Canal (headwaters to U.S. Highway 41). Both of these are Class I waters. Big Slough Canal/Myakkahatchee Creek is a drinking water source for the city of North Port.

Estuarine portions of the following river systems draining the CFPD that are designated as Class II waters:

- The lowermost reach of the Peace River, extending from the Barron Collier (U.S. Highway 41) Bridge to the river mouth, falls within the Charlotte Harbor Aquatic Preserve and is designated as a shellfish propagation and harvesting area.
- The southernmost reaches of the Myakka River, extending south from the western line of Section 35, T39S, R20E in Sarasota County and all of the river in Charlotte County are designated as a shellfish propagation and harvesting area.

In assessing the potential for phosphate mining to affect the designated uses of these CFPD and downstream water bodies, compliance with the applicable numerical standards is an important aspect to be included in the evaluations. The specific numeric criteria applicable to surface waters in the state of Florida are detailed in Chapter 62-302, F.A.C.

Evaluation of a water body's compliance with water quality standards is outlined in Florida's assessment methodology at Chapter 62-303, F.A.C. As required by the CWA, FDEP updates USEPA on a biennial basis (every 2 years) regarding surface water body use attainment in its 305(b) report and 303(d) list of impaired waters. On the basis of these updates, the agencies identify water bodies that show water quality impairment such that the applicable designated use is not met. For each of the waters where the impairment is due to abatable, human-induced causes, Florida must develop a total maximum daily load (TMDL) for the parameters that are out of compliance. A TMDL is the maximum loading of a particular pollutant that can be discharged in a surface water and still allow it to meet its designated uses and applicable water quality standards. TMDL evaluations include parameter-specific analyses identifying daily loads to be used as pollutant limitations for a water body; they set the stage for identifying Basin Management Action Plans (BMAPs) that will lower excessive pollutant loads and return the water body to a state of compliance with its designated use.

The most recently approved Florida 303(d) list of impaired waters is for Reporting Year 2010, which was formally approved by USEPA on May 13, 2010. This is the current list of waters that the USEPA considers impaired and either need a TMDL or have already had a TMDL completed. It can be accessed on USEPA's website (http://iaspub.epa.gov/waters10/attains_impaired_waters.impaired_waters_list?p_state=FL&p_cycle=2010). Appendix D provides a listing and maps of current listings; however, TMDL status is dynamic and is updated frequently. FDEP frequently evaluates the impaired waters list and maintains the current regulatory assessment on water quality conditions in water bodies, which is available on the FDEP website (http://www.dep.state.fl.us/water/watersheds/assessment/vdllists.htm).

During the past 25 years, USEPA has defended numerous cases in which plaintiffs have alleged that USEPA has a mandatory duty to "backstop" state establishment of TMDLs under CWA section 303(d); that is, USEPA has a duty to establish TMDLs in states that fail to do so. In 27 state cases, including Florida, USEPA was placed under a court order, or agreed in a consent decree, to establish TMDLs if the state failed to do so within a prescribed schedule. In Florida, the backstop for TMDLs is for waters identified on the 1998 list, and the consent decree is due to be fully complied with in 2013 (*Consent Decree entered in the case of Florida Wildlife Federation et al. v. Carol Browner et al. [*Case No. 98-356-CIV-Stafford]).

To assist in TMDL development, Florida is currently implementing a “5-Year Rotating Basin Cycle” by analyzing each of the state’s major river basins over a 5-year period. The current list of Florida TMDLs proposed or finalized by USEPA (including Public Notices of Availability) can be accessed on USEPA’s website (http://www.epa.gov/region4/water/tmdl/florida/index.html).

This cycle of water quality assessment for the state’s major river basins is continually implemented using the following actions:

- Updating criteria with new scientific information
- Monitoring, reporting, and creating TMDLs for impaired waters
- Adjusting permit limits
- Using BMPs to restore waters

Fundamental to this process is Florida’s antidegradation policy, which protects existing water quality above the minimum criteria levels and requires that, once uses are achieved, they must be maintained.

Table 3-10 lists the locations in the CFPD of study areas for TMDLs completed by FDEP, along with the specific applicable water quality parameters of concern. Figure 3-35 indicates the locations of these TMDL study areas in relation to lands in the CFPD, and specifically in relation to the Applicants’ Preferred Alternatives, including the four new mines and the two offsite alternatives identified by Mosaic. Of the 18 TMDLs in the table and the figure, only one, for Thirty Mile Creek, has a parameter associated with phosphate mining (total nitrogen) and is in a basin dominated by phosphate mining. However, the phosphate beneficiation process no longer uses ammonia nitrogen as a reagent, so the loading in Thirty Mile Creek is not from mining chemical use. No WBIDs where the Applicants’ Preferred Alternatives are located are considered impaired. If a water body is listed at a later date, the mines’ NPDES permits may be modified to reflect new reduction goals.

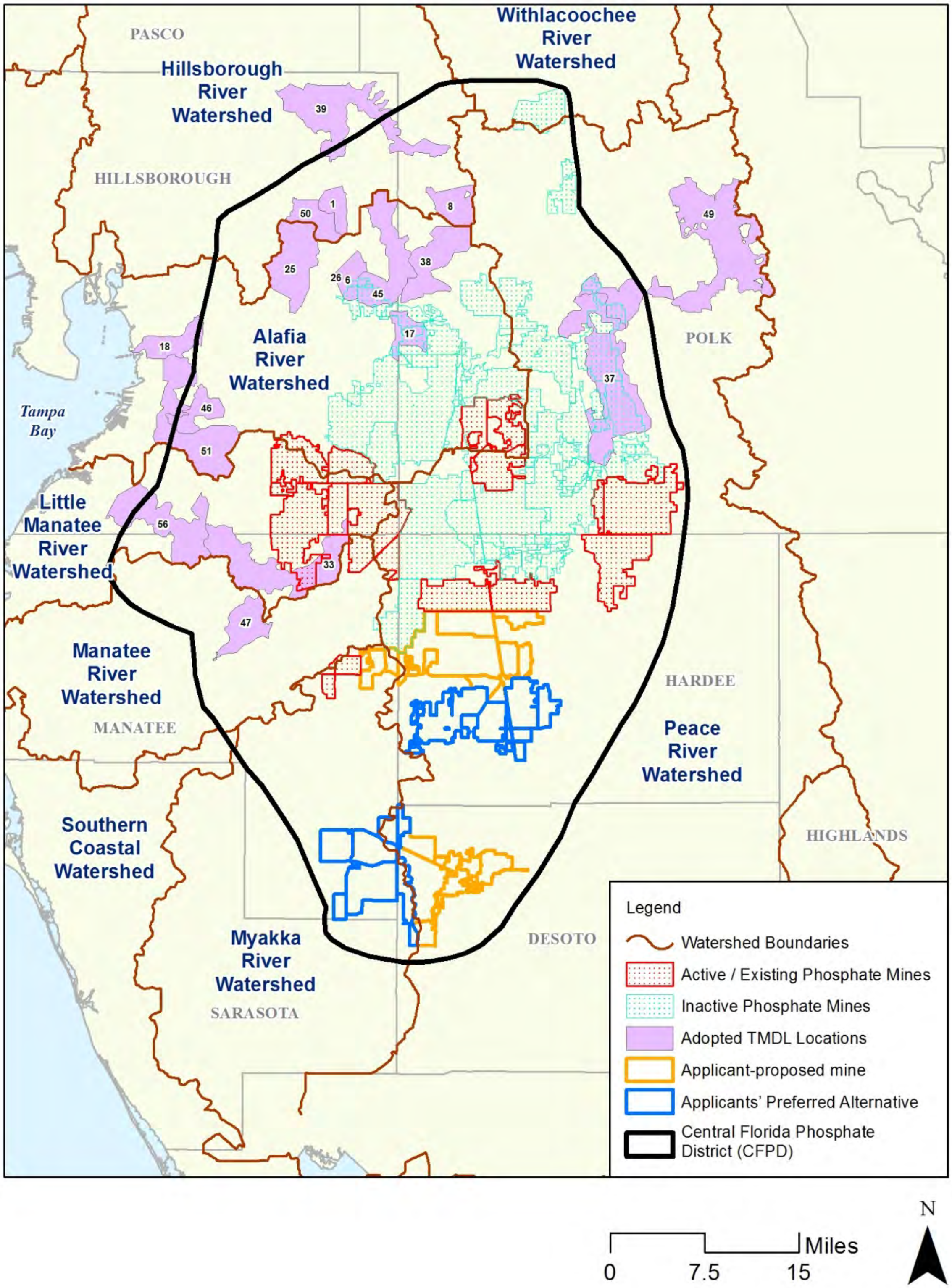
Table 3-10. Summary of Completed TMDLs for Water Body Segments in the CFPD as of 2012

Map I.D.	WBID	Water Body	Type	TMDL Parameter	Pollutant of Concern	TMDL Status
56	1742A	Little Manatee River	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved
51	1666	Bullfrog Creek	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved
47	1840	Gilly Creek	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved
33	1790	Little Manatee River (South Fork)	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved
25	1578B	Turkey Creek Above Little Alafia River	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved
39	1482	Blackwater Creek	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved
6	1592C	Mustang Ranch Creek	Stream	Dissolved Oxygen and Nutrient	Total Nitrogen and Total Phosphorus	Adopted TMDL and USEPA Approved
45	1552	English Creek	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved
26	1592C	Mustang Ranch Creek	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved
1	1542A	Mill Creek	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL
50	1561	Spartman Branch	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved
17	1639	Thirty Mile Creek	Stream	Dissolved Oxygen and Nutrient	Total Nitrogen	Adopted TMDL and USEPA Approved
38	1583	Poley Creek	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved

Table 3-10. Summary of Completed TMDLs for Water Body Segments in the CFPD as of 2012

Map I.D.	WBID	Water Body	Type	TMDL Parameter	Pollutant of Concern	TMDL Status
8	1543A	Lake Hunter Outlet	Stream	Nutrient	Total Nitrogen and Total Phosphorus	Adopted TMDL and USEPA Approved
46	1688	Little Bullfrog Creek	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved
18	1621G	Alafia River Above Hillsborough Bay	Estuary	Dissolved Oxygen and Nutrient	Total Nitrogen	Adopted TMDL and USEPA Approved
37	1623J	Peace River Above Bowlegs Creek	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved
49	1539	Peace Creek Drainage Canal	Stream	Fecal Coliform	Fecal Coliform	Adopted TMDL and USEPA Approved

Source: FDEP, 2013c



Source: FDEP, 2013d

Figure 3-35. Locations of Completed TMDL Studies in the CFPD

Historical Phosphate Mining Effects on Surface Water Quality

Various investigations have documented the relationships between phosphate mining and surface water quality conditions in CFPD watersheds. As described below, a key USGS study specifically compared surface water quality of mined/reclaimed and unmined watersheds (Lewelling and Wylie, 1993). Other investigators have studied historical changes in surface water quality in selected subbasins within the AEIS study area in relation to the relative levels of historical phosphate mining activities or other human activity influences on ambient water quality, such as agricultural irrigation practices using Floridan aquifer well water. Summaries of some of these key investigations are provided below.

Lewelling and Wylie (1993) evaluated hydrology, groundwater quality, and surface water quality for USGS and the FIPR Institute in several small drainage basins in the “Four Corners” area of west-central Florida, where the boundaries of Hillsborough, Polk, Manatee, and Hardee Counties meet. The surface water evaluation included three unmined basins that ranged from 90 to 420 acres in size, and four basins ranging in area from 47 to 250 acres that had been mined for phosphate rock and subsequently reclaimed using several different methods. Two of the former phosphate mining areas were reclaimed by backfilling with clay, one was backfilled with sand tailings and capped with overburden, and one was backfilled solely with overburden.

Surface water samples were collected during an initial reconnaissance evaluation and also during routine sampling that occurred during base-flow and high-flow conditions in most of the basins from November 1988 through October 1990. Two basins that were reclaimed using clay only had sufficient water for sampling during two routine sampling events. The number of samples collected from the three unmined basins and the other two mined and subsequently reclaimed basins ranged from 11 to 16. Reconnaissance samples were analyzed for nutrients, major ions, trace metals, and radionuclides. Routine samples were analyzed for alkalinity, chloride, sulfate, specific conductance, pH, orthophosphorus, dissolved solids, and suspended solids. USGS observations included the following:

- The major constituents in water from the streams in the study basins were the cations calcium, magnesium, sodium, and potassium, and the anions sulfate, chloride, fluoride, nitrate, and carbonate or bicarbonate.
- Parameters for which there were no observed differences between the reclaimed and unmined basins included: color, nitrate/nitrite, sulfate, sodium, fluoride, potassium, and total dissolved solids (TDS).
- Analysis of the few water samples collected from streams during base-flow and high-flow conditions indicated that water chemistry of surface waters in the unmined and the reclaimed basins generally was similar. Higher concentrations of magnesium, orthophosphorus, alkalinity, and calcium were detected in water from streams at some of the reclaimed basins. None of the parameters was in exceedance of FDEP criteria at the time of the study.

- Radionuclides analyzed included gross-alpha and radium-226. Gross-alpha activity levels in water samples from streams in unmined basins ranged between 0.34 and 3.54 picoCuries per liter (pCi/L) as compared to 0.34 to 10.2 pCi/L in reclaimed basins. All values were less than the Florida surface water standard of 15 pCi/L. All measurements of radium-226 activity levels were below the Florida surface water standard of 5 pCi/L.

- The hydrologic characteristics and surface and groundwater quality of two reclaimed basins where overburden was used to either fill the mine cuts or cap sand tailings used to fill mine cuts had characteristics similar to those of the unmined basins.

- In contrast, the hydrologic characteristics and surface and groundwater quality of two reclaimed basins where either clay or a clay/sand mix were used to support reclamation differed from the unmined basins somewhat in exhibiting reduced runoff due to surface storage, increased uranium-234 activity levels at one recently reclaimed site, more rapid runoff response to rainfall, reduced flow rates, and greater depths to the water table, and a more gradual water table response to recharge at a more mature reclaimed site.

Overall, the surface water quality data gathered by USGS over this 2-year study period indicated that all the basins were in compliance with surface water quality standards that were applicable at the time of the study (Lewelling and Wylie, 1993). Another evaluation of water quality, habitat conditions, and macroinvertebrate communities in unmined and reclaimed streams (FDEP, 2007b) found that nutrient concentrations in both types of systems were not statistically different.

Biological Research Associates (BRA, 2006a) summarized historical information about surface water quality, quantity, and aquatic biology in Horse Creek, a tributary to the Peace River, as part of the Horse Creek Stewardship Program (HCSP). The drainage basin encompasses approximately 241 square miles and agricultural land uses predominate; phosphate mining in the basin started in 1988, and approximately 13.1 square miles (8,400 acres) had been mined as of 2003.

The monitoring records documented that seasonal patterns of rainfall, groundwater discharge, and agricultural runoff were correlated with a number of surface water quality parameters. Elevated values of turbidity, ammonia, organic and total nitrogen, color, and iron occurred during periods of high rainfall and streamflow. On the other hand, the highest values of pH, dissolved oxygen (DO), phosphorus, nitrite and nitrite nitrogen, chlorophyll *a*, conductivity, and major ions were observed during the dry season, when groundwater discharges and agricultural runoff from crop irrigation represented higher percentages of stream baseflow.

The investigators did not attempt to draw specific conclusions about the potential influence of mining on surface water quality, but did note trends at two stations with the longest periods of record for surface water quality data: Horse Creek near Myakka Head and Horse Creek near Arcadia. Data were available

for those stations from 1972 through 2002. Both locations are downstream from phosphate mining areas in the basin. BRA (2006) concluded that nitrogen species showed decreasing concentrations over the period of record at the Horse Creek station near Myakka Head, while conductivity and fluoride both increased. For the location farther downstream near Arcadia, BRA concluded that ammonia, phosphorus, and fluoride decreased, and increases were observed for nitrate and nitrite nitrogen, conductivity, major ions, and DO.

The HCSP monitoring program protocols identify “trigger levels” for water quality parameters which, if exceeded, or even if negative trends generating concern are demonstrated, require corrective actions by Mosaic if exceedances are linked to upstream phosphate mining activities. For 2007, the monitoring records exhibited exceedances of trigger levels for DO, pH, total nitrogen, chlorophyll *a*, fatty acids, alkalinity, dissolved iron, sulfate, TDS, calcium, and fluoride. The investigators (Entrix, 2010a) concluded that the exceedances were probably due to natural conditions because there was very little mine discharge during 2007 and because the historical data analysis by BRA (2006) showed similar frequencies of exceedances for those parameters under similarly low rainfall and streamflow conditions.

Increasing trends of alkalinity, pH, specific conductance, calcium, and sulfate were documented during 2007, but there were decreasing trends for color and iron. The trends were attributed to the unusually dry conditions during 2006 and 2007 (Entrix, 2009). The investigators hypothesized that higher-than-normal agricultural uses of groundwater because of the dry conditions could have contributed to the increases observed in major ion concentrations. Similar conclusions were supported by information compiled in the Peace River Basin Cumulative Impact Study (PBS&J, 2007); agricultural irrigation withdrawals from the Floridan aquifer were believed to have contributed to elevated dissolved solids and conductivity levels in Shell Creek, among other areas in the lower Peace River basin because of runoff from the irrigated agricultural fields in the basin. This same conclusion was advanced by FDEP in “*Florida’s Total Maximum Daily Load Program: protecting and restoring water quality in the Peace River Basin*” (FDEP, 2006b).

PBS&J prepared a report summarizing the results of hydrobiological monitoring in the Peace River during 2006 for the PRMRWSA (PBS&J, 2010). Although the report documented historical trends in water quality conditions in the Peace River basin, no specific conclusions about the influence of phosphate mining activities on surface water quality were presented. However, it was suggested that early phosphate mining activities caused degraded water quality in the Peace River and that extensive fish kills were caused by occasional accidental discharges from CSAs. PBS&J also indicated that increasing regulation of phosphate mining and improved mining practices since the late 1970s have resulted in decreased phosphorus loadings to the Peace River and fewer and less severe accidental releases from CSAs. While peak inorganic phosphorus concentrations in the Peace River and upper Charlotte Harbor remain high compared to those in rivers and estuaries that are not in phosphate-rich basins, the investigators reported that the phosphorus concentrations have decreased dramatically since the early

1980s (by as much as an order of magnitude at some locations) primarily resulting from the reduction of municipal wastewater discharges.

University of Florida researchers (Khare et al,. 2012) evaluated the relationship between water quality and land use changes in the Alafia and Hillsborough River basins over the period 1974 through 2007. They reported a trend toward urbanization and loss of agricultural land in both basins over that period. Dominant land uses in the Alafia River basin were urban, mining, and agriculture, while urban and agricultural lands and wetlands were the dominant land uses in the Hillsborough River basin. The study also found that streamflow, baseflow, and percent baseflow did not did not exhibit significant increasing or decreasing trends over the study period, and suggested that the increasing use of stormwater management systems may have contributed to the lack of flow trends observed.

Concentrations of total phosphorus, total nitrogen, and dissolved fluoride were generally higher in the Alafia River basin, but biochemical oxygen demand, fecal coliform bacteria, and chlorophyll *a* were higher in the Hillsborough River basin. Total phosphorus (TP) showed significant trends of decreasing concentrations at 11 of 12 sampling locations in the two basins, while one location in the Hillsborough River basin had no significant trend. The authors attributed the decreasing TP concentrations to decreases in agricultural lands in both basins, as well as increased regulatory requirements and improved mining practices in the Alafia River basin.

Most other water quality parameters showed similar trends of decreasing concentrations in both basins. Total nitrogen (TN) and total Kjeldahl nitrogen (TKN) concentrations increased in the Hillsborough River basin even though agricultural land coverage decreased. The authors hypothesized that the increasing trends observed for TN and TKN were due to an increase in coverage by wetlands and/or forest lands in the Hillsborough River basin.

The authors reported that TP and/or TN exceeded the numeric nutrient criteria (NNC) at most stations in both basins (NNC are discussed below and in Appendix D). The Hillsborough River basin had numerous exceedances of the NNC for TN, but complied with the TP limit. Most of the stations in the Alafia River basin had exceedances of the NNC for TP; the authors suggested that alternative numeric criteria would likely need to be developed for the stream segments in this watershed.

The study found that some land uses were related to water quality, notably phosphate mining and TP concentrations. However, it also found that factors other than land use categories and changes in land use appeared to have more influence on water quality trends. The authors concluded that environmental regulations such as the CWA, stormwater treatment and management rules, and retrofitting activities, as well as improved mining practices, have likely impacted the observed surface water quality trends more than land use changes.

Historic incidents of phosphogypsum spills have also had impacts to water quality. The history of major gypsum stack spills includes:

- 1988, there was a large release from the closed Gardinier facility into the Alafia River.
- 1993, there was a spill from the then Cargill facility into Archie Creek from the East Tampa Plant.
- 1994, a sinkhole opened releasing gypsum and water into groundwater from the IMC plant.
- 1997, there was a large release of phosphogypsum process water related to a dam break from the Mulberry phosphate facility and again in 2004 as a result of wind and rain associated with a hurricane.
- And most recently in 2011, there were releases from the Piney point facility, formerly owned by the Mulberry Corporation.

Effects of Evolving Numeric Nutrient Criteria on CFPD Phosphate Mining

Nutrient pollution is one of America's most widespread, costly, and challenging environmental problems. Phosphorus is one of the primary nutrients that regulates algal and macrophyte growth in natural waters, particularly in freshwater. Phosphate, the form in which almost all phosphorus is found in the water column, can enter the aquatic environment in several ways. Natural processes transport phosphate to water through atmospheric deposition, groundwater percolation, and terrestrial runoff. Municipal treatment plants, industries, agriculture, and domestic activities can also contribute to phosphate loading through direct discharge and natural transport mechanisms.

Similar to phosphorus, nitrogen is ubiquitous and naturally present in the environment. Like phosphorus, it is a nutrient that is essential for normal plant and animal growth. At elevated concentrations, however, nitrogen has been shown to contribute to accelerated and enhanced algal and macrophyte growth patterns that can lead to water body eutrophication. Traditionally, nitrogen has been considered the limiting nutrient in estuarine and marine water systems, while phosphorus has been considered the limiting nutrient in freshwater systems. In transitional environments, both can be limiting factors under different ambient conditions. Even within a single water body, nutrient limitation can shift spatially (different limiting nutrients in different segments) and temporally (different limiting nutrients during different seasons). Equally important, by only limiting phosphorus upstream in freshwaters, more nitrogen will be left unreacted, and delivered downstream to estuarine and marine environments--potentially releasing those waters from nitrogen limitation and causing DO sags, turbidity, or harmful algal blooms.

Thus, both USEPA and FDEP have adopted the position that development of NNC is needed for both parameters in fresh and estuarine/coastal waters.

Both FDEP and the USEPA are working to develop water quality standards to prevent nutrient pollution in Florida rivers, perennial streams, lakes and to estuaries/ from Tampa Bay to Biscayne Bay, including Charlotte Harbor. These standards are called NNC and establish levels for nitrogen, phosphorus, and chlorophyll *a*. FDEP's standards also include biological conditions that must be met to protect healthy waterways.

The USEPA's criteria development follows its January 2009 CWA determination that numeric nutrient criteria are necessary in Florida – whether adopted by the state or USEPA. Following that determination, USEPA entered into a Consent Decree with Florida Wildlife Federation and several other groups in August 2009. Under the Consent Decree, USEPA committed to a schedule to propose and finalize nutrient pollution rules covering Florida's inland and coastal waters if the state did not act first. The Consent Decree has since been revised, and some deadlines have been extended.

Pursuant to the Consent Decree, USEPA finalized its Inland Rule in December 2010, promulgating NNC for lakes, springs and flowing waters in Florida. In February 2012, a federal district court upheld part of the Inland Rule against various challenges and sent part of the Rule back to USEPA for further clarification.

In June of 2012, the state submitted its own rule to USEPA for review pursuant to section 303(c) of the CWA. The state rule covered many of the same waters addressed by USEPA's Inland Rule as well as some estuaries. USEPA approved Florida's rule on November 30, 2012, but that rule is not yet effective under state law. Under the Consent Decree, USEPA was still required to move forward with its federal rules for the waters not covered by the state's rule. On November 30, 2012, USEPA proposed NNC for Florida's estuaries and coastal waters and also proposed a new rule covering those parts of the Inland Rule that were remanded by the court. Pursuant to the Consent Decree, USEPA must finalize the new Inland Remand Rule and the Coastal Rule by August and September of 2013, respectively. However, the agency is prepared to not move forward with – or withdraw– its rules for any waters that become covered by state law that meets the requirements of the CWA.

At this time, the only NNC that have taken full effect are those portions of USEPA's Inland Rule applicable to lakes and springs and FDEP's estuary criteria, which cover some state estuaries. The estuary criteria are set out in Section 62-302.532, F.A.C. For flowing waters and the remainder of the state's marine waters, the applicable water quality standards remain the state narrative criteria set out in subsection 62-302.530(47), F.A.C. State rules continue to apply, as well as any established restoration goals in the form of TMDLs.

Tables 3-11 through 3-13 show the results of sampling for total phosphorus, total nitrogen, and chlorophyll *a*, respectively, for several mine outfalls, plus upstream and downstream locations, from 2001 through 2011. It is important to note that these data are provided for informational purposes only. The sampling procedures used to produce this data, and the sampling procedures that may be required to determine NNC compliance, may differ. The NNC limits for TP and TN shown are taken from Section 62-302.532, F.A.C.; the standard described in that statute allows for no more than one exceedance in any 3 calendar year period.

Table 3-11. Total Phosphorus Annual Geometric Mean Values (mg/L) for Mine Outfall, Upstream and Downstream Stations

	Year										
Mine/Station	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
South Pasture											
Outfall 4	0.52	0.79	0.93	1.02	0.98	1.22	1.95	—	—	—	—
Outfall 5	—	0.62	0.77	1.01	0.88	—	—	—	—	—	—
Kingsford (inactive)											
Upstream	—	—	—	—	—	—	—	0.23	0.30	0.37	0.35
Outfall	—	—	—	—	—	—	—	0.69	0.77	0.40	0.62
Downstream	—	—	—	—	—	—	—	0.52	0.52	0.46	0.59
Fort Green (inactive)											
Upstream	—	—	—	—	—	1.12	1.17	1.25	0.78	0.71	0.69
Outfall	—	—	—	—	—	1.18	1.24	1.27	0.89	0.77	0.82
Downstream	—	—	—	—	—	0.91	1.04	0.94	0.66	0.69	0.62
Four Corners 1											
Upstream	—	—	—	—	0.85	0.94	0.94	0.75	0.94	0.78	—
Outfall	0.77	0.74	0.86	1.43	1.11	0.57		0.95	1.38	—	—
Downstream	—	—	—	—	0.56	0.55	0.65	0.65	0.71	0.47	—
Four Corners 2											
Upstream	—	—	0.36	0.54	0.47	0.54	0.76	0.62	0.41	0.13	—
Outfall	—	—	1.20	1.92	1.31	1.10	1.56	0.74	0.89	1.05	—
Downstream	—	—	0.67	1.26	0.98	1.03	1.19	0.57	0.90	0.80	—

Table 3-11. Total Phosphorus Annual Geometric Mean Values (mg/L) for Mine Outfall, Upstream and Downstream Stations

Mine/Station	Year										
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Wingate 1											
Upstream	—	—	—	—	0.24	0.43	0.70	0.64	0.59	—	—
Outfall	—	—	—	—	0.50	—	1.25	—	—	—	—
Downstream	—	—	—	—	—	—	0.34	—	—	—	—
Wingate 2											
Upstream	—	—	—	—	—	—	—	0.19	0.39	—	—
Outfall	—	—	—	0.13	1.30	0.62	1.69	1.17	0.90	—	—
Downstream	—	—	—	—	—	—	—	0.91	0.58	—	—

Notes:

— = indicates less than four data points for that year.

NNC limit for TP = 0.49 milligrams per liter (mg/L)

Table 3-12. Total Nitrogen Annual Geometric Mean Values (mg/L) for Mine Outfall, Upstream and Downstream Stations

Mine/Station	Year										
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
South Pasture											
Outfall 4	0.74	0.61	0.93	0.85	0.99	—	—	—	—	—	—
Outfall 5		0.64	0.47	0.85	1.08	—	—	—	—	—	—
Kingsford											
Upstream	—	—	—	—	—	—	—	1.53	1.75	2.16	2.45
Outfall	—	—	—	—	—	—	—	1.40	1.36	1.25	1.56
Downstream	—	—	—	—	—	—	—	2.76	1.41	1.63	1.90
Fort Green											
Upstream	—	—	—	—	—	—	—	—	—	1.31	—
Outfall	—	—	—	—	—	—	—	1.58	1.40	—	—
Downstream	—	—	—	—	—	—	—	—	—	1.48	1.26
Four Corners 1											
Upstream	—	—	—	—	1.24	1.32	1.33	1.41	1.34	1.13	—
Outfall	0.95	0.96	0.94	1.32	0.82	0.80	—	—	—	—	—
Downstream	—	—	—	—	1.24	1.83	2.33	1.93	1.65	2.76	—

Table 3-12. Total Nitrogen Annual Geometric Mean Values (mg/L) for Mine Outfall, Upstream and Downstream Stations

Mine/Station	Year										
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Four Corners 2											
Upstream	—	—	1.36	1.68	1.46	1.69	1.91	—	1.11	0.52	—
Outfall	—	—	0.91	1.13	0.76	—	—	1.40	1.00	0.59	—
Downstream	—	—	1.20	1.43	0.97	1.06	1.01	—	1.21	0.72	—
Wingate 1											
Upstream	—	—	—	—	—	—	1.15	1.11	1.54	—	—
Outfall	—	—	—	—	—	—	—	—	—	—	—
Downstream	—	—	—	—	—	—	—	—	—	—	—
Wingate 2											
Upstream	—	—	—	—	—	—	—	0.85	1.24	—	—
Outfall	—	—	—	1.56	0.89	0.99	—	1.07	1.10	—	—
Downstream	—	—	—	—	—	—	—	1.04	1.39	—	—

Notes:

— = indicates less than four data points for that year.

NNC limit for TN = 1.65 milligrams per liter (mg/L)

Table 3-13. Chlorophyll *a* Annual Geometric Mean Values (µg/L) for Mine Outfall, Upstream and Downstream Stations

Mine/Station	Year										
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
South Pasture											
Outfall 4	8.1	4.2	2.2	8.4	4.9	—	—	—	—	—	—
Outfall 5	—	—	1.9	14.7	—	—	—	—	—	—	—
Kingsford											
Upstream	—	—	—	—	—	—	—	—	—	—	—
Outfall	—	—	—	—	—	—	—	—	28.6	34.4	47.8
Downstream	—	—	—	—	—	—	—	—	—	—	—
Fort Green											
Upstream	—	—	—	—	—	—	—	—	—	—	—
Outfall	—	—	—	—	—	—	5.0	—	15.7	14.0	9.9
Downstream	—	—	—	—	—	—	—	—	—	—	—
Four Corners 1											
Upstream	—	—	—	—	1.1	1.9	3.4	1.4	1.6	—	—
Outfall	—	8.2	3.8	5.6	0.9	—	—	—	—	—	—
Downstream	—	—	—	—	0.9	2.0	1.8	1.6	1.7	—	—

Table 3-13. Chlorophyll *a* Annual Geometric Mean Values (µg/L) for Mine Outfall, Upstream and Downstream Stations

Mine/Station	Year										
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Four Corners 2											
Upstream	—	—	3.2	9.4	2.0	1.3	3.9	14.6	5.7	1.5	—
Outfall	—	—	9.8	18.4	3.4	—	—	—	—	—	—
Downstream	—	—	7.5	16.2	4.3	3.9	4.4	2.2	14.5	5.7	—
Wingate 1											
Upstream	—	—	—	—	1.5	4.2	5.1	2.0	9.0	3.2	—
Outfall	—	—	—	—	—	—	4.5	—	—	—	—
Downstream	—	—	—	—	—	—	—	—	—	—	—
Wingate 2											
Upstream	—	—	—	—	—	—	—	1.2	2.8	—	—
Outfall	—	—	—	—	7.2	7.7	—	5.5	18.2	—	—
Downstream	—	—	—	—	—	—	—	3.2	10.6	—	—

Notes:

— = indicates less than four data points for that year.

Impairment screening value for chlorophyll *a* = 20 micrograms per liter (µg/L)

For phosphate mines in the CFPD, once NNC requirements are fully implemented, evaluation of compliance with NNC for specific streams will require obtaining total nitrogen and total phosphorus data, as well as performing biological assessments. Stream segments in the AEIS study area that are determined to be noncompliant with the NNC will require developing and implementing basin management regulatory strategies. These nutrient load reductions can be translated to reductions in long-term average total nitrogen and total phosphorus concentrations in waters delivered to downstream water bodies like the Charlotte Harbor estuary.

3.3.3.2 Groundwater Quality

Characterization of groundwater quality is particularly complex, requiring differentiation between the conditions found in the SAS vs. IAS vs. upper FAS. Additionally, within a given aquifer, substantial variation occurs naturally, both horizontally and with depth. With regard to conditions in the CFPD that could be impacted by phosphate mining, the most relevant are those in the surficial aquifer. As described in prior sections of this AEIS, mining effects on the local surficial water quality could potentially occur because of chemical usage during beneficiation, and the potential transport of chemical residues into clay settling areas or into mine cuts being filled with either clay or sand tailings pumped as slurries through the mine's pipeline system. If such chemicals were present in sufficient quantities, they could leach into the surficial aquifer.

Other aspects of phosphate mine operations that could potentially contribute to groundwater quality changes include using FAS water pumped from wells for pipeline booster pump seal maintenance (a small but constant use), and also for augmenting the overall mine recirculation system water supply (typically under prolonged dry conditions when rainfall accumulations are inadequate to meet a mine's needs). Under these types of mining-related operations, FAS waters are mixed with those primarily representing surface waters and/or SAS waters pumped into the recirculation system during mining-related dewatering operations. The subsequent infiltration of water from the recirculation system into the SAS could carry the non-native FAS water quality constituents into the SAS. As for the SAS groundwater, FDEP has established groundwater quality standards for the upper FAS and phosphate mining effects on the water table's water quality are monitored in accordance with permit-specific conditions.

General comments regarding typical groundwater quality in the AEIS study area are provided below, as are groundwater monitoring records generated by routine monitoring around a representative clay settling area to help characterize existing SAS groundwater quality conditions.

General Groundwater Water Quality Conditions in the AEIS Study Area

Surficial Aquifer System

The SWFWMD reports that, within the Eastern Tampa Bay WUCA, which encompasses approximately the northeastern quarter of the CFPD, SAS water quality generally is good except in areas near the coast or along rivers that are tidally influenced or influenced by lower quality water discharging from below. Chloride and sulfate concentrations are higher in these coastal areas and coastal reaches of rivers (SWFWMD, 1993). Recharge to the SAS is primarily from precipitation, and varies from 0 to 20 inches per year. Other minor sources of recharge include irrigation water and upward leakage from underlying aquifers when the underground pressures support it (i.e., when the potentiometric surface of the groundwater in lower layers exceeds that of the upper layers). The hydrochemistry of this aquifer system reflects the low ion concentrations of the recharge water (Table 3-14) and the lithology of the aquifer deposits (Berndt and Katz, 1992), indicating that the surficial aquifer water quality is generally influenced by stormwater.

Table 3-14. Ranges in Concentration of Selected Constituents in Precipitation[a]

Constituent	Concentration Range (mg/L)
Calcium	0.32 to 3.4
Magnesium	0.12 to 0.6
Sodium	0.44 to 2.3
Potassium	0.12 to 0.5
Chloride	0.98 to 3.9
Sulfate	2.05 to 3.34
Total Nitrogen	0.34 to 2.7
Phosphate	0.01 to 0.02[b]
Bicarbonate	<10[c]

Notes:

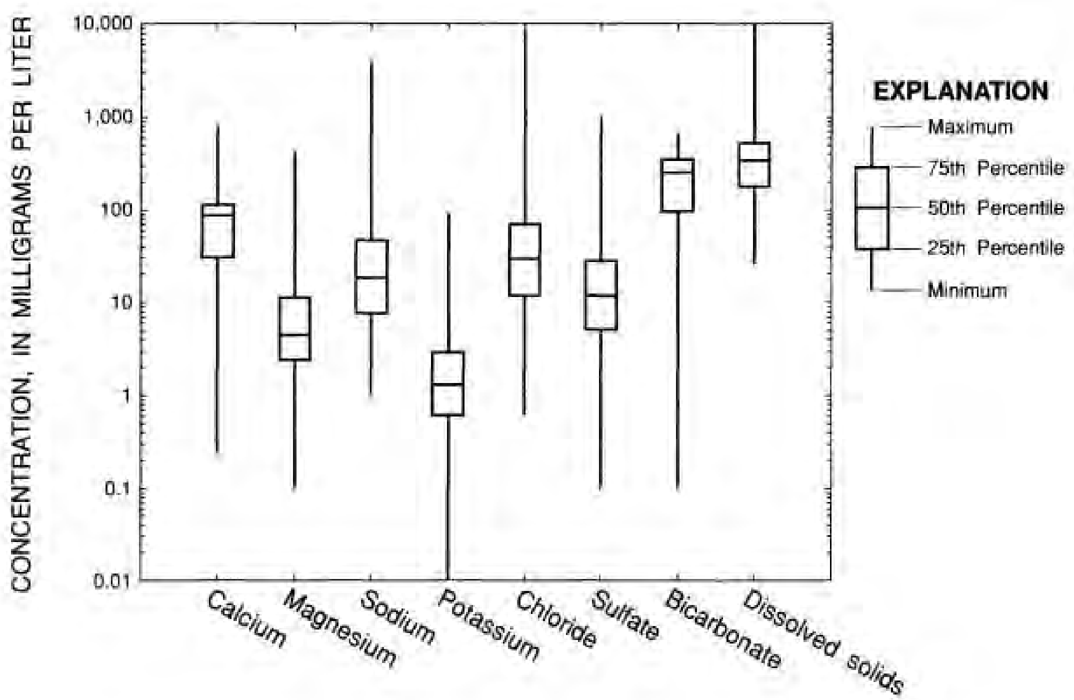
[a] Based on six sites, one in the study area (Hillsborough County).

[b] Based on two sites.

[c] From literature (Berndt and Katz, 1992).

Berndt and Katz (1992) evaluated the hydrochemistry in the SAS and IAS in areas of southwestern Florida where sufficient data were available to compare the effects of leakage from the overlying surficial aquifer system and the underlying Upper Floridan aquifer. These areas were concentrated in the southern CFPD, in the Peace River and Myakka River basins. Median concentration and distribution of selected constituents are shown in Figure 3-36 for wells in the SAS in central Florida (including the study area).

The median total dissolved solids concentration in the SAS in southwest Florida is 351 milligrams per liter (mg/L). The distribution of chloride concentrations in the SAS in the study area suggests that saltwater has impacted the southern and coastal portions. Nitrate and phosphate concentrations in the SAS in central Florida are generally low, ranging from less than the detection limit to some values as high as 52.5 mg/L for nitrate and 4.3 mg/L for phosphate. Median nitrate and phosphate values were 0.035 and 0.031 mg/L, respectively. The median pH value of the SAS in central Florida is 6.8 (Berndt and Katz, 1992).



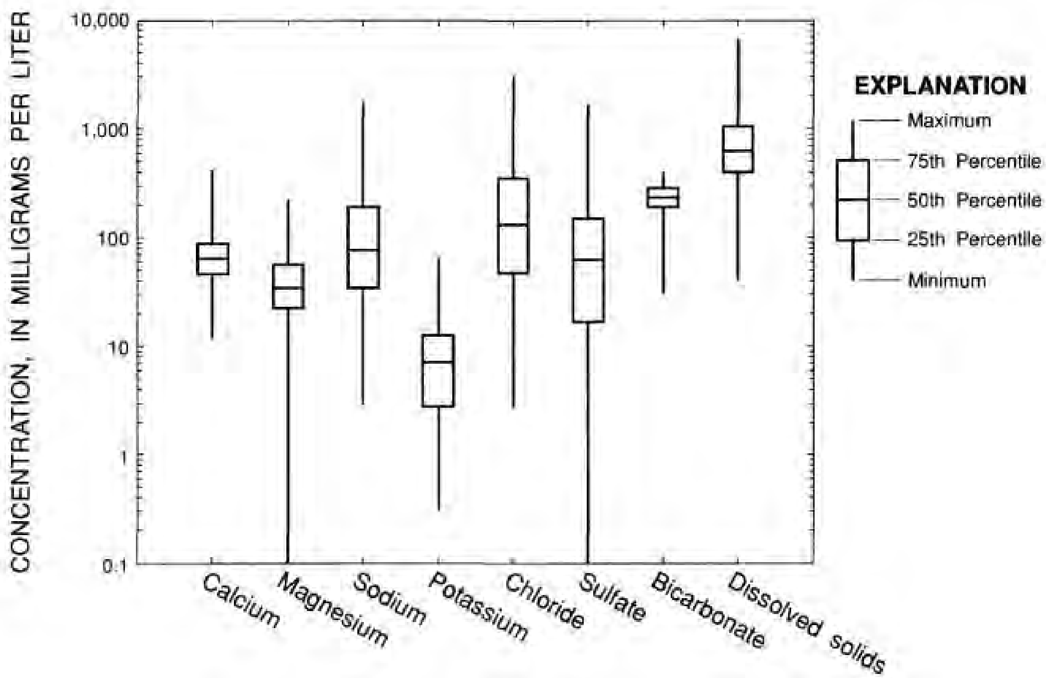
Source: Berndt and Katz, 1992

Figure 3-36. Concentrations of Selected Constituents in the Surficial Aquifer System of Central Florida

Intermediate Aquifer System

Similar median concentrations and distributions of selected constituents are shown in Figure 3-37 for wells in the IAS in southwestern Florida (which includes the study area). TDS concentrations in the IAS in the northern part of the CFPD (e.g., Polk County) typically range from 200 to 300 mg/L, with concentrations generally increasing to the south where values ranging up to 500 mg/L are common (e.g., DeSoto County). This is likely attributable to a greater upper FAS influence in the south. Nitrate and phosphate concentrations in the IAS were low, ranging from less than the detection limit to values as high as 0.5 mg/L for nitrate and 3 mg/L for phosphate. No specific geospatial patterns were notable. Median nitrate and phosphate values were 0.01 and 0.06 mg/L, respectively (Berndt and Katz, 1992). SWFWMD reports that the overall water quality of the IAS in the Northern Tampa Bay WUCA is good, with major ion

concentrations between those of the SAS and FAS – with the exception of coastal areas where chlorides may be elevated.



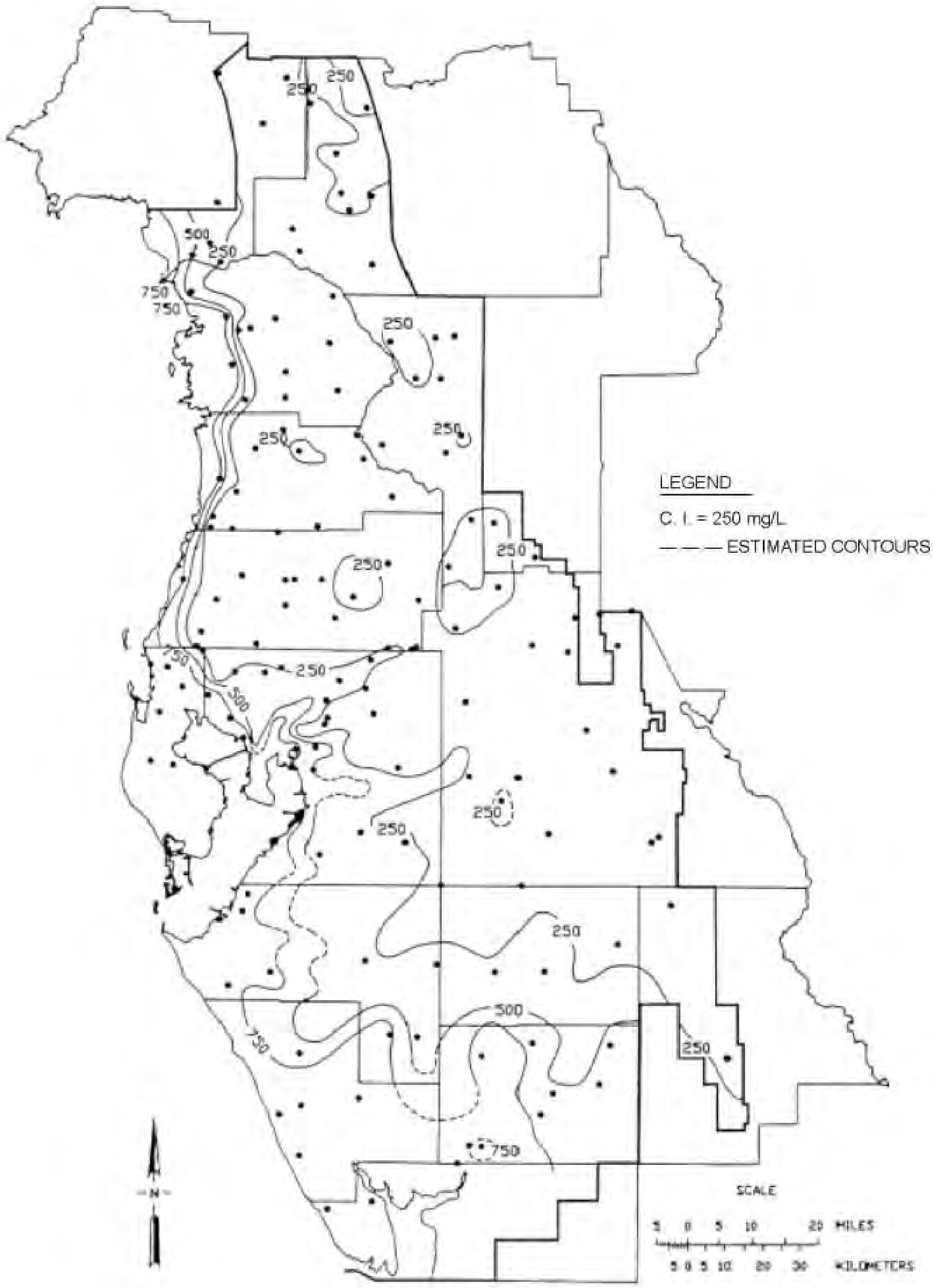
Source: Berndt and Katz, 1992

Figure 3-37. Concentrations of Selected Constituents in the Intermediate Aquifer System of Central Florida

Floridan Aquifer System

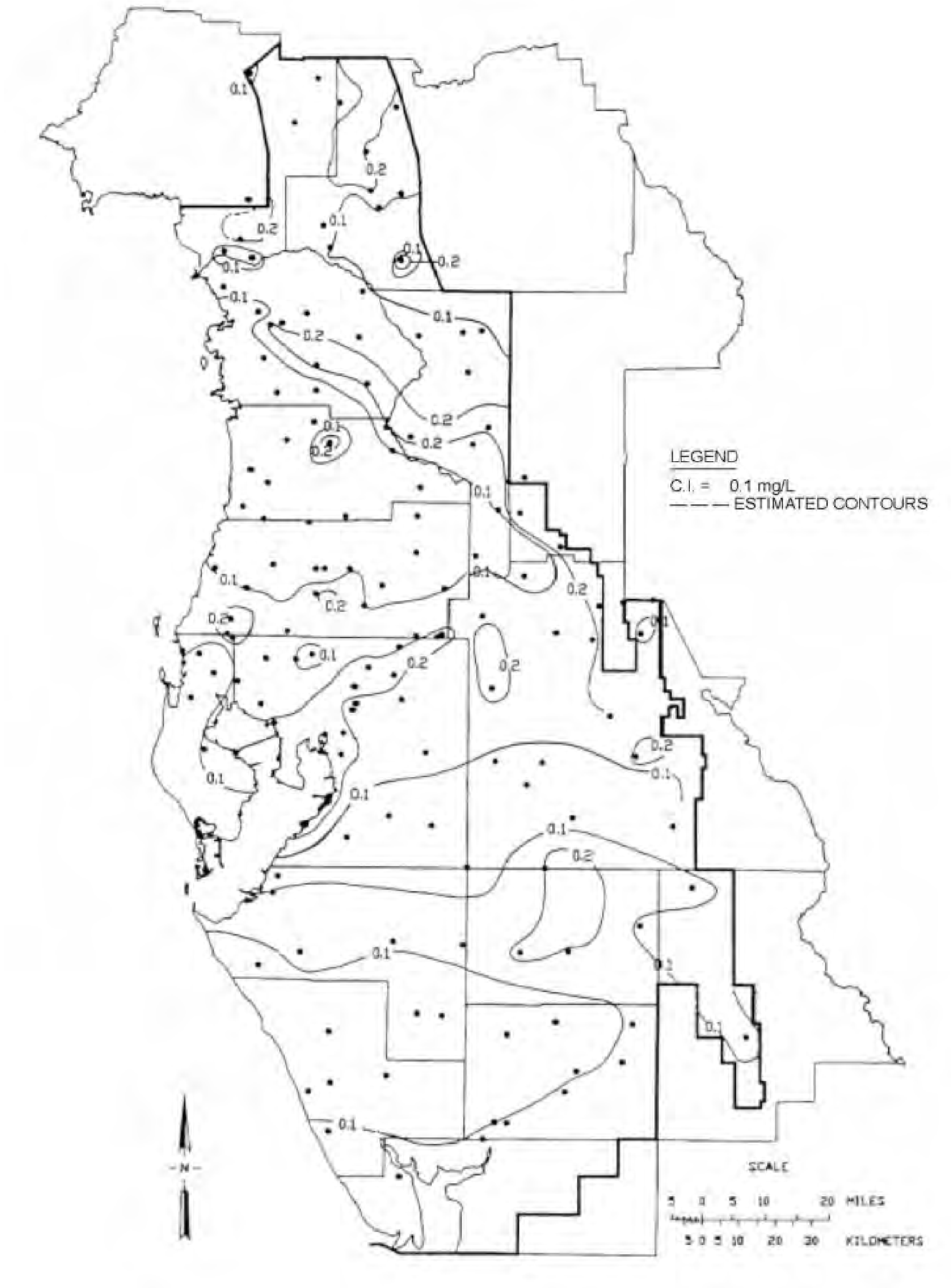
The median TDS concentration in the upper FAS in southwestern Florida is 710 mg/L (Berndt and Katz, 1992); the distribution of TDS concentrations in the study area is shown in Figure 3-38. The distribution of total phosphorus concentrations in the FAS within the study area is shown in Figure 3-39. Water supply withdrawals from the FAS could introduce these constituents into the surface water management system and to some extent to the underlying water table through water percolation into the ground.

SWFWMD reports that the upper FAS water quality in the Northern Tampa Bay WUCA is good in upgradient areas to the north. In downgradient areas, south and toward the coast, the water is of variable to poor quality. High sulfates were observed in some areas in the south and coastal areas of the Northern Tampa Bay WUCA (SWFWMD, 1993).



Source: Maddox et al., 1992

Figure 3-38. Distribution of Total Dissolved Solids Concentrations in the Floridan Aquifer System



Source: Maddox et al., 1992

Figure 3-39. Distribution of Total Phosphorus Concentrations in the Floridan Aquifer System

Historical Phosphate Mining Effects on Surficial Aquifer Groundwater Quality

A study of phosphate mining effects on SAS water quality was conducted by USGS (Lewelling and Wylie, 1993). The study focused on comparing mined/reclaimed and unmined basins in terms of a number of physical and chemical water quality parameters, and included studies focused on the SAS conditions under these basins. The study examined conditions at eight small basins in a CFPD area generally ranging from north to south between Fort Meade and Wauchula, and from east to west from Bowling Green to Fort Lonesome. Three of the basins were unmined reference locations while the other five basins represented mined and reclaimed areas. Reclamation methods for the different sites including clay only, sand/clay mix, sand tailings capped by overburden, and overburden only. The study included reconnaissance studies of short duration and intensive parameter coverage as well as routine monitoring at roughly a bimonthly frequency for a 2-year study period. The investigation represents a comprehensive comparison of mined and unmined basin conditions.

This study collected and analyzed samples of groundwater from multiple SAS monitoring wells in each of the study basins. Parameters analyzed included a broad range of constituents, including pH, conductivity, color, dissolved solids, nitrogen, phosphorus, calcium, magnesium, sodium, potassium, sulfate, chloride, fluoride, nitrate, carbonate/bicarbonate, an extensive list of trace elements, and radionuclides.

These investigators reported that, while "differences in values or concentrations for the … properties or constituents between unmined and mined/reclaimed basins generally are small… Results of water quality analyses of samples from reclaimed basins generally indicated that shallow groundwater in these basins had higher concentrations of most constituents than shallow groundwater in unmined basins."

Specific observations offered by USGS are summarized below:

- Groundwater at the unmined basins is characterized by relatively low specific conductance, alkalinity, and dissolved solids when compared to groundwater at most of the reclaimed basins.
- Specific conductance at unmined basins ranged between 75 and 217 microSiemens per centimeter (μS/cm) compared to a range of 177 to 905 μS/cm in wells at reclaimed basins.
- Calcium levels at unmined basins ranged from 2 to 11 mg/L compared to a range of 6.8 to 100 mg/L at the reclaimed basins.
- Magnesium at unmined basins ranged from 1.3 to 5.1 mg/L compared to a range of 3.1 to 46 mg/L at the reclaimed basins.
- In terms of radionuclides, three values for gross-alpha activity documented for unmined basins were 4, 37, and 53 pCi/L compared to values ranging from 1.9 to 5.2 pCi/L in the reclaimed areas. USGS indicated that the high values at two of the unmined basins, which were above the 15 pCi/L primary

drinking water standard reference value, were *"…single, nonreplicated measurements of water samples from wells in each basin and are attributed to the natural emissions from undisturbed phosphate-ore deposits in the aquifer system."*

- All radium-226 activities documented across the study basins ranged between 0.64 and 2.1 pCi/L – below the primary drinking water standard reference value of 5 pCi/L.

Other parameters for which no substantive difference was found by USGS between the mined and unmined water table water quality included TP, chloride, sodium, iron, and sulfate. USGS concluded that "…most constituents were within the state water quality guidelines established by the Florida Department of Environmental Regulation (FDER, now FDEP). Color and concentrations of dissolved solids, sulfate, iron, manganese and lead exceeded secondary drinking water standards in some water samples from the surficial aquifer system in several of the reclaimed basins, and iron concentrations exceeded secondary drinking water standards and gross-alpha exceeded primary drinking water standards in groundwater at some of the unmined sites."

During the early 1980s, investigations of SAS groundwater quality were conducted to determine the overall compliance of phosphate mining areas with applicable groundwater quality protection guidelines, with the specific goal being to support an FDER decision regarding whether routine groundwater monitoring would be required as provisions of permits from the state for mine operations (Gordon F. Palm and Associates, 1984). Water samples were drawn from wells at 20 phosphate mine sites in the CFPD; they were analyzed for 33 parameters for which primary and secondary drinking water standards existed at the time of the study. Follow-up studies addressed radionuclide activities for gross-alpha and radium 226. The referenced report concluded that:

> *"A meeting was held with the DER in Tallahassee on October 18, 1983 to discuss results of the phosphate industry's ground water study of their surface waters and deeps wells. Based on these studies, the DER stated that the waste water from the beneficiation plants appeared to meet the primary and secondary drinking water standards of the department. They also stated that DER's remaining concern that needed to be addressed was the potential for organic chemical contamination from fuels and flotation agents used in the beneficiation process (Terry Cole, Assistant Secretary of DER, letter of October 24, 1983 to Robert L. Rhodes, Jr., Legal Counsel Florida Phosphate Council). After discussions, it was agreed, between DER and the Florida Phosphate Council members, that each phosphate mine would obtain one sample of tailings water, from a location approved by the DER, and analyze it for all of the priority pollutants. If as a result of analysis, priority pollutants were found above the detection limits, it was agreed that further discussions would be held with the DER to determine subsequent action, if any."* Source: Gordon *F.* Palm and Associates, 1984.

The conclusions reached as a result of those studies serve as the basis for FDEP typically not requiring routine groundwater quality monitoring at phosphate mines. However, annual water quality analyses of waters used to transport sand tailings are required for a suite of organic parameters considered as indicators of potential beneficiation reagent residuals. Additionally, where groundwater monitoring has been included in specific phosphate mine permits, a screening for the primary and secondary drinking water standards is required at the time of each permit renewal. Compliance with the groundwater standards is required at the property boundaries of phosphate mines, as specified in permit conditions found in operating permits issued to phosphate mine facilities over the past 30 years.

3.3.4 Aquatic Biological Communities

The potential for phosphate mining to affect freshwater and estuarine aquatic systems in the AEIS study area is related to how mining affects the quantity, quality, and seasonality or timing of surface water flows through applicable watersheds and to the downstream estuarine systems. Within a mine's footprint, these effects are direct, physically affecting the streams and rivers that flow through the mining area. Indirect effects of phosphate mining may occur because of mining influence on flows or water quality reaching habitats downstream of the subject mining area. In either case, understanding how phosphate mining projects might affect aquatic systems requires a basic understanding of what those aquatic communities consist of, where they typically occur in the AEIS study area, and what key environmental factors play major roles in determining relative aquatic community health.

Freshwater aquatic habitats in and around the CFPD are influenced physically, chemically, and biologically by water source quality and quantity. In general, freshwater habitats fed by surface waters originating from wetlands tend to have higher concentrations of organic materials and have lower pH and conductivity levels than freshwater habitats fed by groundwater. Low-order streams in the AEIS study area, which are small tributaries to larger higher-order streams, typically are shallow and slow flowing; they often exhibit water quality characteristics similar to adjacent wetlands. Such streams may lack well-defined channels and typically are dominated by emergent vegetation and woody snags. They often are characterized by intermittent seasonal flows that depend mostly on antecedent rainfall.

The larger, higher-order streams in the AEIS study area similarly display seasonally variable flows tied to rainfall conditions. These streams tend to be deeper than their tributaries. They typically exhibit floodplain characteristics with broader channel cross sections that convey water depending on flow conditions prevalent at any given time during the year. Habitat diversity is provided by substrate variability, presence of woody debris and sand bars, and the presence of floating and/or emergent aquatic vegetation. Greater diversity in habitat conditions (representing the combination of physical and biological features, water flow conditions, and associated water quality characteristics) leads to greater diversity in the fish and invertebrate populations present in these higher-order streams during the different seasons of the year.

3.3.4.1 Fish Communities

Freshwater fish communities in the AEIS study area are typical of southeastern Coastal Plain communities occupying low-gradient rivers and creeks with low dissolved oxygen and adjacent wetland habitats. Among the watersheds of the CFPD, the majority of surveys on fish communities have been conducted in the Peace River watershed. PBS&J (2007) reported that 45 native freshwater fish species occur in the Peace River watershed. The fish community of this watershed is numerically dominated by members of the families Poeciliidae (examples: eastern mosquitofish and least killifish) and Centrarchidae (examples: largemouth bass, sunfish, and pygmy sunfish).

The major factors influencing the relative abundance of fish in the watershed include hydrological regime, density of macrophytic vegetation, and dominant substrate. Past studies have shown that centrarchids are most abundant in open, flowing portions of streams where scoured sand is the dominant substrate. In contrast, poeciliids are most abundant in low-flowing, densely vegetated areas where macrophytic vegetation and other structures provide shelter (BRA, 2006a).

Overall, data for the Peace River watershed have indicated a decline in the number of fish species over time. Reduction in native fish species present in the watershed has been attributed to the alteration or elimination of habitats (PBS&J, 2007). Direct and indirect impacts to fish habitats in the watershed include alterations and loss of first and second order streams, removal of woody snags for navigation, eutrophication of lakes, loss of groundwater discharge to stream baseflow and spring discharge, increased surface water conductivity in some areas because of agricultural irrigation use of FAS well water, decreases in surface flow, reduction in coverage by submerged aquatic vegetation, and introduction of exotic species. At least six exotic fish species have established reproducing populations in the Peace River basin (PBS&J, 2007). Where such species outcompete native species for key limiting resources, loss of native species can occur.

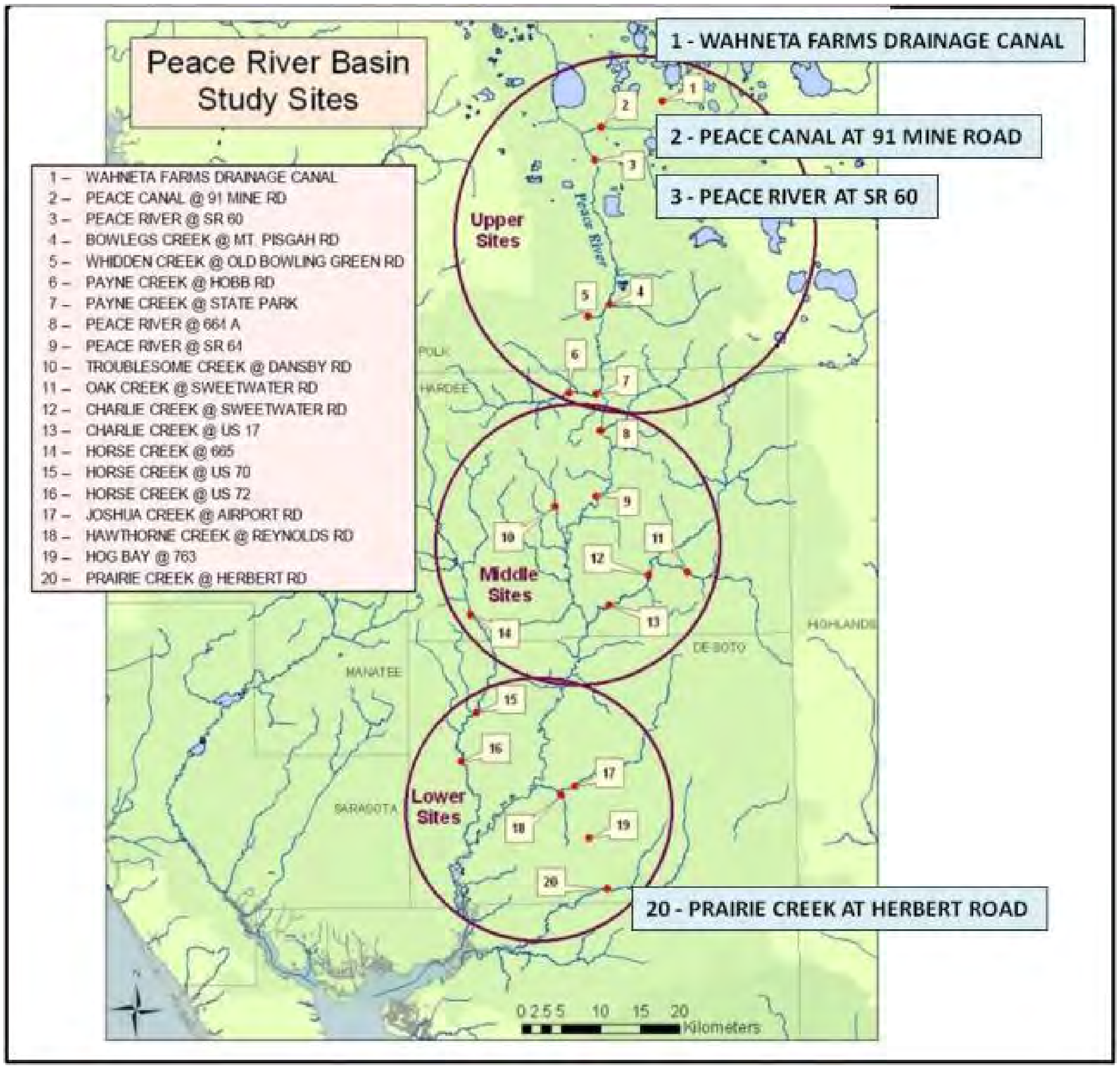
Fish sampling has been conducted at the sites of the Applicants' Preferred Alternatives to support planning and environmental permitting (CF Industries, 2010a; Mosaic, 2011a; Mosaic, 2011b; Mosaic, 2011c). Fish sampling for these mines was conducted primarily by seining, dip netting, and electroshocking. Fish data were reported primarily in terms of abundance of individuals, lists of taxa, and general community structure. Based on the sampling data presented in the federal Section 404 permit applications for the Applicants' Preferred Alternatives, fish communities at the mine sites are typical of those in the Peace River watershed. Most of the fish communities at the mine sites were composed of species typically associated with wetlands and small streams that have low flow and low dissolved oxygen levels.

3.3.4.2 Aquatic Invertebrates

Data on freshwater aquatic invertebrates in the AEIS study area have been collected by the phosphate industry during mine planning and to support environmental permitting activities, and by FDEP and other agencies during studies of sites in the Peace River watershed. Common freshwater benthic invertebrate groups that occur in aquatic habitats in the study area include Spaeriidae (fingernail clams), Oligochaeta (freshwater worms), and Chironomidae (midges). Common aquatic insect orders with larval forms contributing to aquatic invertebrate community composition and structure at various times of the year include Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies), Odonata (dragonflies), and Coleoptera (beetles).

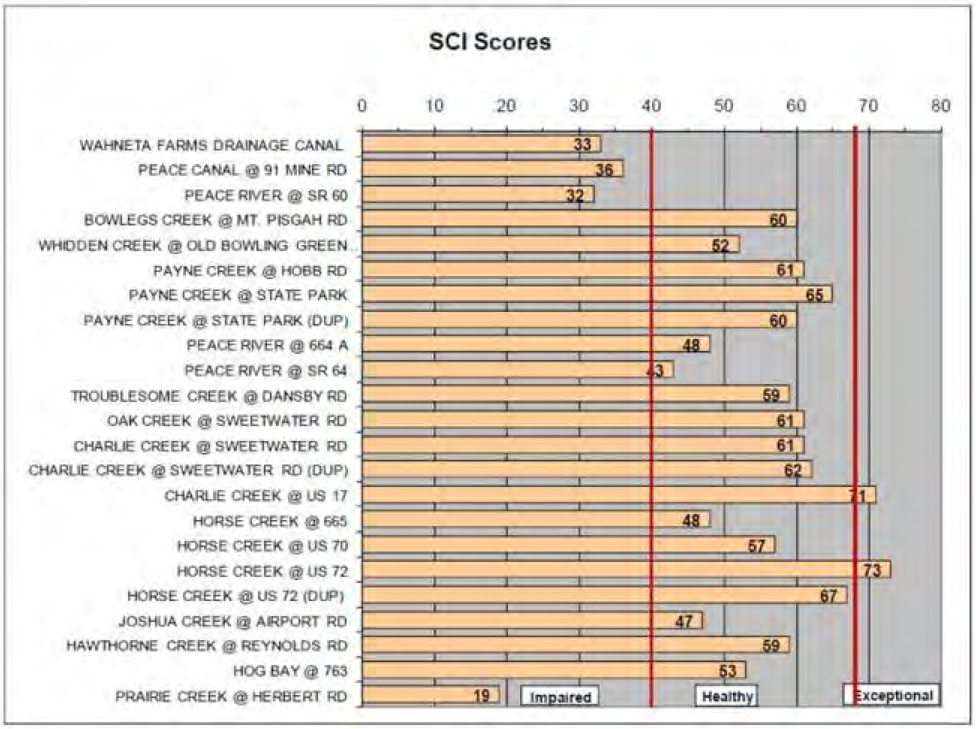
Freshwater benthic invertebrate community composition and relative abundance in the region vary by habitat type, which is determined largely by substrates present and surface water quantity and quality. Motile swimming invertebrates, or those that colonize through insect egg laying and larval form development, are capable of reestablishing populations in habitats that periodically dry out or alternatively experience high water velocities that can scour such invertebrates downstream during peak flow periods. Less motile organisms, such as mollusks, crustaceans, oligochaete worms, and other invertebrates that live attached to or burrowed into the substrate are more susceptible to such periodic disturbances and have slower rates of recolonization because of their life histories.

Freshwater invertebrate populations in the Peace River watershed, like fish populations, have been impacted by habitat loss and alterations. Impacts to aquatic invertebrates in the watershed have included habitat smothering by sediment, reduced surface water flows, stream channelization, and degraded water quality (PBS&J, 2007). Despite these documented impacts, benthic macroinvertebrate communities in the Peace River watershed are currently considered to be in relatively good condition based on watershed-wide sampling conducted by the FDEP in 2008 (FDEP, 2009). The 2008 sampling was conducted at 23 sites throughout the watershed; the locations of the sampling sites are shown in Figure 3-40. Data gathered supported analyses using the Stream Condition Index (SCI) methodology, a method of assessment of the relative health of the invertebrate communities that FDEP has adopted for regulatory review of surface water systems in Florida. The average SCI score throughout the watershed was 53, which corresponds to a rating of “healthy” (SCI scores between 40 and 67 points as defined by FDEP for this study). Figure 3-41 illustrates that of the 23 individual sampling sites, 17 were rated “healthy,” two sites were rated “exceptional” (SCI scores greater than 67 points), and four sites were rated “impaired” (SCI scores below 40 points). Sites that FDEP rated as “impaired” included the Wahneta Farms Discharge Canal, Peace Canal at 91 Mine Road, Peace River at State Road 60, and Prairie Creek at Herbert Road.



Source: Modified from FDEP, 2009

Figure 3-40. Locations of FDEP Macroinvertebrate Sampling Stations in the Peace River Watershed, with the Four Impaired Stations Highlighted



Source: FDEP, 2009

Figure 3-41. Stream Condition Index Scores Based on a 2008 FDEP Survey of Macroinvertebrate Communities in the Peace River Watershed

Factors that FDEP identified as having potentially contributed to impairment at some locations included:

- Lack of available habitats due to silt smothering
- Low dissolved oxygen levels
- Hydrological modifications
- Localized water quality issues
- Increased conductivity

None of the four impaired sites was near areas in the CFPD where active mining is ongoing. Rather, the first three were in Polk County in areas influenced by runoff from agricultural or urbanized land areas. The fourth site was south of the CFPD in a watershed identified in the Peace River Cumulative Impact Study as influenced by agricultural use of FAS water for irrigation purposes (PBS&J, 2007).

FDEP concluded that even though 13 sites exceeded NNC limits, only two also had SCI scores in the impaired range. FDEP stated that aquatic systems in the Peace River basin may be adapted to high

nutrient concentrations and be capable of maintaining healthy biological communities. FDEP also concluded that site-specific alternative criteria may be appropriate for streams that exceed the NNC limits but also have healthy biological communities, provided downstream waters are not impaired.

Aquatic macroinvertebrate sampling has been conducted at the sites of the Applicants' Preferred Alternatives to support planning and environmental permitting (CF Industries, 2010; Mosaic, 2011a; Mosaic, 2011b; Mosaic, 2011c). This sampling was conducted primarily using the SCI methodology. Based on the sampling data presented in the Applicants' federal Section 404 permit applications, most of the sites sampled at the South Pasture Extension, Ona, and Wingate East Mines had low SCI scores and were rated as "impaired." The low SCI scores at these sites were attributed to the intermittent or ephemeral flow regimes and the low dissolved oxygen levels of the streams. Of the sites sampled at the Desoto Mine, approximately half were rated as "impaired" and half were rated as "healthy." Trends in SCI scores were not evident and it was concluded that low flow and low dissolved oxygen levels likely impacted aquatic macroinvertebrate assemblages at the sampling sites. The sampling data suggested that aquatic macroinvertebrate communities in some locations on the Desoto Mine site may vary seasonally.

3.3.4.3 Estuarine Aquatic Communities

No phosphate mines directly impact estuarine habitats of rivers draining the CFPD land areas. However, the AEIS scoping process identified stakeholder concerns about possible cumulative effects of multiple mines with overlapping periods of operation in the same watershed or sub-basins in a watershed. For example, if multiple mines operating in a single sub-basin resulted in a sufficient cumulative reduction in freshwater flows to an estuary, the changed flows could lead to an extension of higher salinity waters upstream into the river, in turn influencing the species composition and structure of biological populations. Alternatively, if the multiple phosphate mines had surface water discharges that sufficiently differed from the natural water quality of streams draining a sub-basin, those changes in water quality could also potentially cause shifts in aquatic community characteristics. For these reasons, it is appropriate to characterize the general conditions of the estuarine aquatic communities present in the tidal reaches of the key river watersheds in which future mining projects are proposed.

The focus of this AEIS is on the Applicants' Preferred Alternatives, primarily in the lower Peace and Myakka River watersheds. These watersheds are tributary to the Charlotte Harbor estuary. Charlotte Harbor is one of the largest and most productive estuaries in Florida (FDEP, 2011b). Segmentation of the Charlotte Harbor estuary has been done in support of water quality and estuarine biological monitoring program design; the most relevant segments of the estuary to this AEIS are those described in Section 3.3.2.1.

The high productivity of Charlotte Harbor results from its diverse habitats, which include seagrass beds, mud flats, sand flats, mangrove swamps, salt marshes, and oyster reefs. All of these habitat types are

found in the Charlotte Harbor estuary, including the transition zones into the tidal reaches of the Peace and Myakka Rivers. These habitats serve as foraging and nursery grounds for approximately 270 species of fish (USEPA, 2011a) and 370 species of aquatic invertebrates (Mote Marine Laboratory, 2007). Common fish in the estuary include mullet, red drum, spotted sea trout, flounder, snook, tarpon, snapper, sheepshead, and sharks. Common invertebrates include blue crab, stone crab, shrimp, polychaete worms, and oysters. While not the focus of this specific section, it is acknowledged that larger aquatic biota also occur in the estuary, including the Florida manatee, dolphins, and sea turtles.

Surveys of aquatic communities, primarily focused on benthic macroinvertebrates, have been conducted by Mote Marine Laboratory in Charlotte Harbor and in the upper tidal reaches of the Peace and Myakka Rivers (Mote Marine Laboratory, 2007; Mote Marine Laboratory, 2005). In Charlotte Harbor, the highest benthic species diversity and benthic organism abundance was found in sub-tidal mud and sand habitats. Species diversity and organism abundance were highly variable among basins and among habitats. Organism abundance ranged from 722 to 670,918 per square meter and averaged 23,059 per square meter across all basins and habitats.

The tidally influenced portions of the lower Peace and Myakka Rivers had the greatest average abundance of organisms, but also had the lowest species diversity. The lower Peace and Myakka Rivers had similar total numbers of benthic taxa (61 and 60, respectively). As in Charlotte Harbor, species diversity and organism abundance in the lower Peace River and Myakka River were highest in sub-tidal mud and sand habitats. Tidal salt marshes in the lower Peace and Myakka rivers are often seasonally dry, which results in depauperate benthic communities. A total of 23 macro-mollusk species was found in the tidally influenced parts of the Myakka River; species found there are also common in Charlotte Harbor. Mollusk abundance was highest in intertidal zones near the mouth of the river and highest in sub-tidal zones further upstream. The mollusk community was numerically dominated by the Asian clam (an introduced species), Carolina marsh clam, Gulf wedge clam, stout razor clam, marsh periwinkle, ribbed muscle, eastern oyster, and hooked mussel (Mote Marine Laboratory, 2007; Mote Marine Laboratory, 2005).

Estuarine invertebrate and fish communities tend to be numerically dominated by species that are adapted to fairly wide variations in salinity regime related to natural seasonal and/or year-to-year fluctuations, depending on the cumulative influences of rainfall and watershed runoff deliveries. During dry seasons, river discharges decline and salinity regimes in the estuarine portions of the rivers increase. During wetter periods of the year, river discharges increase and salinity regimes are lowered. Another way to view these natural variations is that the saltwater-influenced zones in the lower portions of the rivers transitioning into Charlotte Harbor shift upstream or downstream seasonally, and also may vary in upriver extent widely from year to year depending on annual precipitation variability, watershed storage, and downstream river discharge delivery. Species of fish and invertebrates with life histories and physiological mechanisms that are adapted to this variability in salinity are the most successful in

establishing and maintaining viable populations in these transitional habitat zones. The potential effects of phosphate mining operations on estuarine communities are analyzed in Chapter 4.

3.3.5 Wetlands

Wetlands are areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands are areas that generally include swamps, marshes, bogs, and similar areas. As an important natural resource, wetlands provide ecosystem functions such as food chain production, habitat, nesting spawning, rearing and resting sites for aquatic and land species. They also provide protection of other areas from wave action and erosion and natural water filtration and purification functions, and serve as storage areas for storm and flood waters and natural recharge areas for groundwater.

Wetlands in and around the CFPD include several types of forested wetlands (such as bay heads, cypress swamps, and hydric pine flatwoods), vegetated non-forested wetlands (such as wet prairies and marshes), and non-vegetated wetlands (such as tidal flats). Surface waters include streams/waterways, lakes, reservoirs, and bays/estuaries. The current quality of the wetlands in the CFPD is variable and lower overall compared to pre-development conditions due to land alterations that have occurred over the past two centuries as a result of agriculture, urban development, and mining. Due to such land-use practices, much of the historical coverage of wetlands in the region has been lost and many of the streams have been displaced, channelized, or otherwise hydrologically impacted. Although some portions of the region contain large areas of contiguous wetland systems, much of the region consists of remnant wetlands interspersed in disturbed areas.

The primary system used to classify land use in Florida is the Florida Land Use, Cover and Forms Classification System (FLUCCS; FDOT, 1999). The land information provided by FLUCCS is derived from aerial photography and from the current generation of airborne and satellite multispectral imaging systems. In FLUCCS, land covers such as wetlands and surface waters are defined broadly under the Level 1 classification and with increasing detail under the Level 2, 3, and 4 classifications. The most currently available FLUCCS mapping of wetlands and surface waters in and around the CFPD is for 2009 and is maintained by SWFWMD. In the SWFWMD FLUCCS (SWFWMD, 2009a), wetlands and surface waters are defined by Level 1 Codes 6000 and 5000, respectively.

The 2009 coverage of wetlands and surface waters (including systems that are not under the USACE's regulatory jurisdiction) in and around the CFPD based on FLUCCS data maintained by SWFWMD is shown on Figures 3-42 and 3-43, respectively. It should be noted that the 2009 SWFWMD FLUCCS mapping does not account for all land uses/habitats created through reclamation because it classifies reclaimed areas along with mined areas as Extractive land use.

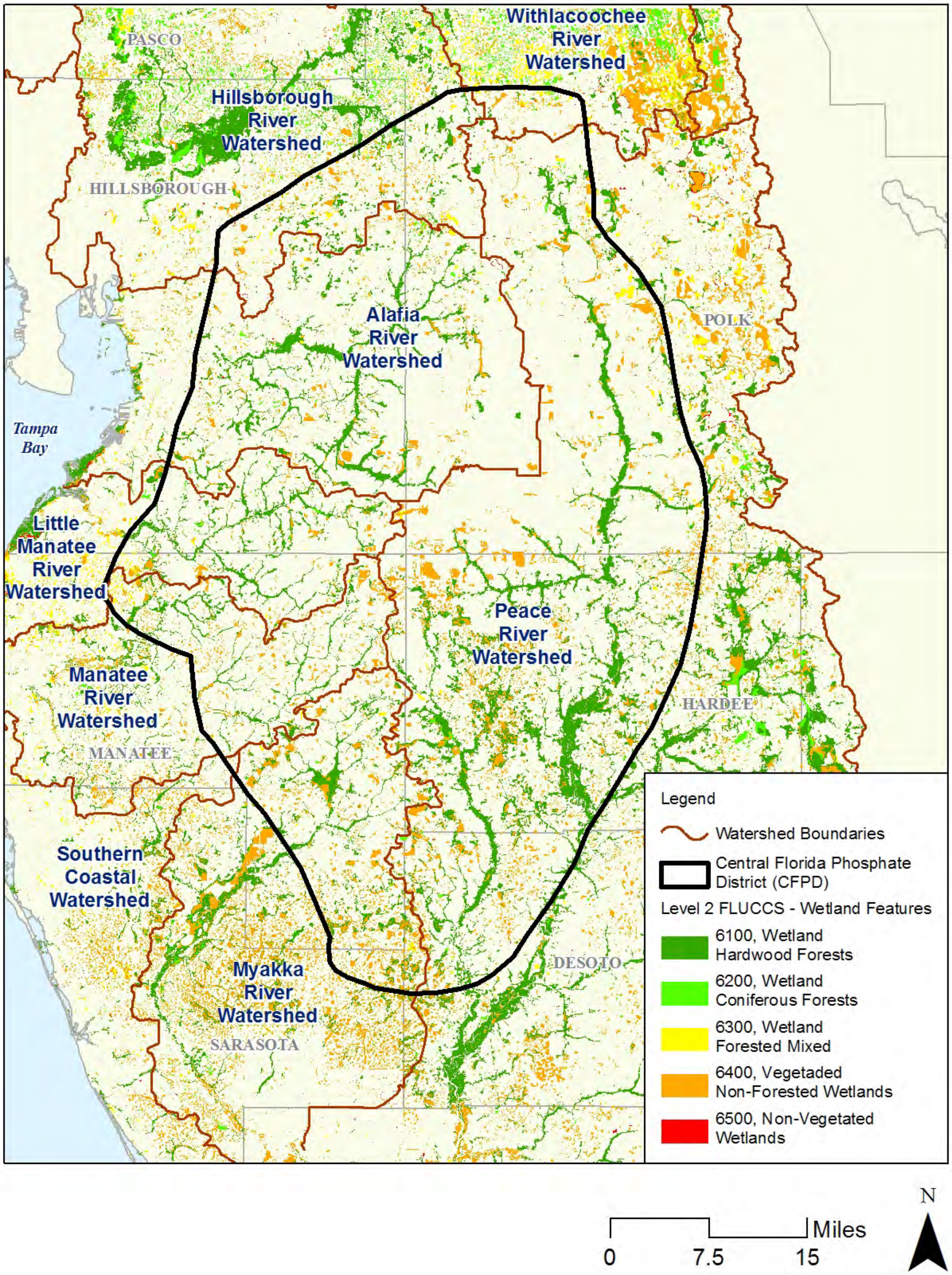


Figure 3-42. 2009 Wetland Coverage in and Surrounding the CFPD

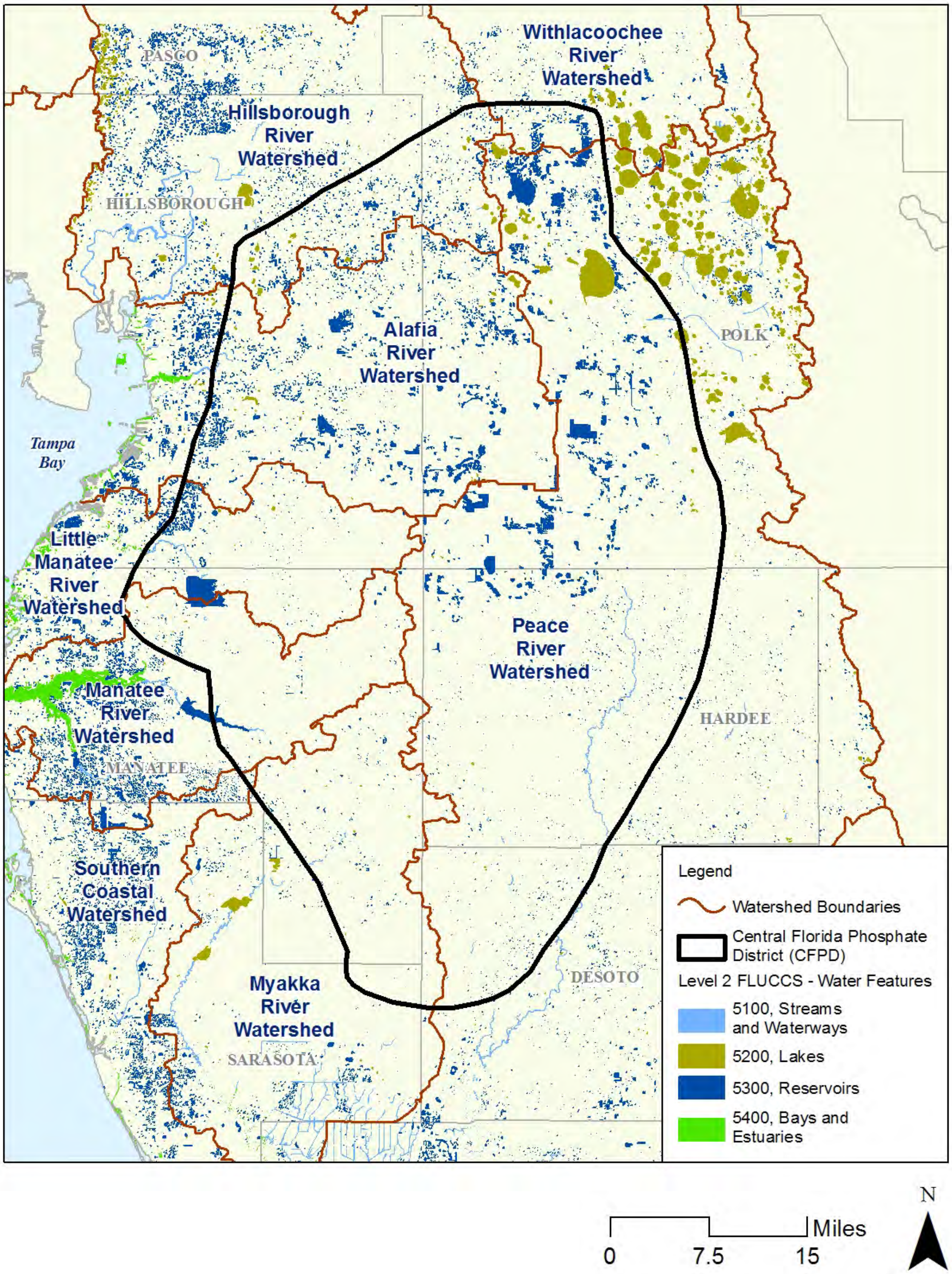


Figure 3-43. 2009 Surface Water Coverage in and Surrounding the CFPD

As shown on Figure 3-42, the FLUCCS Level 2 wetland types in and around the CFPD include Wetland Hardwood Forests (6100), Wetland Coniferous Forests (6200), Wetland Forested Mixed (6300), Vegetated Non-Forested Wetlands (6400), and Non-Vegetated Wetlands (6500). As shown on Figure 3-43, the FLUCCS Level 2 surface water types in and around the CFPD include Streams and Waterways (5100), Lakes (5200), Reservoirs (5300), and Bays and Estuaries (5400). Descriptions of these wetland and surface water types are presented in Table 3-15.

Table 3-15. Descriptions of FLUCCS Wetland and Surface Water Types

Code	Definition	Description
Surface Waters		
5100	Streams and Waterways	Linear water bodies including rivers, creeks, and canals having mouths that are less than one mile wide.
5200	Lakes	Extensive inland water bodies excluding reservoirs.
5300	Reservoirs	Artificial impoundments of water used for irrigation, flood control, municipal and rural water supplies, recreation, and hydroelectric power generation.
5400	Bays and Estuaries	Inlets or arms of the sea that extend into the land mass of Florida.
Wetlands		
6100	Wetland Hardwood Forests	Wetlands that have canopy crown closures of greater than 10% and that are 66% or more dominated by wetland hardwood species. Examples include mangrove swamps and gum swamps.
6200	Wetland Coniferous Forests	Wetlands that have canopy crown closures of greater than 10% and that are 66% or more dominated by wetland coniferous species. Examples include cypress swamps and hydric pine flatwoods.
6300	Wetland Forested Mixed	Forested wetlands in which neither hardwoods nor conifers achieve a 66% dominance of the canopy composition.
6400	Vegetated Non-Forested Wetlands	Vegetated wetlands that do not meet the canopy crown closure threshold of forested wetlands. These systems include wet prairies, freshwater marshes, saltwater marshes, and seasonally flooded basins and meadows.
6500	Non-Vegetated Wetlands	Wetlands that lack vegetation due to effects of erosion or water fluctuations. Examples include tidal flats, shorelines, and intermittent ponds.

Notes:

FLUCCS = Florida Land Use, Cover, and Forms Classification System

Source: FDOT, 1999

The 2009 acreages of wetlands and surface waters in the CFPD portions of the AEIS study area are presented in Tables 3-16 and 3-17, respectively.

Table 3-16. 2009 Acreages of Wetlands within the CFPD Portions of the AEIS Study Area

Location	FLUCCS Code					
	6100 Wetland Hardwood Forests	**6200 Wetland Coniferous Forests**	**6300 Wetland Forested Mixed**	**6400 Vegetated Non-Forested Mixed**	**6500 Non-Vegetated Wetlands**	**TOTAL**
CFPD	126,706	3,250	5,328	81,624	530	217,440
Peace River Watershed Within CFPD	67,022	1,121	1,743	41,011	172	111,070
Myakka River Watershed Within CFPD	11,370	249	377	14,690	5	26,693
Alafia River Watershed Within CFPD	24,570	652	567	9,265	171	35,227
Manatee River Watershed Within CFPD	7,882	65	686	6,559	4	15,197
Little Manatee River Watershed Within CFPD	10,359	608	519	3,954	25	15,467
Withlacoochee River Watershed Within CFPD	147	266	492	1,134	20	2,061
Hillsborough River Watershed Within CFPD	5,352	287	941	4,991	130	11,703
Southern Coastal Watershed Within CFPD	0	0	0	19	0	19

Notes:

FLUCCS = Florida Land Use, Cover, and Forms Classification System

Acreages reported in whole units

Source: SWFWMD, 2009a

Table 3-17. 2009 Acreages of Surface Water Types within the CFPD Portions of the AEIS Study Area

Location	FLUCCS Code				
	5100 Streams and Waterways	5200 Lakes	5300 Reservoirs	5400 Bays and Estuaries	TOTAL
CFPD	643	8,165	31,225	0.5	40,034
Peace River Watershed Within CFPD	418	6,817	15,299	0.0	22,535
Myakka River Watershed Within CFPD	36	24	276	0.0	336
Alafia River Watershed Within CFPD	93	514	8,752	0.0	9,360
Manatee River Watershed Within CFPD	29	13	1,572	0.0	1,615
Little Manatee River Watershed Within CFPD	60	53	3,058	0.5	3,173
Withlacoochee River Watershed Within CFPD	0	41	791	0.0	833
Hillsborough River Watershed Within CFPD	4	700	1,467	0.0	2,173
Southern Coastal Watershed Within CFPD	0	0	7	0.0	7

Notes:

FLUCCS = Florida Land Use, Cover, and Forms Classification System

Acreages reported in whole units except for category 5400

Source: SWFWMD, 2009a

As indicated in Table 3-16, Wetland Hardwood Forest (6100) and Vegetated Non-Forested Mixed (6400) were the dominant wetland types in the CFPD, and in the Peace River and Myakka River watersheds, in 2009. These wetland types are distributed relatively evenly throughout the CFPD, except in portions of the oldest historical mining areas where their coverage is less abundant. As indicated in Table 3-17, Reservoirs (5300) and Lakes (5200) are the dominant surface water types in the CFPD based on 2009 SWFWMD FLUCCS data (SWFWMD, 2009a). Reservoirs and lakes are also the dominant surface water types in the Peace River watershed; however, Streams and Waterways (5100) are more dominant than lakes in the portion of the Myakka River watershed in the CFPD. Reservoirs and lakes are more abundant in the northern half of the CFPD than in the southern half of the CFPD.

The Peace River Cumulative Impacts Study (PBS&J, 2007) reported the following historical impacts to wetlands and waters in the Peace River basin:

- Approximately 343 miles of streams and associated floodplains were lost in the basin during the study period from the 1940s through 1999.

- During the same period, the basin sustained a 38.5 percent reduction in wetland acres, a loss of about 136,000 of the original 355,000 acres.

The study concluded that the loss of wetlands in the Peace River watershed resulted primarily from agriculture, urban development, and phosphate mining. According to the study, acres of phosphate mined land in the Peace River watershed increased from less than 7,500 acres in the 1940s to more than 64,000 acres in 1979 and to approximately 143,000 acres in 1999. The study reported that approximately 19,000 acres of wetlands were converted to phosphate mined land between the 1940s and 1979 and that 15,000 acres of wetlands were converted to phosphate mined land between 1979 and 1999. It should be noted that since publication of the study, various parties have indicated that due to mapping errors, the study overestimated the mining-related wetland impact that occurred between 1979 and 1999, and underestimated the reclamation of wetlands that occurred during the same period.

For this AEIS, SWFWMD FLUCCS land cover data were used to compare the estimated wetland coverage in the Peace, Myakka, Manatee, and Little Manatee River watersheds during 1990, 1999, and 2009 (Table 3-18). These data indicate that wetland coverage in the Little Manatee and Manatee River watersheds has been relatively stable during the period between 1990 and 2009. The data also indicate that wetland coverage increased substantially in both the Myakka and Peace River watersheds during that period. Although this increase cannot be readily explained, it is possible that at least some of this increase is associated with more intensive wetland reclamation/mitigation in these watersheds during this period.

Table 3-18. Estimated Wetland Acreages in Selected AEIS Study Area Watersheds during 1990, 1999, and 2009

Watershed	1990	1999	2009
Little Manatee	31,366	29,747	30,287
Manatee	31,730	30,309	30,786
Myakka	82,190	82,039	86,685
Peace	248,117	245,638	281,421
Totals	**393,403**	**387,733**	**429,179**

Source: SWFWMD, 2009a

For this AEIS, information on the wetlands and surface waters on the sites of the Applicants' Preferred Alternatives was based on the USACE-approved Jurisdictional Determinations, and on the proposed mine plans shown in the June 1, 2012 public notices for the four projects.

The federal jurisdictional wetland determinations for the sites of the Applicants' Preferred Alternatives were conducted by the Applicants in accordance with the 1987 USACE Delineation Manual. Atlantic and

Gulf Coastal Plain Regional Supplement. Streams on the sites of the Applicants' Preferred Alternatives were classified using FLUCCS and the Rosgen Level-II morphological classification system (Rosgen, 1996). Historical aerial photographs were used by the Applicants to identify manmade stream channels and alterations to natural channels on these sites. The centerlines of all natural and ditched natural streams on these sites were mapped in the field using sub-meter GPS technology or digitally in ArcGIS using available high-resolution LiDAR topographic data. Stream mapping was conducted to determine the locations and lengths of the streams on these sites.

Based on the USACE-approved Jurisdictional Determinations, forested wetlands under federal jurisdiction represent approximately 13, 11, 16, and 11 percent of the total area of the Desoto, Ona, Wingate East, and South Pasture Mine Extension sites, respectively. Mixed wetland hardwood is the dominant forested wetland type on each site. Non-forested wetlands (herbaceous or shrub) under federal jurisdiction represent approximately 9, 13, 10, and 12 percent of the total area of the Desoto, Ona, Wingate East, and South Pasture Mine Extension sites, respectively. Freshwater marsh is the dominant non-forested wetland type on each site. Surface waters (excluding streams) under federal jurisdiction represent less than 1 percent of the total area of each site. Upland-cut ditch is the dominant non-stream surface water type on the Desoto Mine site; cattle pond is the dominant non-stream surface water type on the Ona Mine site; and ditched wetland is the dominant non-stream surface water type on the Wingate East and South Pasture Mine Extension sites. The Desoto, Ona, Wingate East, and South Pasture Mine Extension sites contain approximately 128,639, 208,366, 68,138, and 92,809 linear feet of streams, respectively.

Two methodologies are currently used to assess wetland functionality and quality in Florida: the Wetland Rapid Assessment Procedure (WRAP) and the Unified Mitigation Assessment Method (UMAM). Both UMAM and WRAP are accepted by USACE for regulatory evaluation of Section 404 permit applications and associated mitigation plans. The WRAP or UMAM score for a wetland is an indicator of its overall quality. In general, a higher score indicates a wetland of higher quality (highest score = 1.0). WRAP was used as the wetland functional assessment method for three of the mines (Desoto, Ona, and Wingate East) and UMAM was used as the wetland functional assessment method for the South Pasture Extension. The WRAP and UMAM data presented below are from the Applicants' Section 404 permit applications and are subject to change after review by the USACE.

Based on the respective federal Section 404 permit applications, the average WRAP score for all wetlands on the Desoto, Ona, and Wingate East Mine sites are 0.50, 0.61, and 0.67, respectively, indicating that wetlands on each mine site are, on average, of moderate quality. Some individual wetlands on each of these mine sites have WRAP scores well above the average score and others have WRAP scores well below the average score. Based on the average WRAP score of each wetland type, forested wetlands on the Desoto, Ona, and Wingate East Mine sites, overall, are of moderate to moderately high quality. (The average WRAP scores for forested wetlands on the Desoto, Ona, and Wingate East Mine

sites are 0.62, 0.64, and 0.70, respectively.) Average forested wetland WRAP scores range from a high of 0.77 (hydric pine savannahs) to a low of 0.54 (gum swamps) at the Desoto Mine site; from a high of 0.74 (bay swamps) to a low of 0.67 (wetland forested mixed) at the Ona Mine site; and from a high of 0.74 (gum swamps) to a low of 0.63 (wetland forested mixed) at the Wingate East Mine site.

Based on their average WRAP scores, the non-forested wetlands on the sites of the Applicants' Preferred Alternatives are moderate quality, but lower quality than the forested wetlands. The average WRAP score for non-forested wetlands on the Desoto, Ona, and Wingate East Mine sites are 0.45, 0.59, and 0.64, respectively. Average non-forested wetland WRAP scores range from a high of 0.58 (shrub swamp, mixed) to a low of 0.37 (wet pastures) at the Desoto Mine site; from a high of 0.66 (freshwater marshes) to a low of 0.59 (wet prairies) at the Ona Mine site; and from a high of 0.69 (wet palmetto prairies) to a low of 0.50 (wet pastures) at the Wingate East Mine site. The WRAP data indicate that the wetland systems on the Desoto, Ona, and Wingate East Mine sites, overall, are functionally viable but have been directly and/or indirectly impacted by past land use practices. Wetlands on the Desoto, Ona, and Wingate East Mine sites are expected to have been disturbed mostly by agriculture given that agriculture is the dominant land use on each site (see Section 3.3.7.4). Based on their lower relative WRAP scores, the non-forested wetlands on these sites appear to have been more impacted by past land disturbances than have the forested wetlands.

CF Industries' federal Section 404 permit application presented the average UMAM composite score for the wetlands that would be avoided and for the wetlands that would be impacted at the South Pasture Mine Extension site. Based on the UMAM data, the average functionality/quality of wetlands that would be avoided (average UMAM composite score = 6.2) is greater than the average functionality/quality of wetlands that would be impacted (average UMAM composite score = 5.2). The relatively low average UMAM scores for wetlands that would be avoided and impacted indicate that most wetlands that are under federal jurisdiction on the South Pasture Mine Extension site have been directly and/or indirectly impacted by past land use practices. Wetlands on the South Pasture Mine Extension site are expected to have been disturbed mostly by agriculture given that agriculture is the dominant land use on the site (see Section 3.3.7.4).

Stream quality on the sites of the Applicants' Preferred Alternatives was assessed by the Applicants using FDEP SOP 001/01, FT 3100, *Stream and River Habitat Assessment* (FDEP, 2008). Most of the streams assessed on the Desoto and Ona Mine sites were ranked as sub-optimal; however, a relatively high percentage of the streams on these mine sites was ranked as optimal. Most of the streams assessed on the Wingate East Mine site were ranked as optimal; however, a relatively high percentage of the streams were ranked as sub-optimal. Relatively few streams on the Desoto, Ona, and Wingate East Mine sites were ranked as marginal or poor. Most of the streams assessed on the South Pasture Mine Extension site were ranked as either sub-optimal or optimal; no streams were ranked as marginal or poor.

3.3.6 Wildlife Habitat and Listed Species

3.3.6.1 Wildlife Habitat

The various upland and wetland vegetative communities and surface waters in the AEIS study area provide habitat for numerous wildlife species endemic to west-central Florida. Wildlife habitat in the region primarily includes upland forests, rangelands, forested wetlands, herbaceous wetlands, streams, lakes/reservoirs, and some types of pasturelands. Wetlands and surface waters in the AEIS study area are addressed in Section 3.3.5. The primary upland types in the AEIS study area that provide wildlife habitat are rangelands and upland forests. Rangeland is non-forested upland that is composed primarily of native grasses, forbs, and shrubs. In FLUCCS, the Rangeland (Level 1 Code 3000) classification includes Grassland (Level 2 Code 3100), Shrub and Brushland (Level 2 Code 3200), and Mixed Rangeland (Level 2 Code 3300). Upland forests are areas where the tree canopy closure is greater than 10 percent. In FLUCCS, the Upland Forest (Level 1 Code 4000) classification includes Upland Coniferous Forest (Level 2 Code 4100), Upland Hardwood Forest (Level 2 Codes 4200 and 4300), and Tree Plantations (Level 2 Code 4400). The Agricultural (Level 1 Code 2000) classification also includes some vegetated upland subclasses that are known to support certain types of wildlife species. The following types of pasturelands in particular serve as wildlife habitat in and around the CFPD: Unimproved Pasture (Level 3 Code 2120), Woodland Pasture (Level 3 Code 2130), and to a lesser degree Improved Pasture (Level 3 Code 2110). The overall wildlife habitat quality of these pasturelands is typically lower than that of the natural upland communities.

The Year 2009 acreages of rangeland and upland forest in the CFPD and its watersheds are presented in Table 3-19. The Year 2009 coverage of rangeland and upland forest in and around the CFPD based on FLUCCS data maintained by SWFWMD is shown on Figure 3-44.

Table 3-19. 2009 Acreages of Rangeland and Upland Forest within the CFPD Portions of the AEIS Study Area

Location	FLUCCS Code		TOTAL
	3000 Rangeland	4000 Upland Forest	
CFPD	79,236	88,593	167,829
Peace River Watershed Within CFPD	27,501	26,702	54,203
Myakka River Watershed Within CFPD	13,911	17,603	31,514
Alafia River Watershed Within CFPD	5,382	17,470	22,852
Manatee River Watershed Within CFPD	24,140	12,064	36,205
Little Manatee River Watershed Within CFPD	7,373	9,014	16,388
Withlacoochee River Watershed Within CFPD	138	378	517
Hillsborough River Watershed Within CFPD	730	5,308	6,038
Southern Coastal Watershed Within CFPD	58	49	108

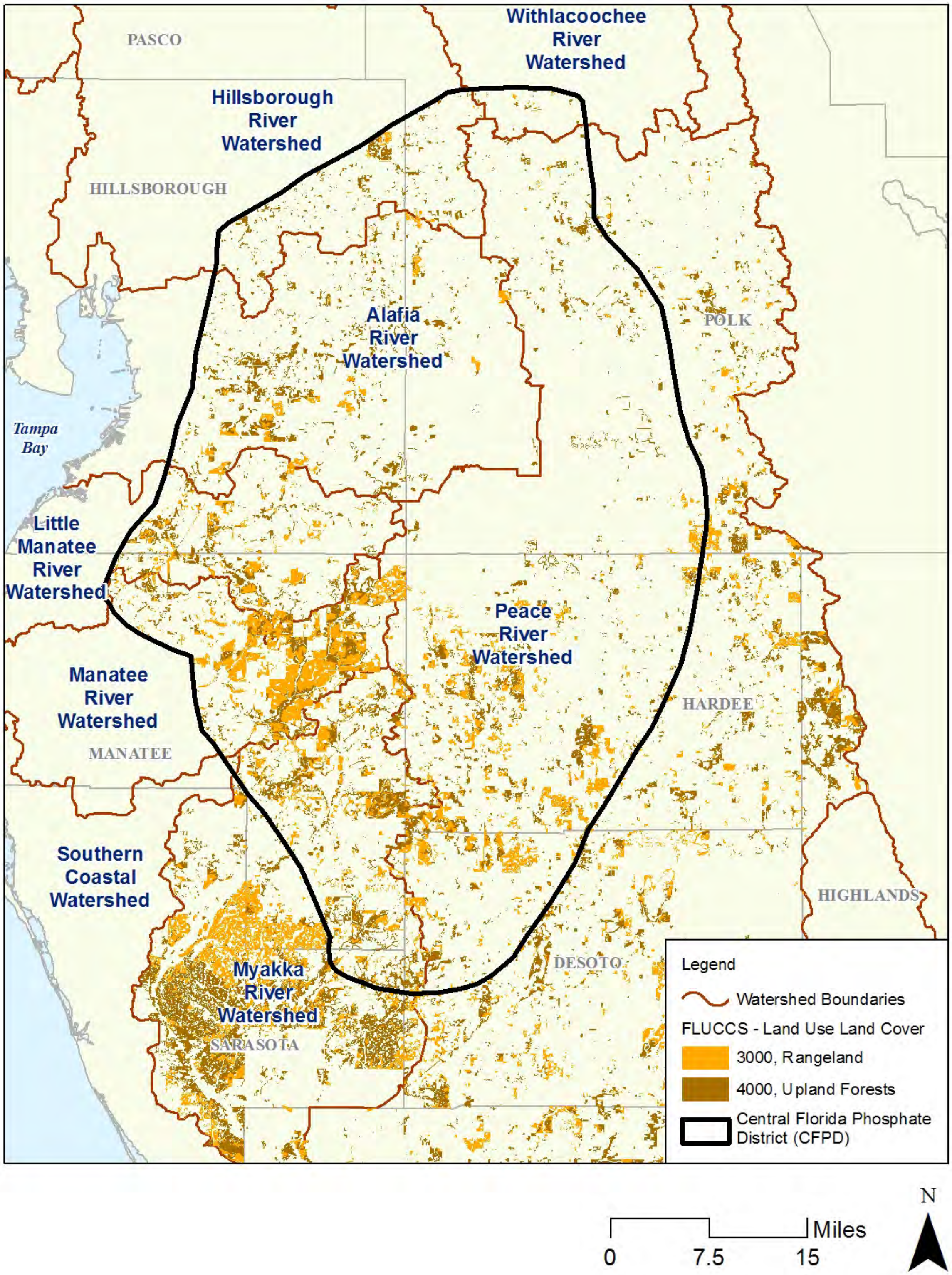
Notes:

FLUCCS = Florida Land Use, Cover, and Forms Classification System

Acreages reported in whole units

Source: SWFWMD, 2009a

As indicated in Table 3-19, there are 79,237 acres of rangeland and 88,593 acres of upland forest in the CFPD portions of the AEIS study area based on 2009 SWFWMD FLUCCS mapping. In the CFPD, the Peace River watershed contains the most rangeland (approximately 27,501 acres or 35 percent of the total rangeland cover) and upland forest (approximately 26,702 acres or 30 percent of the total upland forest cover). Among the watersheds in the CFPD, the Manatee River watershed and Myakka River watershed also have high relative abundances of rangeland and upland forest, respectively.



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2 **Figure 3-44. 2009 Coverage of Rangeland and Upland Forest within**
3 **and Surrounding the CFPD**

Based on the Applicants' federal Section 404 permit applications, pastureland, represented mostly by improved pasture, is the dominant type of upland wildlife habitat on the sites of all four of the Applicants' Preferred Alternatives. Pastureland represents approximately 47, 41, 28, and 37 percent of the total area of the Desoto, Ona, Wingate East, and South Pasture Mine Extension sites, respectively. If the other agricultural subclasses (such as row crops and citrus groves) are included, the relative percentage of agricultural land cover on three of the four sites is even greater (the exception being Wingate East, which does not contain other agricultural subclasses). Upland forest is the second most dominant type of upland wildlife habitat on the sites of all four of the Applicants' Preferred Alternatives. Much of the upland forest on the mine sites is represented by the pine flatwoods, live oak, and hardwood–conifer mixed subclasses. Xeric oak is also a relatively abundant upland forest community on the Wingate East Mine site. Rangeland is the least abundant upland wildlife habitat on the sites of all four of the Applicants' Preferred Alternatives. Palmetto prairie is the dominant rangeland community on the Desoto, Ona, and South Pasture Mine Extension sites. The Wingate East Mine site is co-dominated by mixed rangeland and palmetto prairie.

The types and abundance of wildlife species that occur in the CFPD have been assessed primarily through field surveys conducted by the phosphate industry for mine planning and environmental permitting. Information on wildlife occurrence in and around the CFPD has also been compiled by academic institutions and certain state organizations/regulatory agencies such as the Florida Natural Areas Inventory (FNAI) and the Florida Fish and Wildlife Conservation Commission (FFWCC). Based on the findings of wildlife surveys conducted by the Applicants, the vast majority of the species observed on the sites of the four Applicants' Preferred Alternatives are native to west-central Florida, and are known to commonly occur in the same types of habitats elsewhere in the region.

Inventories of wildlife community characteristics for land areas impacted by phosphate mining have been conducted by a number of researchers. For example, Kale (1992) conducted a 2-year study of the avifauna of reclaimed and unreclaimed mined lands in a Polk County study area. The study included an inventory of bird species using three types of mined lands: unreclaimed old mined pits and spoil piles, active clay settling ponds, and reclaimed wetland sites. Over a 2-year period (March 1989 to February 1991), Kale recorded 160 bird species using the wetlands and adjacent uplands at eight phosphate mined habitats. In comparison, he noted that a census of bird populations at Lake Kissimmee State Park conducted monthly from March 1979 through February 1980 by members of the Lake Region Audubon Society recorded a similar number of species (164) from a mixture of pine flatwoods, wet prairies, and improved pasture lands in east central Polk County. Many of the same species were recorded by both of these field investigations.

Kale (1992) also reported that the Lake Region Audubon Society conducted monthly surveys from November 1980 through October 1981 at the Nature Conservancy's Tiger Creek Sanctuary in

southeastern Polk County. Habitats surveyed were representative of native habitats that included river swamp, bayheads, pine flatwoods, longleaf pine, and turkey oak areas; the total of 127 bird species recorded as present was similar to the total found at the previously mined areas studied. These field studies recorded similar total numbers of species for similar durations of study in the same county area, although these did not occur during the same time periods. Kale (1992) concluded that "*All of the major wetland types – clay settling ponds, unreclaimed pits and spoil piles, and reclaimed (=constructed) wetlands – on phosphate-mined lands provided varied, rich and productive habitats for a large number of birds"*.

Mushinsky et al. (1996) compared small vertebrate communities of unmined and phosphate mined xeric (well drained) uplands in central Florida. Unmined upland habitats evaluated were sandhill, scrub, and scrubby flatwoods. Mined lands included in the investigation consisted of areas mined prior to 1975 (that were not subject to the Mandatory Reclamation Rule) as well as areas mined and reclaimed following implementation of the Mandatory Reclamation Rule. Thus, the previously mined and reclaimed areas represented sites of varied maturity and reclamation strategies. Despite these study limitations, the observations are relevant in comparing unmined areas with historically reclaimed phosphate lands.

Amphibians, reptiles, and mammals were identified through capture methods while birds were identified solely through field observations. Detailed characterization of habitat features was done for each study site category. For example, mined sites had "…a much smaller percentage of woody vegetation and litter and a much higher percentage of grasses, sedges, and legumes." Further, mined sites tended to have much higher percentages of very coarse and coarse sand than did unmined sites, while unmined sites had much higher percentages of very fine sand. Soil compaction was similar for unmined and mined soils at the surface, but in deeper zones compaction was greater for the mined sites compared to unmined soils. In terms of soil chemistry, these researchers reported that potassium and phosphorus concentrations were higher at the mined sites than at the unmined sites. Mushinsky et al. (1996), considered these factors relevant in influencing re-vegetation success related to root zone development and overlying vegetation community composition and structure.

On the basis of the surveys and trapping efforts conducted by these researchers, a total of 79 species was documented from the combined sites evaluated. Of these, 9 were amphibians, 24 were reptiles, 7 were mammals, and 39 were birds. Of the 79 species, more than 60 percent occurred in both the unmined and mined study sites. However, 28 were identified as being notably less present at the mined sites than at the unmined reference habitats (5 amphibians, 8 reptiles, 1 mammal, and 14 bird species). Key observations noted by the researchers regarding these 28 species included the following:

- Presence of woody ground cover (pine tree stands and a relatively extensive mid-canopy layer) corresponded to greater wildlife presence.

- Mined sites were dominated by fewer vegetative foliage layers, and generally had less canopy closure than unmined sites.

- Sites reclaimed with sand tailings and overburden generally ranked higher in terms of amphibians, reptiles, or mammals than sites reclaimed with either only sand tailings or only overburden.

- Sites re-vegetated with woody plants tended to rank higher in terms of bird usage than sites solely re-vegetated with herbaceous plants.

In general, the areas where wildlife presence was the greatest were those that provided the greatest level of habitat diversity for the various wildlife species reviewed.

In a similar study of wildlife present in central Florida mesic flatwoods and mined lands, these same researchers compared wildlife species presence and relative abundance at 30 unmined reference sites and 30 mined land areas, roughly half of which had been mined prior to 1975 with the remainder mined and reclaimed under the Mandatory Reclamation Rule (Mushinsky et al., 2001). Relatively few differences between the reference and reclaimed sites were detected for most physical variables. For these mesic sites, however, soils at reclaimed sites tended to have higher percentages of fine sand than the reference sites. Also, higher pH and phosphorus concentrations but lower amounts of organic matter were found at the reclaimed locations. Further, reclaimed sites generally had a lower percentage of woody ground cover, higher grass coverage, and less developed middle canopy layer coverage. Shrubs and snags were absent from the reclaimed sites studied, which contributed to a less developed wildlife community composition and structure at these sites compared to the reference locations. A key conclusion advanced was that, “Any sort of vegetative structure serves to attract wildlife to reclaimed lands” (Mushinsky et al., 2001). These investigations highlighted the patchiness of both xeric and mesic upland habitats and many of their resident wildlife species, and led to the researchers’ support for regional reclamation strategies for phosphate mined lands. Regional strategies were advocated because they could help connect isolated habitat areas, thereby promoting wildlife movement among patches.

Similar conclusions were supported by an investigation of wildlife species utilization of phosphate mined lands (Durbin et al., 2008). This 3-year study was conducted to document wildlife use of 62 previously mined areas, and included 24 upland sites, 18 wetlands, and 20 mixed sites. Presence and relative abundance of mammals, birds, reptiles, amphibians, and freshwater fish species at these study areas were documented through trapping and field observation methods. A total of 299 vertebrate species was present at these various study areas over the 3-year period. Mixed habitat sites generally had the highest number of species, followed by wetlands and then uplands. This was attributed to the increased habitat heterogeneity found at the mixed sites. The three characteristics which Durbin et al. believed were positively correlated with increased wildlife species presence were:

- Proximity to the nearest body of water
- Proximity to a wildlife corridor
- Proximity to natural unmined habitats

In short, geographic isolation of reclaimed habitats was believed to result in reduced rates of colonization of the reclaimed areas by wildlife. The researchers concluded that reclamation success, if gaged by relative wildlife use of the applicable lands, would be enhanced by consideration of these factors during reclamation planning.

The results of this 3-year study provided a number of generalizations regarding which vertebrate groups were favored by what physical conditions of the reclaimed habitats over time. These patterns indicated that as reclamation sites mature over time, their physical heterogeneity (largely linked to vegetative community development) evolves over time, leading to varied benefits to the different vertebrate groups. For example, the number of mammals on upland sites was higher on recently reclaimed areas but tended to decrease over time as conditions evolved, canopy development increased, and ground cover (grasses and other herbaceous vegetation) decreased. Factors that initially favored area use by mice or other small mammals were gradually replaced by conditions favoring more bird use and reduced mouse populations. The number of reptile species also seemed positively correlated with reclamation site maturation, but amphibian species richness was not found to be correlated with these observed habitat changes over time. Durbin et al. (2008) concluded that because of differences in habitat requirements of the different vertebrate groups, no single reclamation approach, vegetation plan, or management scheme would favor all groups concurrently. Rather, flexibility in reclamation strategies supporting habitat heterogeneity would be a better approach, leading to diversity in wildlife species presence and richness.

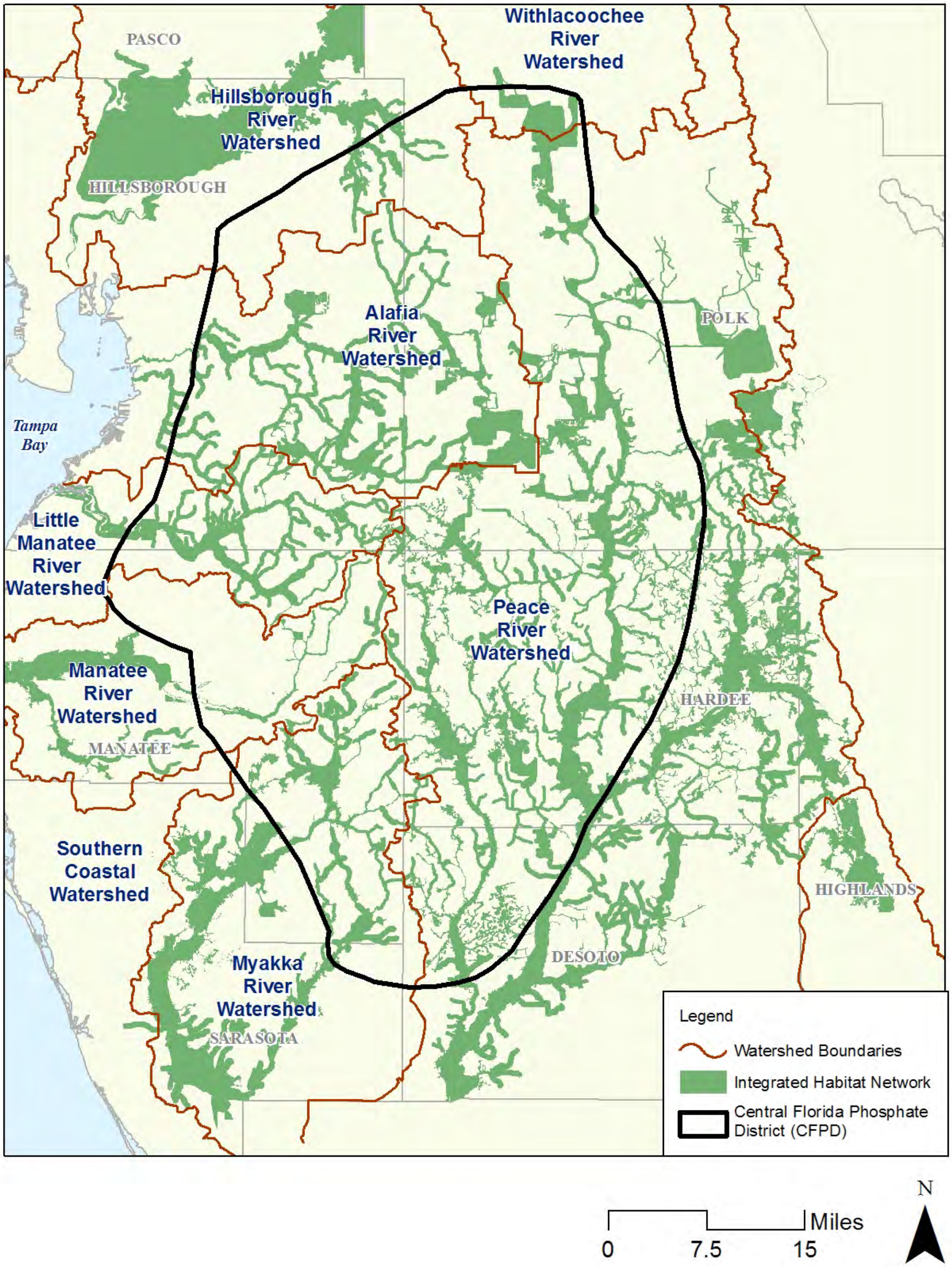
Together, these investigations confirmed the expected condition – that recolonization of reclaimed phosphate-mined lands by a variety of wildlife species does occur, but that it takes time for such areas to support wildlife communities resembling those of unmined reference habitats falling into comparable upland, wetland, or mixed habitat categories. Sites representing unreclaimed areas that were mined prior to promulgation of reclamation requirements in 1975 still provide habitat for birds and other wildlife species that are able to occupy the vegetative communities and water-related land areas that have evolved over time. Recent reclamation technology is better focused on creating habitat heterogeneity in terms of a three-dimensional structure than that used in the early years following Mandatory Reclamation Rule implementation. Some species are capable of more rapid colonization because of their life history characteristics and relative mobility. Colonization by others is hindered, particularly if habitat fragmentation has disrupted wildlife corridor access that would allow colonization of reclaimed land areas. Habitat heterogeneity, connectivity to donor habitats, and proximity to water sources are all factors favoring enhanced wildlife use of areas reclaimed in the future.

3.3.6.2 Integrated Habitat Network

The quality of upland as well as wetland wildlife habitat in the CFPD has been impacted by the cumulative effects of agricultural, urban, and industrial/mining development in the region for well over the past century. Because of such land-use practices, much of the historical coverage of natural upland, wetland, and surface water habitats in the region has been replaced by pastureland, cropland, urban areas, and phosphate-mined areas. Regional hydrology has been modified through development of an extensive network of drainage systems to accomplish water management objectives aligned with those land uses. Reduced wildlife abundance and diversity in the Peace River watershed have been attributed to increased deforestation of uplands and draining of wetlands as a result of improved pasture expansion in the 1950s, followed by subsequent increases in more intense forms of agriculture, such as row crops and citrus (PBS&J, 2007).

Although some portions of the region still contain contiguous areas of connected habitats that serve as wildlife corridors, much of the region consists of fragmented habitat patches. Disturbed areas among these patches of good habitat result in little to no connectivity to support the movement of wildlife species from patch to patch. Historically, phosphate mining contributed to this habitat fragmentation. In more recent times, the phosphate industry has worked with federal and state regulatory agencies toward improved mine planning that preserves prioritized and still-functional wildlife corridors, primarily along creeks and rivers and associated floodplain areas.

In part to promote creation or restoration of regional ecosystem connectivity, FDEP has developed what is now known as the Integrated Habitat Network (IHN) – a conceptual network of reclaimed and natural habitat corridors within and outside the CFPD. Initially conceptualized by the Bureau of Mining and Minerals Regulation (Cates, 1992), the IHN is intended to benefit water quality/quantity, improve wildlife habitat, and serve as an integrated system of connections of the phosphate mining region’s rivers with significant environmental features outside the CFPD. The creation of wildlife corridors consisting of various connected habitats could result in regional benefits for wildlife within and outside the CFPD by improving wildlife habitat and promoting increased wildlife utilization of the area. The IHN in and around the CFPD is shown in Figure 3-45.



1

Figure 3-45. FDEP's Conceptual Integrated Habitat Network within and Surrounding the CFPD

The IHN goal reflects a wildlife management vision of all affected parties working together – it represents a blueprint that can help guide regional management decisions supporting realization of ecological benefits beyond those likely to result if each decision were made in isolation rather than in the interest of achieving an integrated goal. The IHN footprint incorporates creek and river corridors known to be in relatively good condition and functioning as wildlife corridors, or at a minimum as wildlife refugia. It also includes lands already categorized for agricultural or industrial use that have been variably impacted by past agricultural use as pastureland and in some areas more active farming practices, phosphate mining, or other industrial/commercial development. The IHN vision includes areas warranting preservation or other forms of protection from further ingress of land uses jeopardizing continued wildlife habitat integrity, as well as areas warranting consideration as impact mitigation zones that, if properly integrated into habitat creation or restoration plans, could help promote wildlife corridor restoration. For example, Figure 3-46 depicts the IHN vision superimposed over CFPD areas classified as agricultural lands under the FLUCCS Level 1 category (2000). Areas of overlap of these two GIS coverages represent areas of opportunity for land enhancement to meet habitat improvement and corridor connection goals. These geospatial relationships may be relevant as potential effects of proposed phosphate mines are evaluated in the future.

3.3.6.3 Listed Species

The Endangered Species Act (ESA) is the primary legislation that affords legal protection to plant and animal species that are federally listed as Endangered or Threatened. The ESA is administered by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). Generally, USFWS manages land and freshwater species and NMFS manages marine and anadromous species, which are species that breed in freshwater but live most of their lives in the sea. The federally listed plant and animal species that have the potential to occur in the AEIS study area are presented in Table 3-20.

The federally listed plant species identified are those documented to occur in counties in the Myakka and Peace River watersheds. The federally listed animal species identified include those documented to occur in the study area and those identified by USFWS as having the potential to occur in the CFPD or in downstream water bodies or associated habitats.

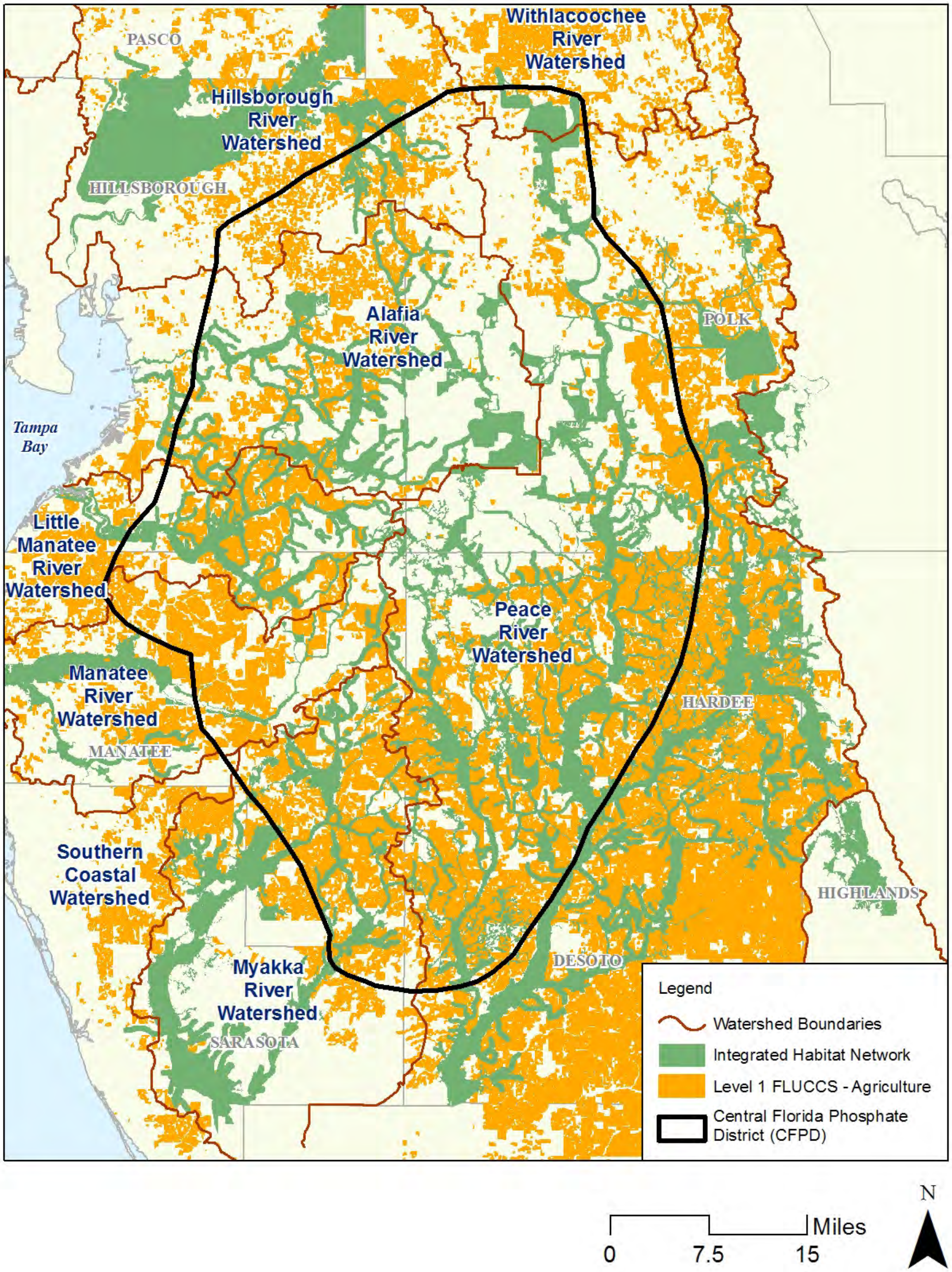


Figure 3-46. FDEP's Conceptual Integrated Habitat Network and Agricultural Land Use Coverage in the CFPD

Table 3-20. Federally Listed Species with the Potential to Occur in the AEIS Study Area

Scientific Name	Common Name	Federal Legal Status (USFWS)	Preferred Habitat in and around CFPD
Plants			
Bonamia grandiflora	Florida bonamia	LT	White sand scrub
Chrysopsis floridana	Florida goldenaster	LE	Sand pine scrub; low sand ridges
Cladonia perforata	Perforate reindeer lichen	LE	Rosemary scrub
Deeringothamnus pulchellus	Beautiful pawpaw	LE	Open flatwoods
Fish			
Pristis pectinata	Smalltooth sawfish	LE	Charlotte Harbor
Reptiles			
Alligator mississippiensis	American alligator	SAT	Bodies of freshwater including marshes, swamps, lakes, and rivers
Drymarchon couperi	Eastern indigo snake	LT	Broad range of wetland and upland habitats; often utilizes gopher tortoise burrows
Eumeces egregius lividus	Bluetail mole skink	LT	Scrub; sandhill; xeric hammock; well drained sandy uplands
Neoseps reynoldsi	Sand skink	LT	Scrub; sand pine; scrubby flatwoods
Birds			
Ammodramus savannarum floridanus	Florida grasshopper sparrow	LE	Large areas of frequently burned dry prairie habitat with patchy open areas
Aphelocoma coerulescens	Florida scrub jay	LT	Fire-dominated oak scrub
Mycteria americana	Woodstork	LE	Nests primarily in inundated forested wetlands; forages primarily in shallow water habitats
Picoides borealis	Red-cockaded woodpecker	LE	Longleaf and slash pine flatwoods
Polyborus plancus audubonii	Audubon's crested caracara	LT	Dry prairie and pasturelands; preferred nest trees are cabbage palm followed by live oaks
Rostrhamus sociabilis plumbeus	Snail kite	LE	Large open freshwater marshes and lakes with shallow water and a low density of emergent vegetation; forages primarily on apple snails
Mammals			
Puma concolor coryi	Florida panther	LE	Requires extensive areas of mostly forested communities; large remote wetlands are important for diurnal refuge
Trichechus manatus	Manatee	LE	Charlotte Harbor

Federal Legal Status

LE Endangered: species in danger of extinction throughout all or a significant portion of its range.

LT Threatened: species likely to become Endangered within the foreseeable future throughout all or a significant portion of its range.

SAT Treated as threatened due to similarity of appearance to a species that is federally listed such that enforcement personnel have difficulty in attempting to differentiate between the listed and unlisted species.

N Not currently listed, nor currently being considered for listed as Endangered or Threatened.

Plants

Species identified are those documented to occur in counties within the Myakka and Peace River watersheds.

Agencies/Organizations

USFWS U.S. Fish & Wildlife Service

Sources

USFWS AEIS public scoping comments
FDEP, 2011c
Florida Natural Areas Inventory

Federally listed species that have consistently been observed in the CFPD during past surveys include the woodstork (*Mycteria americana*), which is federally listed as Endangered, and the eastern indigo snake (*Drymarchon couperi*), American alligator (*Alligator mississippiensis*), Florida scrub jay (*Aphelocoma coerulescens*), and Audubon's crested caracara (*Polyborus plancus audubonii*), which are federally listed as Threatened. The American alligator is federally listed as Threatened solely because of its resemblance to the American crocodile (*Crocodylus acutus*), which is federally listed as Endangered. In addition to these federally listed species, USFWS commented during the AEIS public scoping period that the AEIS should consider the potential effects of the Applicants' Preferred Alternative on the following federally listed species: red-cockaded woodpecker (*Picoides borealis*), snail kite (*Rostrhamus sociabilis plumbeus*), Florida grasshopper sparrow (*Ammodramus savannarum floridanus*), bluetail mole skink (*Eumeces egregius lividus*), sand skink (*Neoseps reynoldsi*), Florida panther (*Puma concolor coryi*), manatee (*Trichechus manatus*), smalltooth sawfish (*Pristis pectinata*), and federally listed plant species (species not identified).

Animal species in Florida may also be awarded state listing and associated regulatory protection in accordance with Rule 68A-27, F.A.C. FFWCC maintains the state's list of such animal species. Animal species that are not federally listed, but which are determined to be at risk of extinction in the state, are state-listed as Threatened. Species that are considered vulnerable and have the potential to become threatened are state-listed as Species of Special Concern. Plant species in Florida may also be awarded state listing and associated regulatory protection in accordance with Chapter 5B-40, F.A.C. The Florida Department of Agriculture and Consumer Services (FDACS) maintains the state's list of such plant species.

State-listed species that have consistently been observed in the CFPD during past surveys include the gopher tortoise (*Gopherus polyphemus*), southeastern American kestrel (*Falco sparverius paulus*), and Florida sandhill crane (*Grus canadensis pratensis*), which are state-listed as Threatened, and the gopher frog (*Rana capito*), burrowing owl (*Athene cunicularia*), little blue heron (*Egretta caerulea*), snowy egret (*Egretta thula*), tricolored heron (*Egretta tricolor*), white ibis (*Eudocimus albus*), Florida mouse (*Podomys floridanus*), and Sherman's fox squirrel (*Sciurus niger shermani*), which are state-listed as Species of Special Concern. The bald eagle (*Haliaeetus leucocephalus*), which is no longer state or federally listed, but which is afforded federal protection under the Bald and Golden Eagle Protection Act, has also been consistently observed in the CFPD during past surveys.

The Applicants have conducted numerous field surveys to assess the presence and potential occurrence of listed species on the sites of the Applicants' Preferred Alternatives. The surveys have been extensive and have included helicopter fly-overs, ground transect surveys, small mammal trapping, pit trapping for reptiles and amphibians, and several types of specialty surveys targeting specific species. The work plans that documented the methodologies for the surveys were approved by USFWS and FFWCC prior to

implementation. The reports documenting the survey findings are attached to the Applicants' federal Section 404 permit applications. The findings of the listed species surveys conducted for all four of the Applicants' Preferred Alternatives are discussed in the following subsections.

Listed Species –Desoto Mine

Listed species surveys for the Desoto Mine site were conducted by BRA from October 2006 through November 2007 (BRA, 2008); by Entrix (formerly known as BRA) from April through June 2010 (Entrix, 2010b); and by Cardno-Entrix (formerly known as BRA and as Entrix) from April through May 2011 (Cardno-Entrix, 2011a). The 2006 – 2007 survey conducted by BRA included pedestrian and vehicular surveys, helicopter fly-overs, small mammal trapping, funnel trapping, and several types of species-specific surveys, including those for the gopher frog, gopher tortoise, Eastern indigo snake, Florida scrub-jay, Florida grasshopper sparrow, red-cockaded woodpecker, Audubon's crested caracara, burrowing owl, southeastern American kestrel, Florida sandhill crane, bald eagle, listed wading birds, Florida mouse, and Sherman's fox squirrel. The 2010 and 2011 surveys specifically targeted the bald eagle, Audubon's crested caracara, red-cockaded woodpecker, and Florida bonneted bat (*Eumops floridanus*). The state and federally listed species observed on the Desoto Mine site during the surveys are presented in Table 3-21.

As indicated in Table 3-21, four federally listed species were observed on the Desoto Mine site during one or more of the surveys: the woodstork, which is federally listed as Endangered, and the American alligator, Eastern indigo snake, and Audubon's crested caracara, which are federally listed as Threatened. Woodstorks were observed foraging on the site during the surveys; however, no woodstork nests were found. Several American alligators were observed on the site during the surveys. One eastern indigo snake was captured in a funnel trap and one shed was found during the surveys. Several Audubon's crested caracaras were observed foraging and roosting on the site during the 2011 survey. One active caracara nest was also found offsite directly adjacent to the property boundary. Suitable nesting and foraging habitat for the red-cockaded woodpecker (federally listed as Endangered) exists on the site; however, no red-cockaded woodpeckers or red-cockaded woodpecker cavities were observed during the surveys. A few small areas of potentially suitable habitat for the Florida scrub jay (federally listed as Threatened) exist on the site; however, no scrub jays or scrub jay nests were observed during the surveys. Suitable habitat for the Florida grasshopper sparrow (federally listed as Endangered) was determined not to exist on the site. Federally listed plant species were not observed during the surveys. None of the federally listed species that were not observed were reported as having a high probability of occurring on the site.

Table 3-21. State and Federally Listed Plant and Animal Species Observed on the Desoto Mine Site

Scientific Name	Common Name	Federal Legal Status (USFWS)	State Legal Status (FFWCC or FDACS)
Amphibians			
Rana capito	Gopher frog	N	SSC
Reptiles			
Alligator mississippiensis	American alligator	SAT	FT(S/A)
Drymarchon couperi	Eastern indigo snake	LT	FT
Gopherus polyphemus	Gopher tortoise	N	ST
Birds			
Athene cunicularia	Burrowing owl	N	SSC
Egretta thula	Snowy egret	N	SSC
Egretta tricolor	Tricolored heron	N	SSC
Eudocimus albus	White ibis	N	SSC
Grus canadensis pratensis	Florida sandhill crane	N	ST
Haliaeetus leucocephalus	Bald eagle	N	N
Mycteria americana	Woodstork	LE	FE
Polyborus plancus audubonii	Audubon's crested caracara	LT	FT
Mammals			
Sciurus niger shermani	Sherman's fox squirrel	N	SSC

Federal Legal Status
LE Endangered: species in danger of extinction throughout all or a significant portion of its range.
LT Threatened: species likely to become Endangered within the foreseeable future throughout all or a significant portion of its range.
SAT Treated as threatened due to similarity of appearance to a species that is federally listed such that enforcement personnel have difficulty in attempting to differentiate between the listed and unlisted species.
N Not currently listed, nor currently being considered for listed as Endangered or Threatened.

State Legal Status
Animals:
FE Listed as Endangered Species at the Federal level by USFWS
FT Listed as Threatened Species at the Federal level by USFWS
ST State Threatened: species, subspecies, or isolated population which is acutely vulnerable to environmental alteration, declining in number at a rapid rate, or whose range or habitat is decreasing in area at a rapid rate and as a consequence is destined or very likely to become an endangered species in the foreseeable future.
SSC Species of Special Concern: a population which warrants special protection, recognition, or consideration because it has an inherent significant vulnerability to habitat modification, environmental alteration, human disturbance, or substantial human exploitation which, in the foreseeable future, may result in its becoming a threatened species.
FT(S/A) Federal Threatened due to similarity of appearance.
N Not currently listed, nor currently being considered for listing.

Plants:
LE Endangered: species of plants native to Florida that are in imminent danger of extinction within the state, the survival of which is unlikely if the causes of a decline in the number of plants continue; includes all species determined to be endangered or threatened pursuant to the U.S. Endangered Species Act.
LT Threatened: species native to the state that are in rapid decline in the number of plants within the state, but which have not so decreased in number as to cause them to be Endangered.
N Not currently listed, nor currently being considered for listing.

Agencies/Organizations
FDACS Florida Department of Agriculture & Consumer Services
FFWCC Florida Fish & Wildlife Conservation Commission
USFWS U.S. Fish & Wildlife Service

Sources
Entrix, 2010b
BRA, 2008
FDEP, 2011c

Of the state-listed species observed on the site, two are listed as Threatened (gopher tortoise and Florida sandhill crane) and six are listed as Species of Special Concern (gopher frog, burrowing owl, snowy egret, tricolored heron, white ibis, and Sherman's fox squirrel). Gopher tortoise densities were reported as being relatively high in certain pastures and flatwood areas on the site. Gopher frog densities were also reported as appearing to be high in flatwood areas that contain high gopher tortoise densities. Several Florida sandhill cranes were observed foraging throughout the site and one nest was found. Several burrowing owls and Sherman's fox squirrels were observed during the surveys. Several listed wading bird species (snowy egret, tricolored heron, and white ibis) were observed on the site during the surveys and one wading bird nesting area was found. The bald eagle was observed on the site during the 2011 survey; two active bald eagle nests were found on the property and one active nest was found offsite relatively close to the property. State-listed plant species were not observed during the surveys. One commercially exploited plant species, the Tampa Bay butterfly orchid (*Encyclia tampensis*), was found on the property. The southeastern American kestrel and Catesby lily, which are state-listed as Threatened, were not observed, but were reported as being expected to potentially occur on the site.

Listed Species – Ona Mine

Listed species surveys for the Ona Mine site were conducted by Environmental Consulting & Technology, Inc. (ECT) during 1998 (ECT, 1998); during April and August 2009 (ECT, 2010a); during February 2010 (ECT, 2010b); during April and August 2010 (ECT, 2010c); and during March and April 2011 (ECT, 2011). These surveys included pedestrian and vehicular surveys, helicopter fly overs, small mammal trapping, pit trapping, amphibian call surveys, and Florida scrub-jay surveys. The February 2010 survey specifically targeted potential nesting on the site by the bald eagle, Audubon's crested caracara, and listed wading bird species. The state and federally listed species observed on the Ona Mine site during the surveys are presented in Table 3-22.

As indicated in Table 3-22, six federally listed species were observed on the Ona Mine site during one or more of the surveys: the woodstork, red-cockaded woodpecker, and Florida panther, which are federally listed as Endangered, and the American alligator, eastern indigo snake, and Audubon's crested caracara, which are federally listed as Threatened. Woodstorks were observed on the site during the surveys; however, no woodstork nests were found. Evidence of Florida panther occurrence was found only during the 1998 survey and its occurrence then was attributed to a transitory animal. ECT reported that no evidence of Florida panther occurrence was found during any of the surveys conducted since 1998, and that the site is well outside of the normal range of the Florida panther. Similarly, evidence of red-cockaded woodpecker occurrence on the site, which was a historical abandoned cavity, was found only during the 1998 survey. ECT reported that no evidence of red-cockaded woodpecker occurrence was found during any of the surveys conducted since 1998. For these reasons, ECT reported that it did not conclude that the Florida panther and red-cockaded woodpecker still occur on the site. American alligators were observed throughout the site during the surveys. The eastern indigo snake was observed only during the 1998 survey;

however, ECT concluded that it potentially occurs on the site. Audubon's crested caracaras were observed foraging on the site and two active caracara nests were found, one during the spring 2010 survey and one during the spring 2011 survey. Listed plant species were not observed during the surveys. Federally listed species that were not observed were not reported as having a high probability of occurring on the site.

Table 3-22. State and Federally Listed Plant and Animal Species Observed on the Ona Mine Site

Scientific Name	Common Name	Federal Legal Status (USFWS)	State Legal Status (FFWCC or FDACS)
Amphibians			
Rana capito	Gopher frog	N	SSC
Reptiles			
Alligator mississippiensis	American alligator	SAT	FT(S/A)
Drymarchon couperi	Eastern indigo snake	LT	FT
Gopherus polyphemus	Gopher tortoise	N	ST
Birds			
Athene cunicularia	Burrowing owl	N	SSC
Egretta caerulea	Little blue heron	N	SSC
Egretta thula	Snowy egret	N	SSC
Egretta tricolor	Tricolored heron	N	SSC
Eudocimus albus	White ibis	N	SSC
Falco sparverius paulus	Southeastern American kestrel	N	ST
Grus canadensis pratensis	Florida sandhill crane	N	ST
Haliaeetus leucocephalus	Bald eagle	N	N
Mycteria americana	Woodstork	LE	FE
Picoides borealis	Red-cockaded woodpecker	LE	FE
Polyborus plancus audubonii	Audubon's crested caracara	LT	FT
Platalea ajaja	Roseate spoonbill	N	SSC
Mammals			
Podomys floridanus	Florida mouse	N	SSC
Puma concolor coryi	Florida panther	LE	FE
Sciurus niger shermani	Sherman's fox squirrel	N	SSC

Federal Legal Status

LE Endangered: species in danger of extinction throughout all or a significant portion of its range.

LT Threatened: species likely to become Endangered within the foreseeable future throughout all or a significant portion of its range.

SAT Treated as threatened due to similarity of appearance to a species that is federally listed such that enforcement personnel have difficulty in attempting to differentiate between the listed and unlisted species.

N Not currently listed, nor currently being considered for listed as Endangered or Threatened.

State Legal Status

Animals:

FE Listed as Endangered Species at the Federal level by USFWS

FT Listed as Threatened Species at the Federal level by USFWS

ST State Threatened: species, subspecies, or isolated population which is acutely vulnerable to environmental alteration, declining in number at a rapid rate, or whose range or habitat is decreasing in area at a rapid rate and as a consequence is destined or very likely to become an endangered species in the foreseeable future.

SSC Species of Special Concern: a population which warrants special protection, recognition, or consideration because it has an inherent significant vulnerability to habitat modification, environmental alteration, human disturbance, or substantial human exploitation which, in the foreseeable future, may result in its becoming a threatened species.

FT(S/A) Federal Threatened due to similarity of appearance.

N Not currently listed, nor currently being considered for listing.

Table 3-22. State and Federally Listed Plant and Animal Species Observed on the Ona Mine Site

Scientific Name	Common Name	Federal Legal Status (USFWS)	State Legal Status (FFWCC or FDACS)

Plants:

LE Endangered: species of plants native to Florida that are in imminent danger of extinction within the state, the survival of which is unlikely if the causes of a decline in the number of plants continue; includes all species determined to be endangered or threatened pursuant to the U.S. Endangered Species Act.

LT Threatened: species native to the state that are in rapid decline in the number of plants within the state, but which have not so decreased in number as to cause them to be Endangered.

N Not currently listed, nor currently being considered for listing.

Agencies/Organizations

FDACS Florida Department of Agriculture & Consumer Services
FFWCC Florida Fish & Wildlife Conservation Commission
USFWS U.S. Fish & Wildlife Service

Sources

ECT, 1998, 2010a, 2010b, 2010c, and 2011.
FDEP, 2011c.

Of the state listed species observed on the site, three are listed as Threatened (gopher tortoise, southeastern American kestrel, and Florida sandhill crane) and nine are listed as Species of Special Concern (gopher frog, burrowing owl, little blue heron, snowy egret, tricolored heron, white ibis, roseate spoonbill [*Platalea ajaja*], Florida mouse, and Sherman's fox squirrel). Numerous active and inactive gopher tortoise burrows were found during the surveys in pastures and xeric habitats and several Florida mice were trapped around gopher tortoise burrows during the spring 2011 survey. The gopher frog was observed only during the 1998 survey; however, ECT concluded that it potentially occurs on the site. The southeastern American kestrel was observed on the site during 2009; however, no nests were reported to exist. Several Florida sandhill cranes and two active nests were found during the surveys. Several burrowing owl burrows were found in dry pastures on the site. Several listed wading bird species (little blue heron, snowy egret, tricolored heron, white ibis, and roseate spoonbill) were observed on the site during the surveys. One active wading bird nesting area was found during the spring 2010 survey; evidence of wading bird nesting was not found during any of the other surveys. Several Sherman's fox squirrels were observed during the surveys. The bald eagle was observed on the site; however, no eagle nests were found. State-listed plant species were not observed on the property.

Listed Species –Wingate East Mine

Listed species surveys for the Wingate East Mine site were conducted by BRA from September 2005 through March 2006 (BRA, 2006b). Entrix conducted a species-specific survey for the southeastern American kestrel on the property in April 2010 (Entrix, 2010c). Cardno-Entrix conducted a listed species survey for the Wingate Extension, which is adjacent to the Wingate East Mine, in October and November 2010 (Cardno-Entrix, 2011b). Although this survey did not cover the Wingate East Mine, the survey report includes discussion of the previous surveys of the Wingate East Mine site.

The 2005 – 2006 survey conducted by BRA included pedestrian and vehicular surveys, small mammal trapping, funnel trapping, and several types of species-specific surveys, including those for the gopher frog, gopher tortoise, eastern indigo snake, Florida scrub-jay, red-cockaded woodpecker, burrowing owl, Florida sandhill crane, listed wading birds, Florida mouse, and Sherman's fox squirrel. The April 2010 survey specifically targeted the Southeastern American kestrel. The state and federally listed species observed on the Wingate East Mine site during the surveys are presented in Table 3-23.

As indicated in Table 3-23, five federally listed species were observed on the Wingate East Mine site during one or more of the surveys: the woodstork, which is federally listed as Endangered, and the American alligator, eastern indigo snake, Florida scrub jay, and Audubon's crested caracara, which are federally listed as Threatened. Woodstorks were observed foraging on the site during the surveys; however, no woodstork nests were found. Several American alligators were observed on the site during the surveys. One eastern indigo snake was captured in a funnel trap during the survey.

Table 3-23. State and Federally Listed Plant and Animal Species Observed on the Wingate East Mine Site

Scientific Name	Common Name	Federal Legal Status (USFWS)	State Legal Status (FFWCC or FDACS)
Plants			
Lilium catesbaei	Catesby's lily	N	LT
Amphibians			
Rana capito	Gopher frog	N	SSC
Reptiles			
Alligator mississippiensis	American alligator	SAT	FT(S/A)
Drymarchon couperi	Eastern indigo snake	LT	FT
Gopherus polyphemus	Gopher tortoise	N	ST
Birds			
Aphelocoma coerulescens	Florida scrub jay	LT	FT
Athene cunicularia	Burrowing owl	N	SSC
Egretta caerulea	Little blue heron	N	SSC
Egretta thula	Snowy egret	N	SSC
Egretta tricolor	Tricolored heron	N	SSC
Eudocimus albus	White ibis	N	SSC
Falco sparverius paulus	Southeastern American kestrel	N	ST
Grus canadensis pratensis	Florida sandhill crane	N	ST
Haliaeetus leucocephalus	Bald eagle	N	N
Mycteria americana	Woodstork	LE	FE
Polyborus plancus audubonii	Audubon's crested caracara	LT	FT

Table 3-23. State and Federally Listed Plant and Animal Species Observed on the Wingate East Mine Site

Scientific Name	Common Name	Federal Legal Status (USFWS)	State Legal Status (FFWCC or FDACS)
Mammals			
Podomys floridanus	Florida mouse	N	SSC
Sciurus niger shermani	Sherman's fox squirrel	N	SSC

Federal Legal Status

LE Endangered: species in danger of extinction throughout all or a significant portion of its range.

LT Threatened: species likely to become Endangered within the foreseeable future throughout all or a significant portion of its range.

SAT Treated as threatened due to similarity of appearance to a species that is federally listed such that enforcement personnel have difficulty in attempting to differentiate between the listed and unlisted species.

N Not currently listed, nor currently being considered for listed as Endangered or Threatened.

State Legal Status

Animals:

FE Listed as Endangered Species at the Federal level by USFWS

F Listed as Threatened Species at the Federal level by USFWS

ST State Threatened: species, subspecies, or isolated population which is acutely vulnerable to environmental alteration, declining in number at a rapid rate, or whose range or habitat is decreasing in area at a rapid rate and as a consequence is destined or very likely to become an endangered species in the foreseeable future.

SSC Species of Special Concern: a population which warrants special protection, recognition, or consideration because it has an inherent significant vulnerability to habitat modification, environmental alteration, human disturbance, or substantial human exploitation which, in the foreseeable future, may result in its becoming a threatened species.

FT(S/A) Federal Threatened due to similarity of appearance.

N Not currently listed, nor currently being considered for listing.

Plants:

LE Endangered: species of plants native to Florida that are in imminent danger of extinction within the state, the survival of which is unlikely if the causes of a decline in the number of plants continue; includes all species determined to be endangered or threatened pursuant to the U.S. Endangered Species Act.

LT Threatened: species native to the state that are in rapid decline in the number of plants within the state, but which have not so decreased in number as to cause them to be Endangered.

N Not currently listed, nor currently being considered for listing.

Agencies/Organizations

FDACS Florida Department of Agriculture & Consumer Services

FFWCC Florida Fish & Wildlife Conservation Commission

USFWS U.S. Fish & Wildlife Service

Sources

Cardno-Entrix, 2011b

Entrix, 2010c

BRA, 2006b

FDEP, 2011c

One Florida scrub jay territory was identified on the site and five scrub jays were observed occupying the territory during the surveys; however, no scrub jay nests were found. Audubon's crested caracaras were observed foraging on the site during the surveys; however, no caracara nests were found. Some suitable habitat for the federally Endangered red-cockaded woodpecker exists on the site; however, no red-cockaded woodpeckers or red-cockaded woodpecker cavities were observed during the surveys.

Federally listed plant species were not observed during the surveys. Federally listed species that were not observed were not reported as having a high probability of occurring on the site.

Of the state-listed species observed on the site, four are listed as Threatened (Catesby's lily [*Lilium catesbaei*], gopher tortoise, southeastern American kestrel, and Florida sandhill crane) and eight are listed as Species of Special Concern (gopher frog, burrowing owl, little blue heron, snowy egret, tricolored heron, white ibis, Florida mouse, and Sherman's fox squirrel). Gopher tortoise densities were reported as being relatively high in certain pastures and xeric areas on the site. Florida mouse densities were also reported as appearing to be high in xeric areas that contain high gopher tortoise densities. Several gopher frogs were captured in funnel traps set around gopher tortoise burrows. Several Florida sandhill cranes were observed and one nest was found on the site. Several listed wading bird species (little blue heron, snowy egret, tricolored heron, and white ibis) were observed foraging throughout the site; however, no communal wading bird nesting areas were found. During the April 2010 survey, several southeastern American kestrels and one cavity nest were found on the site. Several fox squirrels and burrowing owls were observed on the site. The bald eagle was observed on the site; however, no eagle nests were found. The Catesby's lily was the only state-listed plant species found on the property.

Listed Species – South Pasture Extension

Listed species surveys for the South Pasture Mine Extension site were conducted by Quest Ecology from August 1998 through June 2006 (Quest Ecology, 2006) and by BRA during June 2007 (BRA, 2007). These surveys included pedestrian and vehicular surveys, helicopter fly overs, small mammal trapping, funnel trapping, and several types of species-specific surveys, including those for the gopher tortoise, gopher frog, red-cockaded woodpecker, Florida grasshopper sparrow, Audubon's crested caracara, burrowing owl, Florida sandhill crane, listed wading birds, southeastern American kestrel, bald eagle, and Florida mouse. The state and federally listed species observed on the South Pasture Mine Extension site during the surveys are presented in Table 3-24.

As indicated in Table 3-24, four federally listed species were observed on the South Pasture Mine Extension site during one or more of the surveys: the woodstork, which is federally listed as Endangered, and the American alligator, Eastern indigo snake, and Audubon's crested caracara, which are federally listed as Threatened. One woodstork was observed on the site; no woodstork nests were found. American alligators were observed throughout the site during the surveys. Eastern indigo snakes were observed in several locations on the site. The Audubon's crested caracara and caracara nesting were observed on the site during certain years.

Table 3-24. State and Federally Listed Plant and Animal Species Observed on South Pasture Mine Extension Site

Scientific Name	Common Name	Federal Legal Status (USFWS)	State Legal Status (FFWCC or FDACS)
Plants			
Calopogon multiflorus	Many-flowered grass-pink	N	LE
Tillandsia fasciculate	Common wild pine	N	LE
Tillandsia utriculata	Giant wild pine	N	LE
Reptiles			
Alligator mississippiensis	American alligator	SAT	FT(S/A)
Drymarchon couperi	Eastern indigo snake	LT	FT
Gopherus polyphemus	Gopher tortoise	N	ST
Birds			
Athene cunicularia	Burrowing owl	N	SSC
Egretta caerulea	Little blue heron	N	SSC
Egretta thula	Snowy egret	N	SSC
Egretta tricolor	Tricolored heron	N	SSC
Eudocimus albus	White ibis	N	SSC
Grus canadensis pratensis	Florida sandhill crane	N	ST
Mycteria americana	Woodstork	LE	FE
Polyborus plancus audubonii	Audubon's crested caracara	LT	FT
Mammals			
Podomys floridanus	Florida mouse	N	SSC
Sciurus niger shermani	Sherman's fox squirrel	N	SSC

Federal Legal Status
LE Endangered: species in danger of extinction throughout all or a significant portion of its range.
LT Threatened: species likely to become Endangered within the foreseeable future throughout all or a significant portion of its range.
SAT Treated as threatened due to similarity of appearance to a species that is federally listed such that enforcement personnel have difficulty in attempting to differentiate between the listed and unlisted species.
N Not currently listed, nor currently being considered for listed as Endangered or Threatened.

State Legal Status
Animals:
FE Listed as Endangered Species at the Federal level by USFWS
F Listed as Threatened Species at the Federal level by USFWS
ST State Threatened: species, subspecies, or isolated population which is acutely vulnerable to environmental alteration, declining in number at a rapid rate, or whose range or habitat is decreasing in area at a rapid rate and as a consequence is destined or very likely to become an endangered species in the foreseeable future.
SSC Species of Special Concern: a population which warrants special protection, recognition, or consideration because it has an inherent significant vulnerability to habitat modification, environmental alteration, human disturbance, or substantial human exploitation which, in the foreseeable future, may result in its becoming a threatened species.
FT(S/A) Federal Threatened due to similarity of appearance.
N Not currently listed, nor currently being considered for listing.
Plants:
LE Endangered: species of plants native to Florida that are in imminent danger of extinction within the state, the survival of which is unlikely if the causes of a decline in the number of plants continue; includes all species determined to be endangered or threatened pursuant to the U.S. Endangered Species Act.
LT Threatened: species native to the state that are in rapid decline in the number of plants within the state, but which have not so decreased in number as to cause them to be Endangered.
N Not currently listed, nor currently being considered for listing.

Agencies/Organizations
FDACS Florida Department of Agriculture & Consumer Services
FFWCC Florida Fish & Wildlife Conservation Commission
USFWS U.S. Fish & Wildlife Service

Sources
BRA, 2007
Quest Ecology, 2006
FDEP, 2011c

Quest Ecology reported that one pair of caracaras appeared to have been responsible for all nesting activity on the site during the survey period. No red-cockaded woodpeckers or red-cockaded woodpecker cavities were observed during the surveys and Quest Ecology reported that the live pine trees on the site were of insufficient size to support red-cockaded woodpecker use. No Florida grasshopper sparrows were observed during the surveys. Quest Ecology reported that the site does not contain suitable habitat for the Florida grasshopper sparrow and is outside the currently documented range of this species. No Florida scrub jays were observed on the site during the surveys. Federally listed species that were not observed were not reported as having a high probability of occurring on the site.

Of the state-listed species observed on the site, three are listed as Endangered (many-flowered grass-pink [*Calopogon multiflorus]*, common wild pine [*Tillandsia fasciculate]*, and giant wild pine [*Tillandsia utriculata]*), two are listed as Threatened (gopher tortoise and Florida sandhill crane), and seven are listed as Species of Special Concern (burrowing owl, little blue heron, snowy egret, tricolored heron, white ibis, Florida mouse, and Sherman’s fox squirrel). One specimen of many-flowered grass-pink was found in pine flatwoods habitat during the surveys. Common wild pine and giant wild pine were reported to be common in oak hammock habitat and on the fringes of forested wetlands.

In addition to these state-listed plant species, the following commercially exploited plant species were observed on the site during the surveys: Florida butterfly orchid (*Encyclia tampensis*), green-fly orchid (*Epidendrum conopseum*), cinnamon fern (*Osmunda cinnamomea*) and royal fern (*Osmunda regalis*). Active and inactive gopher tortoise burrows were found during the surveys. Gopher tortoise densities were reported to be lower than expected because of the predominance of poorly drained soils on the site. Several Florida mice were trapped around gopher tortoise burrows; however, no gopher frogs were trapped or observed. Numerous Florida sandhill cranes and their nests were observed throughout the site. A total of 46 sandhill crane nests was found in 29 different herbaceous wetlands during the surveys. Burrowing owls were observed on the site during certain years; however, no nesting activity was confirmed to have occurred on the site. Sherman’s fox squirrels were observed at several locations during the surveys. Several listed wading bird species (little blue heron, snowy egret, tricolored heron, and white ibis) were observed foraging throughout the site. One small rookery containing only non-listed wading bird species was found.

3.3.7 The Human Environment

Phosphate mining has the potential to affect many elements of the human environment. Effects on the human environment can be either negative or positive, depending on the specific element in question. Human environment elements include the following major categories:

- **<u>Land Uses:</u>** Phosphate mining affects the land surfaces within the footprint of a mine. It also has the potential to influence land uses surrounding a mine. Following mine reclamation, mining can have a

significant impact on what happens to a mine and adjacent lands after all mining activities are completed. Understanding of existing land uses in the study area is needed to support evaluations of the environmental consequences of the proposed actions.

- **Populations and Demographics:** Under favorable physical and environmental conditions, populations generally grow. Phosphate mining can influence human population growth by creating direct and indirect employment opportunities and by promoting the economic prosperity of impacted counties as well as of the broader regional economy to which those counties contribute. While such effects of phosphate mining generally may be viewed as positive outcomes, negative effects might also exist. For example, environmental justice concerns might be raised if the mining projects were found to disproportionately negatively impact specific population segments such as minorities or low income residents. Understanding of the existing and projected populations in the study area is needed as background information that may be relevant to impact evaluation.

- **Public Health and Well Being:** Inadvertent release of pollutants of concern by phosphate mining could cause or contribute to air or water pollution, which could negatively impact the quality of life for people residing in or visiting the impacted counties, or the broader regional setting. Phosphate mining effects on regional water resources could affect water availability for potable or agricultural water uses. Noise generated by phosphate mining operations could affect localized human resources near the mine sites, and localized air quality concerns could exist related to fugitive dust because of the significant earthwork involved in phosphate mining. Reclaimed lands have been reported to have elevated levels of radioactivity in the form of radon gas, which in high concentrations can represent a public health risk. Regional aesthetics could be impacted by the presence of mine infrastructure like clay settling areas, which would be visible from regional highway corridors. Positive effects of the phosphate mining industry on local and regional quality of life also exist. Mine planning and reclamation efforts can contribute to county land use planning and achievement of comprehensive plan goals and objectives through convergence of mining objectives with future growth management concepts of local government. Industry contributions to parks and recreational facility development have occurred, and the phosphate industry continues to seek opportunities to support community service and environmental education programs. Evaluation of mining effects on public health and well being under the environmental consequences section of this AEIS requires a basic understanding of existing conditions related to these topics.

The following describes human environment elements and, where applicable, summarize information pertinent to understanding phosphate mining effects on these elements based on previous investigations.

3.3.7.1 Social and Economic Overview of the CFPD Counties

The term “region” relative to this social and economic overview includes all of Hillsborough, Polk, Hardee, Manatee, Sarasota, and DeSoto Counties, not just the portion of these counties with phosphate reserves or ongoing mining-related activities. In USEPA’s 1978 Areawide EIS addressing the phosphate industry in central Florida, these counties were grouped together for evaluation because of the presence of phosphate reserves and the potential effects that phosphate mining might have on the counties’ socioeconomic character. For this AEIS, Charlotte and Lee Counties are also included in light of expressed concerns regarding potential cumulative effects of phosphate mining, in addition to urbanization and agricultural activities, on the watersheds delivering water to the Charlotte Harbor estuary. Table 3-25 provides a summary of selected social and economic profile metrics for the AEIS study area counties.

Of the eight counties in the AEIS study area, Charlotte and Lee Counties are outside of the CFPD, and only about 1,000 acres of Sarasota County are inside the CFPD boundary. Most of the historical mining occurred in Polk and Hillsborough Counties, each with approximately 40 percent of their land areas in the CFPD. More recent mining activities have moved into Manatee and Hardee Counties, each with approximately 65 to 70 percent of their land areas in the CFPD. Roughly 20 percent of DeSoto County, in which no phosphate mining has yet occurred, is in the CFPD.

The human populations in each county vary, ranging from the lowest levels of approximately 25,000 to 35,000 people in Hardee and DeSoto Counties, respectively, to as high as more than 1 million people in Hillsborough County. The corresponding average population densities range from approximately 45 to 55 people per square mile to more than 1,200 people per square mile. As reflected in Figure 3-47, actual population densities vary depending on a finer spatial scale than county-wide levels. These 2010 census results confirm that the CFPD lands generally include the least populated land areas in the respective counties.

Table 3-25. Selected Social and Economic Profile Metrics for the AEIS Study Area Counties

Parameter	DeSoto	Hardee	Hillsborough	Manatee	Polk	Sarasota	Charlotte	Lee	Florida
Land Area, square miles	637	638	1,020	743	1,798	556	680	785	53,625
Approximate % of County Within CFPD	20	65	40	70	40	<1	0	0	N/A
Total Population	34,862	27,731	1,229,226	322,833	602,095	379,448	159,978	618,754	18,801,310
Percent of State's Total Population	0.2%	0.1%	6.5%	1.7%	3.2%	2.0%	0.9%	3.3%	N/A
Average Density, people/square mile	55	43	1,205	434	335	682	235	788	351
Population Structure:									
People < 5 years old, percent	6.5	8.0	6.5	5.7	6.5	3.9	3.5	5.3	5.7
People < 18 years old, percent	22.5	27.7	23.9	20.5	23.5	15.7	14.3	19.5	21.3
People 19-64 years old, percent	53.1	51.4	57.8	50.5	52.0	49.2	48.1	51.7	55.7
People > 65 years old, percent	17.9	12.9	11.8	23.3	18.0	31.2	34.1	23.5	17.3
Median Household Income (2006-2010)	$35,979	$37,466	$49,536	$47,812	$43,946	$49,388	$45,037	$50,014	$47,661
Percent of Population Living Below Poverty Level	26.9	26.1	14.2	12.8	15.2	10.5	10.5	12.0	13.8
2010 Unemployment Rate	10.2	11.3	8.6	8.9	9.3	9.2	11.3	9.9	12.0
Percent of Employed Working in Agriculture, Forestry, Fishing and Hunting, or Mining	22.9	31.7	1.2	1.5	2.6	0.3	0.5	0.8	1.1
Source: U.S. Census Bureau, 2010									

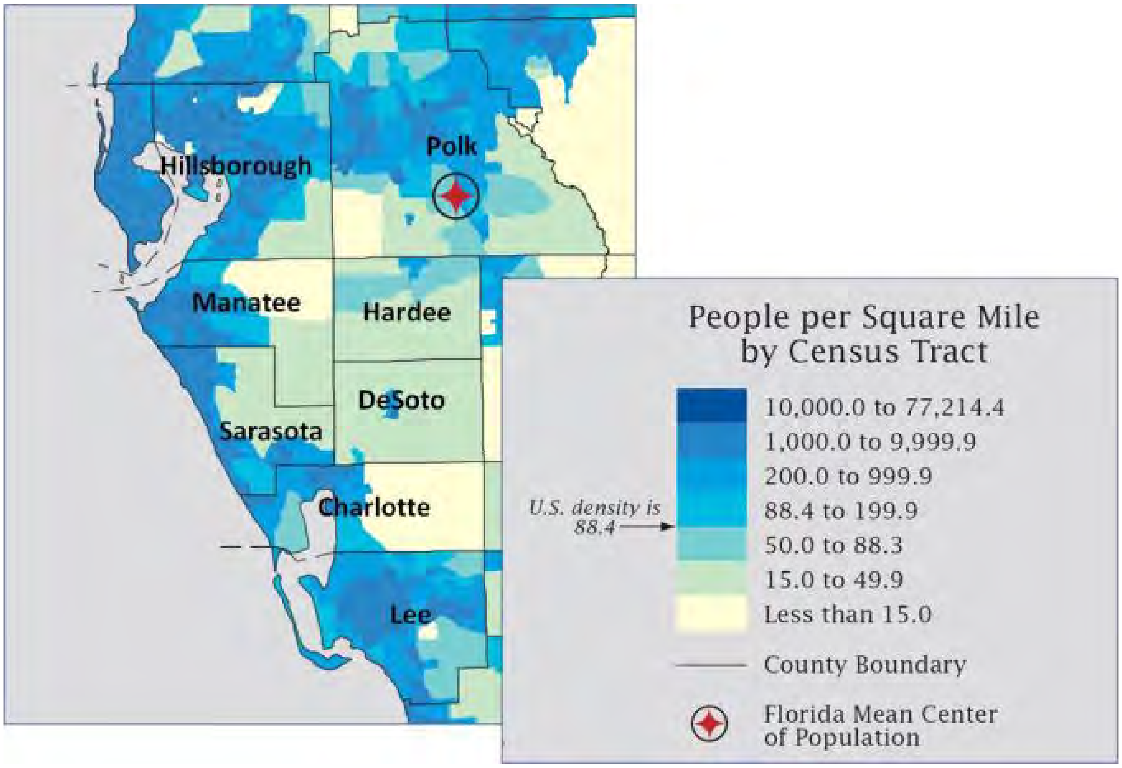


Figure 3-47. Population Densities in the Counties Containing the CFPD

The population structures of the various counties in the study area are similar in that approximately 50 percent of the population in each county is between the ages of 18 and 65, generally considered the majority of the working age individuals of a population. In 2010, the counties reflected unemployment rates ranging between approximately 9 and 11 percent, somewhat lower than the statewide figure of 12 percent.

Hardee and DeSoto Counties were notably different from the other counties in terms of several metrics, including median household income for the 2006-2010 period evaluated under the 2010 census. These counties exhibited median household incomes of approximately $36,000 to $38,000 in contrast to the other counties with median household incomes ranging between approximately $44,000 and $50,000. These two counties also exhibited the highest relative percentages of the population living below the poverty threshold (26-27 percent) compared to the other counties (11-15 percent). DeSoto and Hardee Counties also were characterized by having the highest relative percentage of workers older than 16 years of age who were engaged in employment under the 2010 census category “agriculture, forestry, fishing and hunting, and mining” (approximately 23 and 32 percent for DeSoto and Hardee Counties, respectively). Both agricultural and mining jobs are common modes of employment in Hardee County, whereas phosphate mining has not occurred in DeSoto County, suggesting that agricultural employment is more prevalent in this county to date.

3.3.7.2 Population Growth Projections

Florida's population growth rate from 2000 to 2010 was 18 percent. Table 3-26 shows that the populations of several of the AEIS study area counties have been growing more rapidly than the state as a whole (Hillsborough, Manatee, Polk, and Lee Counties). Of the other four study area counties, DeSoto and Hardee Counties have shown the slowest growth rates (both less than 10 percent from 2000 to 2010).

Table 3-26. Historical Population Growth Records for the AEIS Study Area Counties

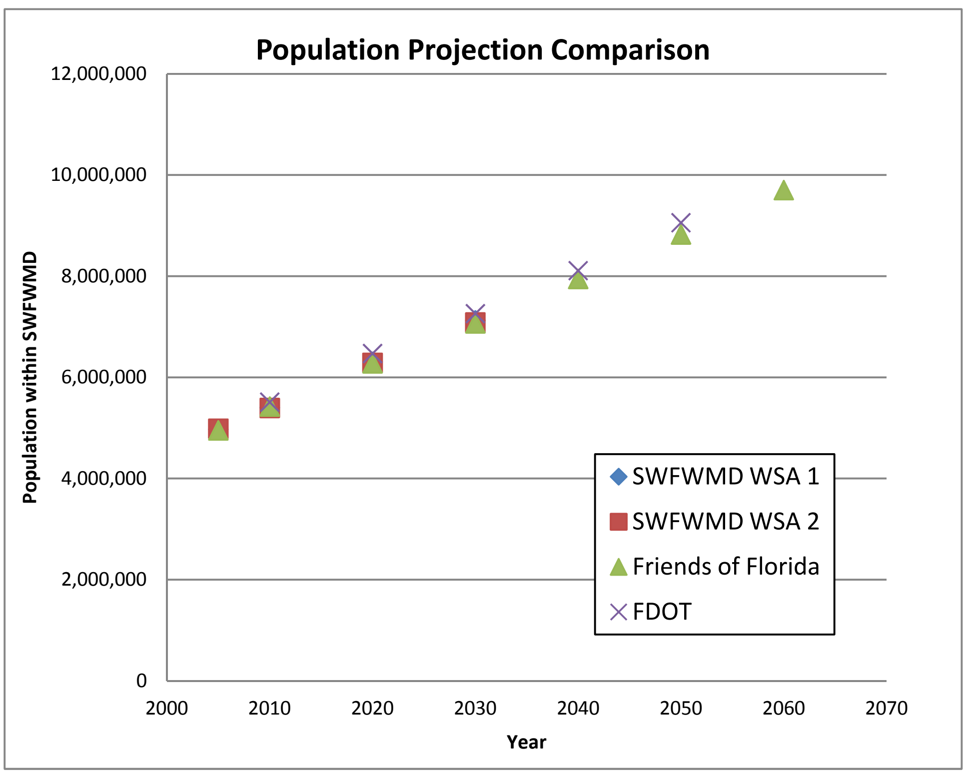
Year	DeSoto	Hardee	Hillsborough	Manatee	Polk	Sarasota	Charlotte	Lee	AEIS Study Area Total	Florida
1980	19,039	19,379	646,960	148,442	321,651	202,251	58,460	205,266	1,621,448	9,746,961
1990	23,865	19,379	834,054	211,707	405,382	277,776	110,975	335,113	2,218,251	12,938,071
2000	32,209	26,938	998,948	264,002	438,924	325,957	141,627	440,888	2,669,493	15,982,378
2010	34,862	27,731	1,229,226	322,833	602,095	379,448	159,978	618,754	3,374,927	18,801,310
Population % Change (2000-2010)	8%	3%	23%	22%	24%	16%	13%	40%	26%	18%

Source: U.S. Census Bureau; 1980, 1990, 2000, 2010

Future population growth patterns are projected to continue on the historical upward trajectories, although at a reduced pace. The University of Florida Bureau of Economic and Business Research (UF-BEBR) generated projections through the year 2030 as summarized in Table 3-27.

Similar projections have been generated by SWFWMD, FDOT, and 1000 Friends of Florida in support of various forward-looking resource planning documents. Projections provided through 2060 for land areas in SWFWMD are summarized in Figure 3-48. These projections are relevant to this AEIS because estimation of phosphate mining effects on the human environment must account for conditions that are likely to exist during the life cycles of the Applicants' Preferred Alternatives, some of which are currently proposed to extend through the 2050 to 2060 planning horizon. The levels of growth projected for SWFWMD as a whole could reflect population increase in the AEIS study area.

Table 3-27. Population Projections for the AEIS Study Area Counties			
County	**2010**	**2020**	**2030**
DeSoto	34,862	37,600	40,400
Hardee	27,731	28,300	28,900
Hillsborough	1,229,226	1,439,000	1,652,700
Manatee	322,833	374,900	428,200
Polk	602,095	713,900	828,500
Sarasota	379,448	424,700	470,700
Charlotte	159,978	176,300	192,700
Lee	618,754	779,800	942,700
Total	**3,374,927**	**3,652,418**	**3,974,676**
Source: UF-BEBR, 2011			



Data summarized from UF-BEBR, FDOT, and 1000 Friends of Florida

Figure 3-48. Comparison of Regional Population Growth Projections for SWFWMD

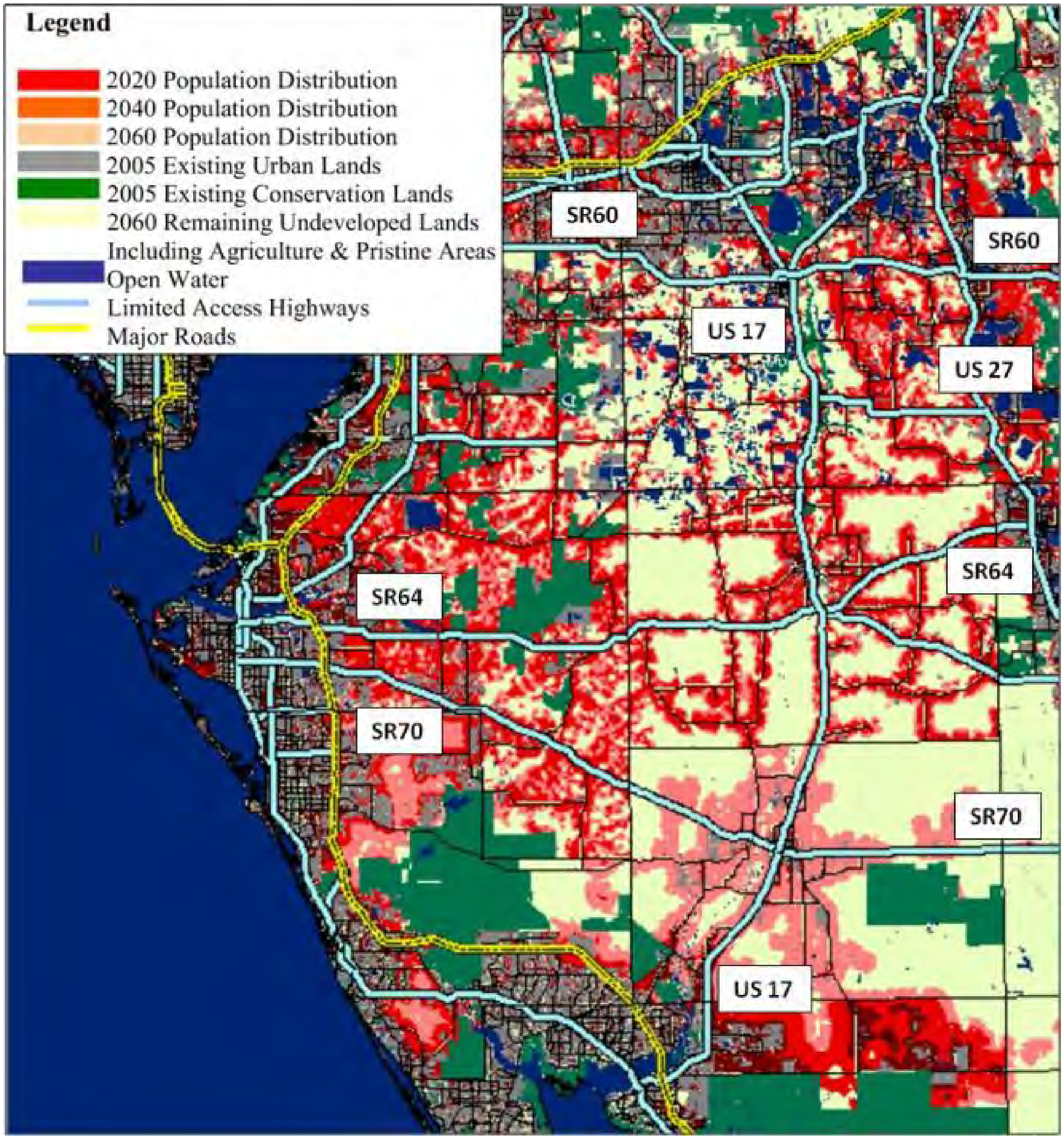
On behalf of 1000 Friends of Florida, the GeoPlan Center at the University of Florida prepared "*Florida 2060, a Population Distribution Scenario for the State of Florida"* (Zwick and Carr, 2006), in which it predicted that as populations increase, urban growth will expand along existing highway corridors into areas that can accommodate population increases. With this in mind, potential urban growth patterns along the major roadways in the CFPD may be important factors to consider when evaluating potential effects of the Applicants' Preferred Alternatives in the AEIS study area. The urban growth pattern predicted by Zwick and Carr (2006) is reflected in Figure 3-49. In considering potential mining effects in terms of potential conflict versus convergence with local and regional growth management goals, close coordination between the applicable county planners, the phosphate industry, and federal and state mining regulators will be needed. With appropriate forward planning, mining followed by coordinated reclamation planning and execution may be possible in ways that provide benefits to the local and regional governmental bodies involved as well as the private sector.

3.3.7.3 Demographics and Environmental Justice

Environmental justice is the fair treatment of people of all races, income, and cultures with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires federal agencies to "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."

CEQ guidelines (CEQ, 1997) define "minority" as members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. Minority populations should be identified where (1) the minority population of the affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. A "low-income" population exists when 20 percent or more of the population is living below the poverty threshold. The U.S. Census Bureau uses a set of income thresholds that vary by family size and composition to establish who is within the poverty level.

The CFPD includes all or portions of the following six counties: DeSoto, Hardee, Hillsborough, Manatee, Polk, and Sarasota. A review of demographic data was conducted for all six of these counties to assess the potential for the Applicants' Preferred Alternatives to result in disproportionate effects on low income or minority populations. The results of the review are shown in Table 3-28.



Modified from: Zwick and Carr, 2006

Figure 3-49. 2020, 2040, and 2060 Regional Urban Growth Projections for South Central Florida by 1000 Friends of Florida

Table 3-28. Selected Demographic Metrics for the AEIS Study Area Counties

Census 2010	DeSoto	Hardee	Hillsborough	Manatee	Polk	Sarasota	Florida
Total Population (number)	34,862	27,731	1,229,226	322,833	602,095	379,448	18,801,310
White/Caucasian (%)	66	72	71	82	75	90	75
Black/African American (%)	13	7	17	9	15	5	16
Native American (%)	0.4	0.6	0.4	0.3	0.4	0.2	0.4
Hawaiian/Pacific Islander (%)	0.0	0.0	0.1	0.1	0.1	0.0	0.1
Asian (%)	0.5	1.1	3.4	1.6	1.6	1.3	2.4
Other race (%)	17.7	17.1	5.0	5.3	5.5	2.0	3.6
Hispanic or Latino origin (%)[a]	30	43	25	15	18	8	23
Total Minority Population (%)[b]	43.9	52.0	46.3	26.6	35.4	15.1	42.1
Percent of Population Living Below the Poverty Level[c]	26.9	26.1	14.2	12.8	15.2	10.5	13.8

Notes:

[a]Hispanic or Latino origin is based on language and country of origin, not race. Persons identified as Hispanic or Latino are also counted in the racial categories shown.

[b]Racial/ethnic background is based on self-identified information provided on Census forms (100% demographic data).

[c]Population living below the poverty level is estimated in the American Community Survey, based on sampling data, and is subject to sampling error.

Sources: U.S. Census Bureau, 2011a.

As a second step in considering environmental justice, the minority and low income populations in the three counties where the Applicants' Preferred Alternatives would be located were reviewed. This review is summarized below.

- **DeSoto County:** The 2010 Census documented that the Black or African American population in DeSoto County represented 13 percent of the population, essentially the same as in 2000 (12.7 percent), and was concentrated in the town of Arcadia or distributed toward the southeastern quadrant of the county. The Hispanic or Latino population represented 30 percent of the population in 2010, also concentrated in Arcadia and along the Highway 17 corridor. Less than 1 percent of the population in DeSoto County was Native American, Hawaiian/Pacific Islander, or Asian. Approximately 26.9 percent of the population lives below the poverty level, a sharp increase from 14 percent in 2000, with a similar pattern of distribution and a concentration in the south central portion of the county. For comparative purposes, in Florida as a whole in 2010, 13.8 percent of the population was living below the poverty level.

- **Hardee County:** The Black or African American population represented approximately 7 percent of the Hardee County population in 2010 (similarly, 8 percent in 2000), with most residing in and

immediately west of Wauchula. The Hispanic or Latino population represented approximately 43 percent of the population in 2010 (up from 36 percent in 2000), with most again living in the Wauchula area and along Highway 17. Approximately 26 percent of the population lived below the poverty level in 2010, a distinct increase from approximately 17 percent in 2000, with most living in the Bowling Green and Wauchula areas and generally along the Highway 17 corridor. The Hardee County Correctional Institution population, which comprises approximately 6 percent of the overall Hardee County population, contributes to these population subgroups on a fluctuating basis with changes in the resident prison population.

- **Manatee County:** The 2010 Census indicated a reduction in the Black or African American population of Manatee County, from 12 percent in 2000 to 9 percent in 2010, residing mostly in the western part of the county near the Gulf coast. The Hispanic or Latino population increased from 12.5 percent in 2000 to 15 percent in 2010, mostly located in the east central areas of the county. The poverty rate in Manatee County was 12.8 percent in 2010, up from 7 percent in 2000, with residents in this group located primarily in the Bradenton area and the southeastern portion of the county.

To obtain more detailed information on existing conditions with regard to potentially affected populations in the vicinity of the Applicants' Preferred Alternatives sites and the four offsite alternative sites, additional review of more recent demographic data (i.e., from the 2010 Census and income data from the 2006-2010 American Community Survey) was conducted at the block group level. Specifically, the 2010 census data for block groups (subsets of census tracts) overlapping with some or all of Alternatives 2 through 9 in the study area were reviewed to identify where the populations meet the criteria for a minority or low income population and how much of the block group falls within the boundaries of new mines or alternative sites. Minority populations are defined as block groups with more than 50 percent minority, or meaningfully greater than the reference population. For the purposes of this analysis, "meaningfully greater" is defined as where the percentage of minority persons in a block group is at least one standard deviation over the mean (average) percentage for all block groups in the study area. Low-income populations are defined as block groups with more than 20 percent poverty.

The Applicants' Preferred Alternatives (Desoto, Ona, Wingate East, and South Pasture Extension) and all of the four offsite alternatives are in DeSoto, Hardee or Manatee Counties. County information was used for comparison as the reference populations. The results of the screening are presented in Table 3-29, showing the alternatives in the study area and noting where the population meets the criteria for a minority or low-income population, as well as indicating how much of the block group falls within the boundaries of the applicable new mine or alternative site.

Table 3-29. Results of Screening Minority and Low-Income Population 2010 Census Data for Mine Sites and Alternatives Considered

Alt #	Site Name	Size (acres)	County	BG with Minority population > 50%	BG with Minority population > Avg + Std Dev [a]	BG with Poverty Rate >20%	Acres of BG within Property	BG as % of site acreage
1	No Action	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Desoto Mine	18,463	DeSoto	No	no	no	N/A	N/A
3	Ona Mine	23,036	Hardee	No	Tract 970300, BG 5	Tract 970300, BG 5	15,878	68.9%
4	Wingate East Mine	2,459	Manatee	No	Tract 970300, BG 5	Tract 970300, BG 5	< 1	0.0%
5	South Pasture Mine Extension	7,513	Hardee	No	Tract 970300, BG 5	Tract 970300, BG 5	7,513	100.0%
6	Pine Level/Keys Tract	24,711	Manatee	No	No	No	N/A	N/A
7	Pioneer Tract	25,259	Hardee	No	No	No	N/A	N/A
8	Site A-2	8,189	Hardee	No	No	No	N/A	N/A
9	Site W-2	9,719	Manatee	No	No	No	7,283	80.9%

Notes:

[a] The minority percentage within a block group was at least one standard deviation above the mean (average) minority percentage for all block groups in the study area.

BG = block group

N/A = not applicable

Data Source: U.S. Census Bureau, 2011a

Of the Applicants' Preferred and Offsite Alternatives, the block group containing Alternative 9 (Site W-2) has a minority population greater than 50 percent. The Ona Mine and the South Pasture Mine Extension each have minority populations less than 50 percent but greater than one standard deviation above the average while the majority of the Wingate East Mine is adjacent to the same block group. Each of the block groups containing the same mines have poverty rates greater than 20 percent. Although detailed demographics data are not available for the Hardee County Correctional Institution, the resident population of approximately 1,600 individuals (Hardee County Correctional Institution, 2013), likely contributes to the minority and low income population in the county.

Table 3-30 summarizes the screening information presented in Table 3-29, showing the alternatives in the study area where the population meets the criteria for a minority or low-income population, and indicates how much of the block group falls within the boundaries of the applicable new mine or alternative site.

Table 3-30. Proposed or Alternative Mining Sites Containing Minority or Low-Income Population (2010 Census Block Groups)

Alt #	Site Name	Size	County	Minority Population[a]	Low-Income Population[a]	Acres of Identified Block Group(s) within Property
3	Ona Mine	23,036	Hardee	X	X	15,878
4	Wingate East Mine	2,459	Manatee	[b]	[b]	< 1
5	South Pasture Mine Extension	7,513	Hardee	X	X	7,513

Notes:

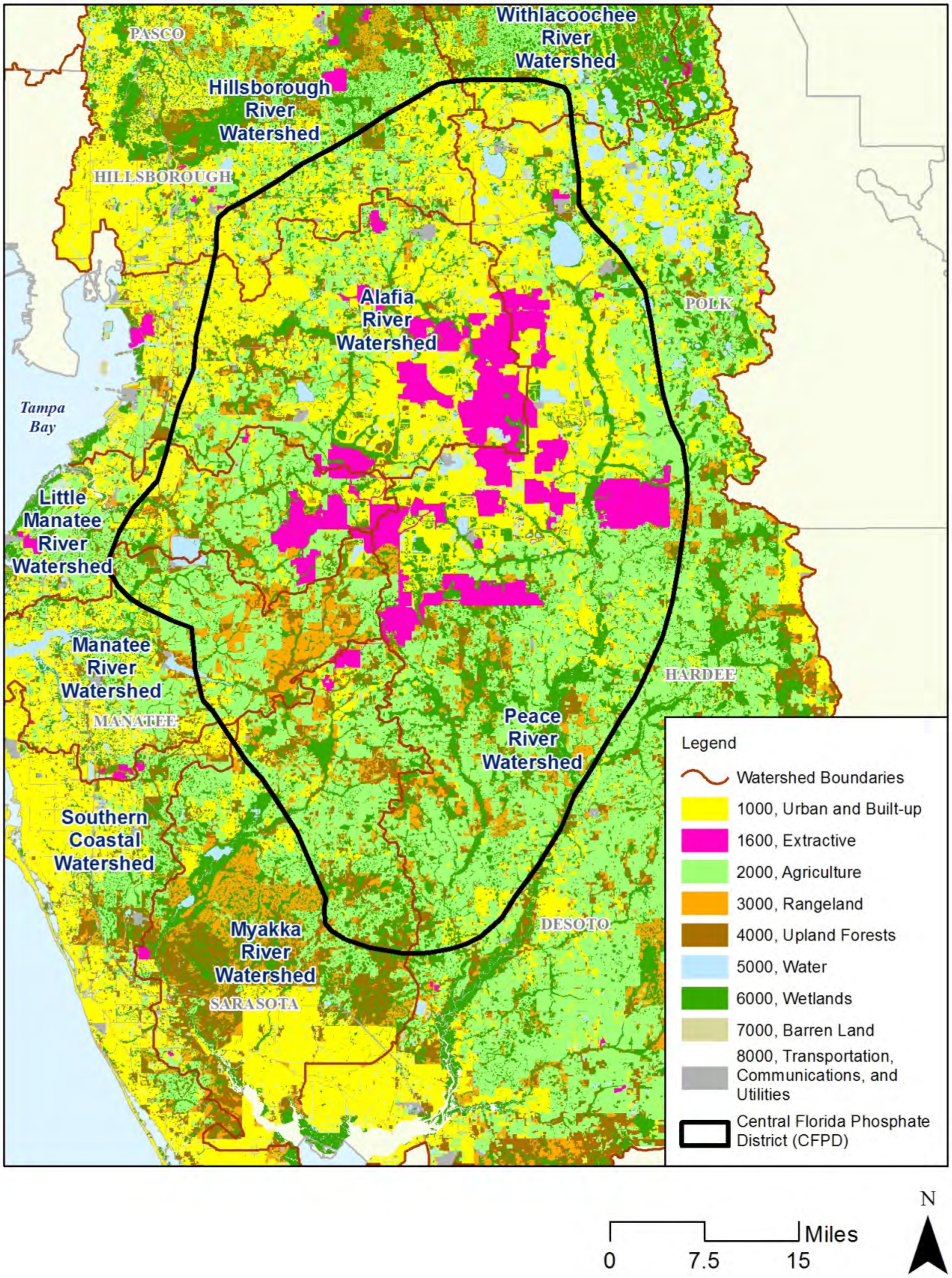
[a]Minority population is defined as either 50 percent minority or meaningfully greater than the reference population. Low-income defined as 20 percent below the poverty rate or meaningfully greater.

[b]The identified block groups comprised less than 1 percent of the site's acreage. Therefore, the site is considered to be near but not within a minority or low-income population area. These sites are not identified as having minority or low income population in the environmental justice section of Chapter 4.

This environmental justice screening review has identified minority and low income populations at two of the Applicants' Preferred Alternatives (Ona Mine and South Pasture Mine Extension). The Wingate East Mine is adjacent to the minority and low income population found in Tract 970300, BG 5. An assessment addressing the potential for the Applicants' Preferred Alternatives or the potential offsite alternatives to cause disproportionately high and adverse human health or environmental effects on minority populations and low-income populations is provided in Chapter 4.

3.3.7.4 Land Use

SWFWMD 2009 FLUCCS data were used to assess existing land use/cover in the AEIS study area. While very detailed data are available, this AEIS land use graphic has been limited to reflect the Level 1 land use codes. More detailed land use information is available in the overall AEIS GIS database. The Level 1 land use data are reflected in Figure 3-50.



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2 *Source: SWFWMD, 2011c*

3 **Figure 3-50. 2009 Level 1 FLUCCS Land Use Map of the AEIS Study Area**

4

This figure reflects the concentration of historical and ongoing phosphate mining activity in the north and central portions of the CFPD in southwest Polk, southeast Hillsborough, eastern Manatee, and western Hardee Counties. From a watershed perspective, the Alafia and upper Peace River watersheds, as well as portions of the Little Manatee River watershed, have been the areas most heavily mined for phosphate to date.

According to the 2009 SWFWMD FLUCCS, agriculture is the dominant land use in the Peace River watershed, accounting for approximately 41 percent of the total area of the watershed. Urban or Built-up land represents approximately 23 percent of the total land cover in the watershed. The Extractive land-use category, which is a component of the Urban land-use classification, accounts for approximately 10 percent of the total watershed area. The Extractive category primarily represents phosphate-mined lands; however, it also includes some reclaimed areas. As such, the 2009 SWFWMD FLUCCS overestimates the coverage of phosphate-mined land and underestimates land uses/habitats that have been created through reclamation. Mining and most urban uses are concentrated in the upper third of the watershed. Native uplands, wetlands, and surface waters combined comprise approximately 35 percent of the watershed area. The remaining 1 percent of the watershed consists of disturbed land and transportation/utility corridors.

Agriculture is the dominant land use in the Myakka River watershed, accounting for approximately 26 percent of the watershed area. Urban and Built-up lands represent approximately 18 percent of the watershed area; only about 0.8 percent of the watershed is classified as Extractive land use. Native uplands, wetlands, and surface waters combined represent approximately 55 percent of the total land cover in the watershed. The remaining 1 percent of the watershed consists of disturbed land and transportation/utility corridors.

Large phosphate industry holdings are being mined in the eastern half of the Little Manatee River watershed. Areas of past, current, and potential future mining include areas along the North Fork and South Fork of the Little Manatee River. This river has been designated by the state as an Outstanding Florida Water under Florida Statutes, Section 403.061, Subsection (27). This designation means that generally the state will not issue permits for direct discharges into this water body and any developments near the river will require additional documentation to prove compliance with water quality degradation criteria before they will approved. Nonetheless, about two-thirds of this watershed has been developed, with associated habitat loss, alterations, and fragmentation, and these changes are expected to continue.

3.3.7.5 Agricultural and Phosphate Mining Influences on the Local and Regional Economy

Agriculture, extraction of natural resources, and related industries provide more than $107 billion in value-added contributions, and accounted for 14 percent of total economic activity in Florida in 2009 (Hodges et al., 2011). According to the United States Department of Agriculture, for every $1 of public investment

in agricultural research and extension, there is a $10 benefit to producers and consumers in terms of greater productivity and lower food prices (Fuglie and Heisey, 2007).

Employment

Table 3-31 summarizes agriculture-related jobs in the AEIS study area counties. When viewed on a county by county basis, Hardee and DeSoto Counties were particularly influenced by agricultural employment (52 and 50 percent of the total employment, respectively).

The two phosphate mining companies working in the CFPD (i.e., CF Industries and Mosaic) contribute directly to local and regional employment. Information provided to the USACE in 2011 and 2012 by the Applicants indicates that:

- Mosaic employs approximately 1,280 people in its Florida mining operations. Mosaic's typical phosphate mine directly employs 300-400 people who reside in the AEIS study area counties.

- CF Industries employs 184 people at the Hardee Phosphate Complex, with 68 percent being residents of Hardee County.

These totals represent individuals who are employed directly by the two companies. Additional phosphate mining-related employment occurs through the Applicants' use of contractors and consultants to carry out mining-related activities, including selected environmental planning and permitting-related support services, as well as many construction-related activities.

Table 3-31. Agriculture-Related Jobs for AEIS Study Area Counties

County	Number of Agriculture-related Jobs[a]	Revenue Generated by Agriculture Industry[a] ($ Billion)	Total Jobs in Each County (2009)	Percentage of Total Jobs Related to Agriculture Industry in Each County (2009)
Charlotte	11,024	0.44	39,612	28%
Sarasota	33,113	1.56	134,583	25%
Polk	95,040	6.18	192,087	49%
Hillsborough	176,577	11.17	572,175	31%
Hardee	7,471	0.40	7,826	95%
Manatee	41,657	2.15	101,224	41%
Lee	56,233	2.83	194,073	29%
DeSoto	6,972	0.34	8,281	84%
Total	**428,087**	**25.70**	**1,249,861**	**34%**

Notes:

[a] Crop, Livestock, Forestry, Fishery Production and Agricultural Inputs & Services

Source: Hodges et al., 2008

Economic effects of phosphate mining on the region, as estimated by EcoNorthwest (2011), include the following:

- For every $1 million paid in local severance and property taxes, 13.8 jobs are created in the local government and 20 throughout the multi-county region. These translate to approximately $803,700 in local government labor income, and $1,052,800 in total labor income in the 5 counties included in these estimates (Hillsborough, Polk, Hardee, Manatee and DeSoto).

- Forty-eight percent of total spending by Mosaic is spent locally. Mosaic's contribution to the local economy per $1 million of local spending on goods and services in Hillsborough, Polk, Hardee, Manatee, and DeSoto Counties supports 2 jobs at local businesses that supply Mosaic and 4.5 more jobs elsewhere in the local economy, for a total of 6.5 jobs created. The total labor income attributed to Mosaic's local spending throughout all 5 counties has been estimated at approximately $382,200 per each $1 million spent (Thornton, 2012, personal communication).

Severance Taxes

In 1971, the Florida Legislature passed Chapter 211, F.S., which created a severance tax on solid minerals mines in Florida. The law encouraged voluntary reclamation of mined lands by providing a means for allocations from severance tax accumulations to fund a portion of the costs of such voluntary reclamation efforts. Further refinements to the severance tax provisions have occurred over the years, but the overall intent remains aligned with collecting funds correlated with mining productivity to improve the safety of mining operations and complete mine reclamation. Severance tax dollars are divided among the state's General Revenue Fund, Non-mandatory Land Reclamation Trust Fund, Minerals Trust Fund, county governments of counties in which phosphate mining occurs, and the FIPR Institute.

Chapter 211, F.S., indicates that "Every person engaging in the business of severing solid minerals, phosphate rock, and heavy minerals from the soils and waters of Florida for commercial use must pay an excise tax. The tax rate is 8 percent of the value at the point of severance. The Florida Department of Revenue website contained information on current severance tax rates applicable to phosphate rock producers, as summarized in Table 3-32.

Table 3-32. Current Severance Tax Rates Applicable to Phosphate Rock Producers

Tax Rate Period	Tax Rate
July 1, 2010 – June 30, 2011	$1.71 per ton
July 1, 2011 – June 30, 2012	$1.61 per ton

Legislation passed in 2012 extended the $1.61 per ton tax rate to June 30, 2015. Thereafter, from July 1, 2015, to June 30, 2022, the rate will be $1.80 per ton.

As summarized in prior chapters, the rate of phosphate rock production has varied substantially in the past depending on the status of the market for phosphate-related end products. According to the USGS, domestic phosphate rock production was 26.4 Mt in 2009 and 26.1 Mt in 2010 (USGS, 2011a). In 2010 Florida's seven mines provided 16.8 Mt or 65 percent of domestic annual production (USGS, 2011a), with approximately 13.2 Mt, or 51 percent of the domestic production obtained from the CFPD. Table 3-33 presents annual rock production by CF Industries from 2009 through 2011 (CF Industries, 2012b).

Table 3-33. CF Industries' Annual Phosphate Rock Production and Acres Mined, 2009 - 2011

	2009	2010	2011
Phosphate Rock Production (tons)	3,088,000	3,343,000	3,504,000
Acres Mined	375	420	452
Source: CF Industries, 2012b			

On the basis of these production records, Mosaic's collective rock production from its multiple mines over the corresponding years has been approximately 10 Mt per year.

Mosaic's website indicates that it paid more than $30 million in severance taxes and more than $17 million in county tangible and real estate taxes in 2010-2011. Table 3-34 presents the annual severance tax totals paid by CF Industries to the state along with the total property taxes paid to Hardee County, for 2009 through 2011 (CF Industries, 2012b).

Table 3-34. Annual State Severance Taxes and Hardee County Property Paid by CF Industries, 2009 - 2011

Tax Type	2009	2010	2011
Severance Tax Paid to State of Florida	$10,268,953	$10,717,689	$5,794,261
Property Taxes Paid to Hardee County	$1,789,796	$1,684,252	$1,771,930
Source: CF Industries, 2012b			

A percentage of the severance tax collected by the state is redistributed to the counties in which the mines are located. Table 3-35 summarizes the historical values of severance taxes returned to the CFPD counties, shown in millions of dollars for each fiscal year, for the 2004 to 2011 period of record. According to the FIPR Institute, 18 percent of the severance tax collected is redistributed to the corresponding counties (FIPR Institute, 2012). However, this rate has varied over time, and also is subject to special provisions.

Table 3-35. Severance Tax Revenues Distributed by Fiscal Year to AEIS Study Area Counties, 2004-2011

Fiscal Year	Hardee	Hillsborough	Manatee	Polk	Total for the Four CFPD Counties
2004-2005	$4.25	$0.44	$1.97	$2.35	$9.01
2005-2006	$3.51	$0.52	$2.02	$2.39	$8.45
2006-2007	$2.74	$0.79	$0.53	$1.80	$5.85
2007-2008	$2.47	$1.16	$0.38	$1.82	$5.83
2008-2009	$3.23	$0.80	$1.20	$2.21	$7.43
2009-2010	$2.68	$0.87	$0.72	$1.70	$5.98
2010-2011	$1.77	$1.68	$1.50	$1.65	$6.60
Total	**$20.66**	**$6.27**	**$8.31**	**$13.91**	**$49.16**

Notes:

All values in millions

Source: FDEP, 2011d

For example, the Florida Legislature established three Rural Areas of Critical Economic Concern (RACECs), defined as regions composed of rural communities that have been adversely impacted by extraordinary economic events or natural disasters. One of the regions is the South Central Florida RACEC, which includes Hardee, DeSoto, Highlands, Okeechobee, Glades, and Hendry Counties. RACECs in Florida receive certain provisions for economic development initiatives, such as waived criteria and requirements for economic development programs. Additionally, funding is provided to the regions to help perform economic research, site selection, and marketing to produce a catalytic economic opportunity. With respect to the AEIS study area, Hardee and DeSoto Counties receive an extra 10 percent severance tax allocation each year.

Severance tax payment distributions and property tax payments to the counties represent significant sources of local government revenue. These factors are important considerations for evaluating the potential economic effects of the Applicants' Preferred Alternatives.

3.3.7.6 Regional Water Supply

An important nexus between the human environment and natural resources in the AEIS study area is the use of surface water and groundwater to support potable water demands. SWFWMD issues water use permits for large water withdrawals and maintains annual consumption records. Due primarily to cumulative historical, and ongoing agricultural, industrial/commercial (including phosphate mining), and potable water withdrawals, SWFWMD has documented what it considers to be unacceptable FAS water level drawdowns (SWFWMD, 2011c).

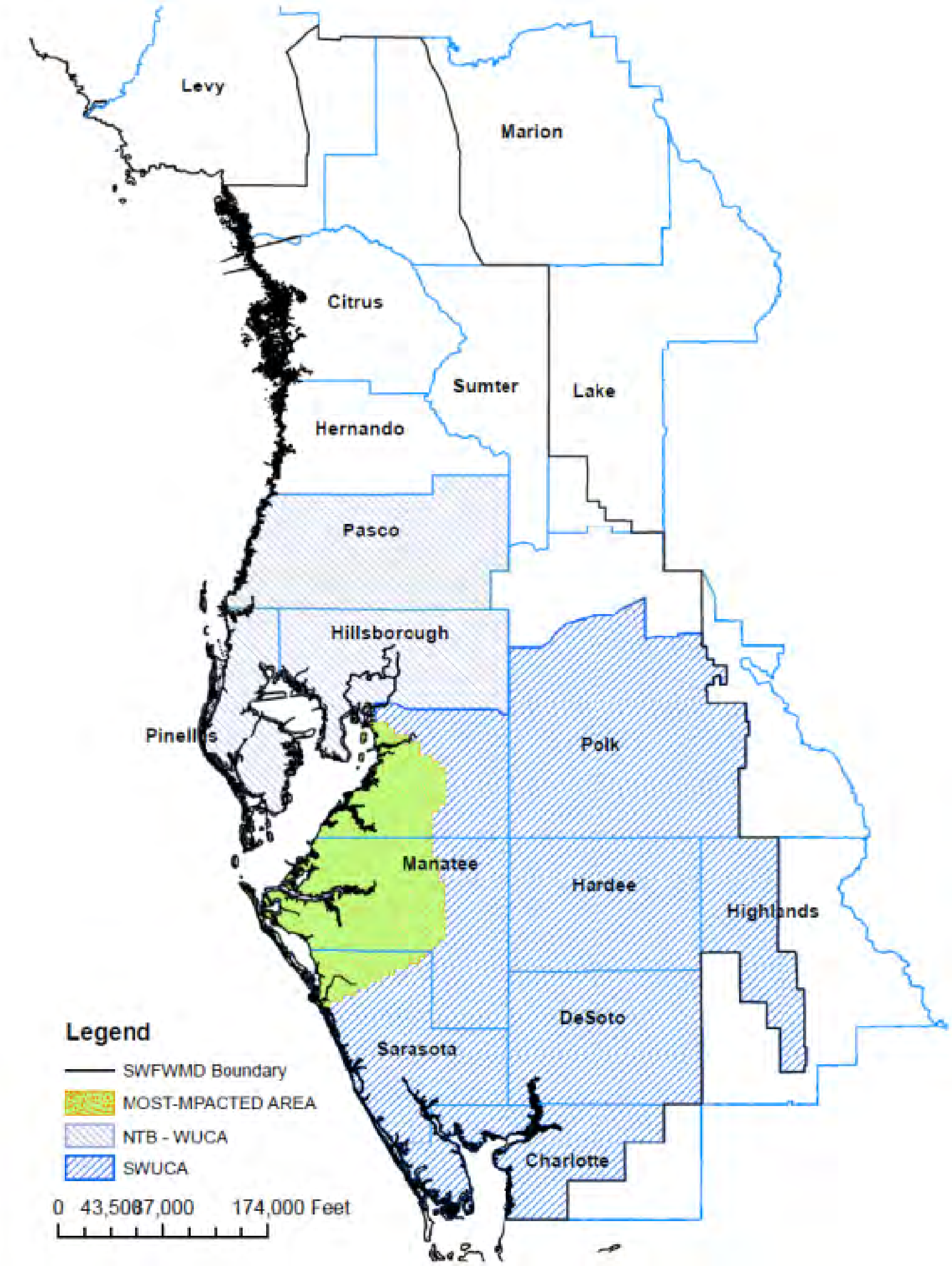
In response, SWFWMD has developed aquifer management and recovery strategies for two areas in its jurisdictional boundaries: the North Tampa Bay Water Use Caution Area (NTB-WUCA) and the SWUCA. As shown in Figure 3-51, the SWUCA includes all of the land area in the CFPD. The “Most Impacted Area” is defined as a geographic zone in which FAS drawdown effects have contributed to increased saltwater intrusion into the aquifer from the direction of the Gulf of Mexico; plans for how to prevent further saltwater intrusion have been developed and are now being implemented.

The SWUCA Recovery Strategy developed by SWFWMD includes capping water supply allocations from the FAS at 650 mgd for all user categories combined, with a net reduction to 600 mgd required by 2025 (SWFWMD, 2006b). In its report, *“2009 Estimated Water Use in the Southwest Florida Water Management District”* (SWFWMD, 2011b), the agency provided the breakdown of 2009 surface and groundwater use by county shown in Figure 3-52.

The report indicates heavy regional reliance on groundwater withdrawals by all users, much of which has been from the upper FAS. Phosphate mining historically was a major user of FAS waters, particularly prior to the 1970s (i.e., before mandatory reclamation was required). However, over the past 40 years, the phosphate mining industry has gradually implemented water conservation measures and a change in water supply strategy, shifting from groundwater to surface water reliance.

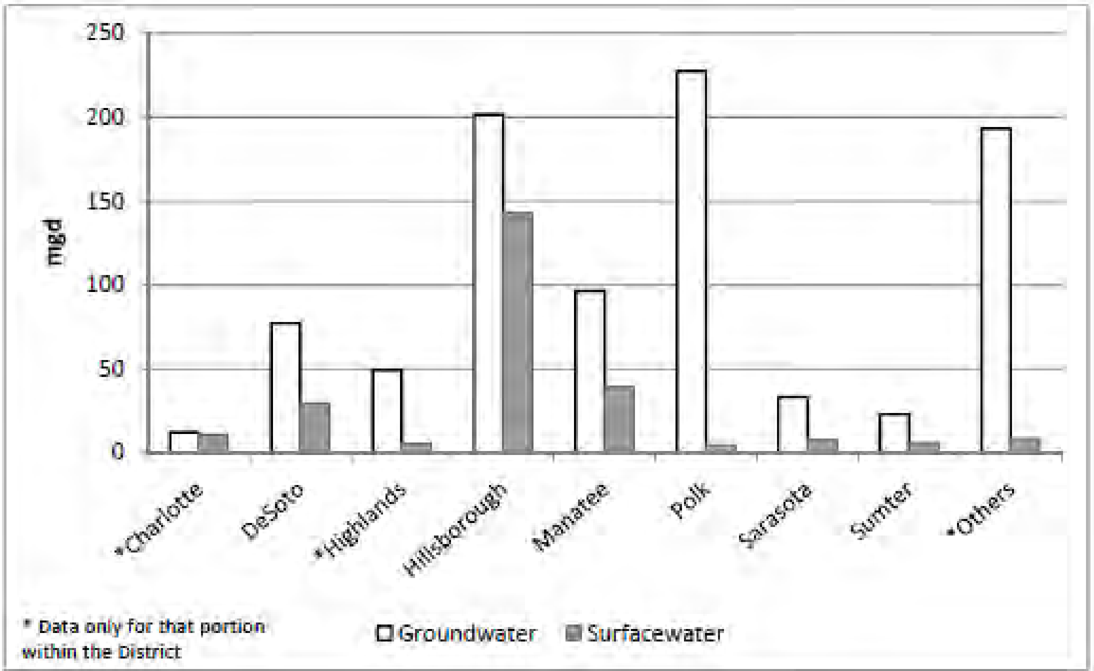
SWFWMD water use records document that the mining industry has reduced groundwater withdrawals, with actual annual average pumpage from FAS wells below the annual average allocations defined in the applicable water use permits It is common for actual average use to be less than permitted allocations because permit limits are established based on the 1-in-5-year drought demand. However, there is public concern that groundwater use by phosphate mining activities significantly impacts groundwater levels, including those in the FAS. Chapter 4 presents an evaluation of the cumulative effects of pumping from the FAS associated with the current, Applicants’ Preferred and reasonably foreseeable future phosphate mines.

While heavy regional water supply reliance on groundwater is indicated, it is noted that substantive surface water use is shown in Figure 3-52 – particularly for Hillsborough and Manatee Counties. The Hillsborough River historically has been the primary source of surface water used by Hillsborough County, but some surface water is now also drawn from the Alafia River. Much of Manatee County’s potable water is drawn from the Lake Evers and Manatee Lake Reservoirs. While the Hillsborough, Alafia, and Little Manatee River watersheds have experienced substantive historical mining, no new mining projects are currently proposed or likely to be proposed in the future in these basins. Therefore, these watersheds received a lesser level of review in this AEIS.



Source: Modified from SWFWMD, 2011c

Figure 3-51. The Counties and Water Use Caution Areas in SWFWMD



Source: Modified from SWFWMD, 2011b

Figure 3-52. Surface and Groundwater Use in 2009, Summarized by County in the SWFWMD

In contrast, future mining projects are currently proposed in Hardee, DeSoto, and Manatee Counties. Manatee County established the Lake Manatee Reservoir and Evers Reservoir Watershed Protection Overlay Districts to protect these key surface water sources through a county ordinance prohibiting certain land uses in these watersheds. The sections of the ordinances that prohibit certain phosphate mining activities in these reservoir overlays, and in county land areas tributary to the Peace River, are pertinent to the AEIS evaluations of potential effects of any proposed new phosphate mines in or adjacent to the applicable land areas.

Three potable water suppliers in the AEIS study area are heavily reliant on surface waters as raw water sources for their potable water treatment facilities and are in the same watersheds as the Applicants' Preferred Alternatives. Two are in the Peace River watershed: the City of Punta Gorda's water utility, which withdraws raw water from Shell Creek, and the PRMRWSA, which withdraws raw water from the Peace River. One potable water supplier is in the Myakka River watershed: the City of North Port's water utility, which withdraws raw water from Big Slough (also known as Myakkahatchee Creek/Cocoplum Waterway). The 2009 raw surface water withdrawals for these three water suppliers were as follows:

- Punta Gorda: 4.436 mgd (permitted allocation of 8.1 mgd)
- PRMRWSA: 13.812 mgd (combined surface and groundwater permitted allocation of 32.7 mgd)
- North Port: 1.445 mgd (permitted allocation of 4.4 mgd)

All three utilities have water use permits from SWFWMD that define the specific stream or river flow conditions under which raw water withdrawals may occur. In all three cases, if stream or river flow conditions fall below specified thresholds, raw water withdrawals are to be suspended. The quality of the water being withdrawn is also an issue for the three utilities. Protection of public drinking water supplies is an important factor to be considered during AEIS evaluations of potential effects of proposed or future phosphate mining.

Based on available information, there is no current or potential offsite alternative proposed in the Shell Creek basin, which is the water source for the City of Punta Gorda's water treatment facility. Therefore, no further evaluation of this potable water withdrawal from Shell Creek is done under this AEIS.

The utilities' interests in sustainable withdrawals from the rivers to meet the potable water demands of their clients are an element of the human environment that warrants special consideration under this AEIS. In its Integrated Regional Water Supply Master Plan, the PRMRWSA described itself as "…an independent special district and a regional water supply authority created by an interlocal agreement in 1982 under Florida law. The PRMRWSA operates water production, storage, treatment, delivery, and ancillary facilities to serve the Charlotte, DeSoto, Manatee, and Sarasota County region" (PRMRWSA, 2006). It owns and operates a complex of water supply infrastructure facilities including the following:

- Intake on the Peace River capable of pumping up to 120 mgd
- Conventional surface water treatment plant capable of producing 48 mgd (finished water)
- 12 million gallons of finished water storage
- High service pumping facilities
- Two raw water reservoirs, one with approximately 0.52 billion gallon (BG) capacity, and another with 6.0 BG capacity
- 21 aquifer storage and recovery wells with average storage capacity of 300 million gallons each (total 6.3 BG theoretical storage capacity)
- Approximately 40 miles of 24-inch- to 42-inch-diameter transmission pipeline
- An additional 25 miles of regional transmission pipeline now under construction

Figure 3-53 shows these facilities in relation to the intake on the Peace River.

Source: PRMRWSA, 2011

Figure 3-53. Surface Water Intake, Treatment, and Water Storage Infrastructure of the Peace River Manasota Regional Water Supply Authority

The PRMRWSA provided a description of river withdrawal operational protocols, summarized as follows:

- PRMRWSA withdrawals from the Peace River are conducted in accordance with the diversion schedule in Special Condition No. 18 of WUP 2010420.006 (as modified 4/26/2011). The schedule is intended to insure that withdrawals do not harm the lower river and the estuary, and in fact the schedule preserves the great majority of river flow to support the estuary.
- Once the sum of flows measured at three USGS gages (Peace River at Arcadia, Joshua Creek at Nocatee, and Horse Creek near Arcadia) upstream of the Peace River Facility intake exceed a prescribed threshold, the PRMRWSA can begin harvest of a small percentage of that flow. Quantities available for harvest at the Peace River Facility are based on the WUP authorized schedule which is consistent with the Minimum Flows and Levels adopted for the Lower Peace River in August 2010. Available quantities are harvested at the intake on the Peace River at rates up to 120 mgd and pumped to Reservoir No. 2 for storage (PRMRWSA, 2011).

Water harvesting occurs only when substantive Peace River flows (i.e., greater than 130 cfs) are occurring. Because of its reliance on the river as a raw water source, the PRMRWSA has contributed to proceedings focused on ensuring protection of both water quantity and quality for this system, and protection of the river and the downstream Charlotte Harbor estuary.

Three of the Applicants' Preferred Alternatives (Desoto, Ona, and South Pasture Extension) would affect portions of the Horse Creek watershed, and at least one offsite alternative (the Pioneer Tract extension of the Ona Mine) would also affect this watershed. Phosphate mining effects that substantively reduced river flow to rates that increased the risk of inhibiting the PRMRWSA's ability to withdraw raw water would be of major concern. Additionally, any substantive change in water quality characteristics of the river water that altered the water treatment plant's ability to achieve potable water standards without treatment system upgrades would be of concern because such changes would impact plant operational costs. Information generated since 2003 by the HCSP monitoring program has been summarized in prior sections of this AEIS (Chapter 3.3.3.1). Additional analysis of the potential effect of the Applicants' Preferred Alternatives on PRMRWSA is discussed in Chapter 4 and Appendix G.

A similar scenario exists with respect to the water supply interests of the City of North Port, which draws water for its water treatment plant from the Myakkahatchee Creek/Cocoplum Waterway. The applicable water use permit conditions provide limitations on raw water withdrawal similar to those of the PRMRWSA's permit. Although none of the Applicants' Preferred Alternatives would impact land areas tributary to this portion of the Myakka River watershed, an offsite alternative (the Pine Level/Keys Tract) has been identified by Mosaic as a likely extension of the Desoto Mine. This tract would affect land areas near the uppermost reaches of the Myakkahatchee Creek watershed. SWFWMD evaluated the North Port withdrawals in its MFL study of the Lower Myakka River and determined that additional flow data were needed to characterize the contributing drainage basin flows (SWFWMD, 2010b). Additional analysis of this offsite alternative is not provided in this AEIS because there is no current application affecting this drainage area and SWFWMD will evaluate it in greater detail in 2015. Again, any potential change in waterway water quality impacting water treatability to achieve potable water standards would be of concern; however, these analyses would be conducted as part of a future application.

3.3.7.7 Public Health

Three specific aspects of phosphate mining have been identified as representing a risk to public health. They include concerns for air quality and noise, radiation, and catastrophic clay settling area dam failures. These topics are addressed in the following sections.

Air Quality and Noise

Air Quality

Air quality and noise concerns related to mining operations are primarily associated with operation of heavy equipment for major earthwork activities associated with land clearing, infrastructure construction, matrix excavation, and final grading in support of mine unit reclamation. The matrix excavation is accomplished by an electric driven dragline, with the other operations using diesel driven earthmoving equipment. The matrix excavation is a wet process. The predominant air pollutant generated during

phosphate mining is particulate matter (PM). Emissions of potentially hazardous air pollutants are generated from the exhaust of fuel-burning equipment, but these are considered of minimal significance and no different than would be associated with any large construction project of similar scale.

In accordance with the requirements of the Clean Air Act (CAA) of 1970, as well as the 1977 and 1990 Amendments (CAAA), USEPA has developed National Ambient Air Quality Standards (NAAQS). These concentration-based standards have been issued for six criteria pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), PM, both with an aerodynamic diameter of 10 microns (PM10) and smaller and with an aerodynamic diameter of 2.5 microns (PM2.5) or smaller; carbon monoxide (CO), ozone (O_3), and lead.

NAAQS consist of primary and secondary standards developed to protect the public from known or anticipated adverse effects associated with the presence of ambient air pollutants. Primary standards are promulgated to protect public health; secondary standards are promulgated to protect public welfare (environmental concerns such as agricultural crops, properties, and so on). States are required to identify areas where NAAQS are being exceeded and to provide a plan to attain the standard by a specified date. Areas not meeting NAAQS are identified as non-attainment areas. *Maintenance area for the 1-hour NAAQS* means an area that was designated non-attainment for the 1-hour NAAQS on or after November 15, 1990, and was redesignated to attainment for the 1-hour NAAQS subject to a maintenance plan as required by section 175A (40 CFR 50.900). Hardee, Manatee, and DeSoto Counties, in which most of the potential phosphate mining expansion is likely to occur in the foreseeable future, are currently classified as attainment areas for all criteria pollutants (Chapter 62-204.340, F.A.C.).

Noise

In general, the outdoor noise environment varies greatly in magnitude and character depending on the time of day, season of the year, human activity, land use, transportation networks, and degree of urbanization, industrialization, and forestation. Residual noise is the relatively constant noise one might hear in a backyard at night, which seems to come from no identifiable direction or source. Daytime residual, or ambient, noise may vary from 33 decibels A-weighted (dBA) on a rural farm to 77 dBA overlooking an eight-lane freeway (Eldred, 1974).

Amplitudes of the various frequencies are electronically weighted to approximate human hearing sensitivity. A decibel is a unit for expressing the relative intensity of sounds on a scale from zero for the average least perceptible sound to approximately 130 for the average pain level. Noise levels have an inverse square relationship to distance; that is, noise dissipates rapidly as distance from the source increases.

The advancement of the mining operations brings with it several sources of mechanical noise. The primary sources associated with this operation include heavy mobile equipment (haulage trucks, scrapers, front-end-loaders, bulldozers, backhoes, or other such equipment), the dragline, maintenance

work (fabrication and repairs), pipeline work (reverberation noise from impact wrenches), diesel pumps and small gasoline engines, air compressors and welding machines, exploratory drill rigs, automobiles, trains, and light trucks. Peak noise levels of heavy mobile equipment used in site preparation for mining are typically around 84 to 91 dBA 50 feet from the equipment (USEPA, 1988a; U. S. Department of Energy, 2003).

Due to the unconsolidated nature of the overburden and the phosphate ore itself, explosives for blasting purposes have not been required. However, the Mine Safety and Health Administration (MSHA) requires that all heavy mobile equipment have back-up alarms. The alarms on the heavy mobile equipment operate only while the equipment is in reverse, and the conveyor start-up alarms operate for a maximum duration of 20 seconds at each start-up. The electric dragline is scheduled to operate 7 days per week and 24 hours per day. Although downtimes occur intermittently for operational and mechanical reasons, start-ups are not frequent. The MSHA regulations require that back-up and start-up alarms be audible enough to be heard over surrounding noise. The perimeter of an active mine area is bordered by a system of ditches, an access road, and, depending on mine block location, varying widths of vegetated buffer.

Radiation

Stakeholders have expressed concern about potential increased exposure to radiation liberated from the ground by phosphate mining, and the subsequent reclamation of mine cuts and clay settling areas. Radiation related to phosphate mining has received substantive scrutiny by regulatory agencies, nongovernmental organizations, the mining industry, and the general public for many years. The material presented below is intended to inform AEIS reviewers of the state of knowledge regarding the natural background radiation levels found in this part of Florida and how those are changed by phosphate ore extraction and subsequent clay settling areas and mine cut reclamation with clay and sand generated during ore beneficiation.

In the context of this AEIS, human exposure to radiation in the CFPD occurs primarily because physical and chemical processes during periods of dramatic sea level changes formed marine deposits that are found in much of the study area and that contain both phosphate and uranium. As uranium decays, daughter nuclides are produced until a stable nuclide is formed (lead). One of the daughter nuclides formed is radium-226, which decays to form radon-222 (radon gas). Radium can concentrate in bone and other tissues when ingested or inhaled, although the primary exposure is by direct gamma radiation emitted by radium-226 from sources outside of the body. Radon enters the body through inhalation and can damage lung tissue upon decay, but radon is an inert gas and its effect is more transitory than that of its solid daughters, like lead-210 and polonium-210, which deposit deep in the lung and deliver radiation for much longer periods.

Uranium concentrations in phosphate ores found in the United States range from 20 to 300 parts per million (ppm), or 7 to 100 picocuries per gram (pCi/g) activity (USEPA, 2012a). Florida topsoil exhibits activities of 1-2 pCi/g of uranium-238 in equilibrium with radium-226, but activities up to 47 pCi/g have been documented in topsoil over undisturbed phosphate deposits. Statistical analysis of 4,852 core samples taken from the first foot of soil on unmined lands by the Florida Department of Health Bureau of Radiation Control indicated an average of 1 pCi/g radium-226, with a standard deviation of 3 and a maximum of 47 (Birky, 2011). It is likely that the highest measurements indicate other disturbances, but measurements in the tens of pCi/g with no indications of disturbance were recorded. Matrix excavation brings material having higher natural radiation levels to the surface in the form of a leach zone, which is a layer of soil immediately above the matrix, and the matrix itself. The industry has, in the past, modified its mining practice by "toe spoiling" the leach zone, which involves placing it in the bottom of the mine pit. Placing the leach zone at a lower elevation than where it had previously been placed reduces its effect on the surface. The subsequent matrix processing during beneficiation results in phosphate being transported to the production facility for fertilizer processing, and a small fraction of the matrix with variable radiation levels remaining in the phosphatic clay.

Background Radiation Exposure

Exposure to radiation happens daily for all persons, through what is called Naturally Occurring Radioactive Material (NORM). NORM is found ubiquitously in the environment; it includes external radiation from solar and cosmic sources, external radiation from radionuclides in soils and rocks, internal exposure from inhalation of radon (and associated decay products), and internal exposure from radionuclides ingested through water, food, or other means (SENES Consultants Limited [SENES], 2011). The typical exposure rate for an average person living in the United States is about 310 millirems per year (mrem/yr), but it does vary based on location and habits (National Council on Radiation Protection & Measurement [NCRP], 2009). Roessler et al. (1980) estimated typical background exposure in Florida to be 200 mrem/yr, with 73 percent of that dose estimated to be from inhalation of radon gas. NCRP (2009) estimated that man-made sources of radiation accounted for a further 310 mrem/yr, bringing the total annual dose to about 510 mrem/yr. The major source of man-made exposure is medical, and is nearly equal to background (SENES, 2011). For comparison, the average total dose for the United States as a whole is 620 mrem/yr (NCRP, 2009). This means that in Florida, the average dose is still less than the average dose for the United States,

Phosphate Mining and Exposure Pathways

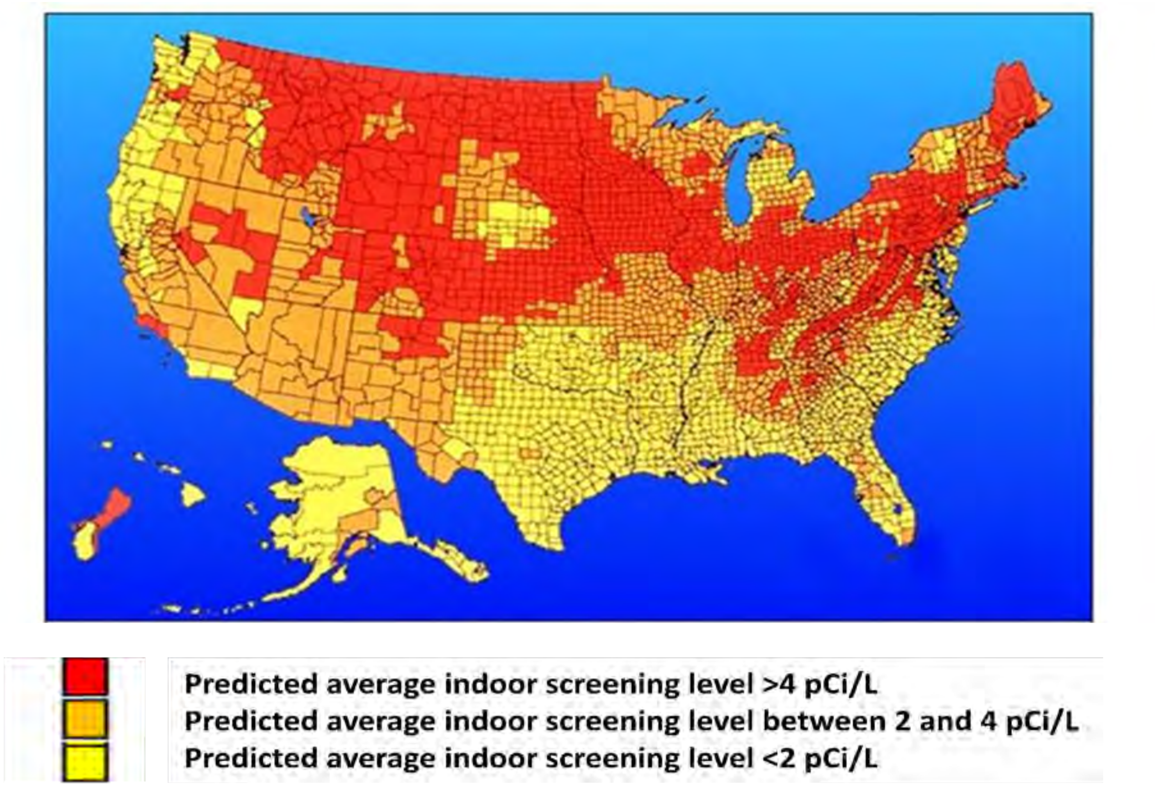
Phosphate mining increases radiation exposure potential when naturally occurring radon/gamma radiation is disturbed by matrix excavation and brought closer to the surface where it can escape to the atmosphere. This is Technologically Enhanced Naturally Occurring Radioactive Material (TENORM). Common exposure pathways include those discussed above as well as transfer of radioactive materials

from soil and water to crops and then to prepared foods, or similarly to forage crops and then to farm animals and food products derived from them. The process of “toe spoiling” the matrix leach zone reduce the future exposure from this source on the reclaimed land to or below pre-mining levels.

Primary Radon Exposure Pathway

Radon in the atmosphere tends to dilute and dissipate from local outdoor areas, but it can concentrate in indoor areas forming a potential health hazard. The primary exposure pathway is through inhalation. USEPA recommends an action level of 4 pCi/L for indoor environments (Price et al., 2007). USEPA (2007a) predicted that average indoor air concentrations for most counties in Florida are less than 2 pCi/L. In comparison, in other parts of the United States, such as northern and western states, concentrations routinely range from 2 to more than 4 pCi/L.

Figure 3-54 shows USEPA-predicted indoor radon concentrations for counties located throughout the United States (USEPA, 2007a).



Source: USEPA, 2007a

Figure 3-54. Predicted Indoor Radon Concentrations in Counties in the United States

Although USEPA predicted no concentrations in Florida over the recommended action level of 4 pCi/L, it is noted that in some areas such concentrations have been documented. The Florida Department of Health (FDOH) has gathered measurements of radon in indoor air of buildings in Florida. SENES' analysis of a combined USEPA and FDOH data set for unattached homes in Florida from 1990 through 2004 found that indoor radon concentrations were most influenced by the underlying natural geology. This analysis revealed a band of higher indoor radon levels from the Gulf of Mexico coast to the center of the peninsula (median values from 0.76 pCi/L to 4 pCi/L), and lowest concentrations along the east coast (median concentrations 0 to 0.75 pCi/L). These findings were consistent with those of earlier studies (GEOMET Technologies Inc. [GEOMET], 1987), which also found variable concentrations throughout Florida, with county averages ranging from 0.3 pCi/L to 3.3 pCi/L and county maximums ranging from 0.7 pCi/L to 32.4 pCi/L.

SENES reported that data from the FDOH database indicated that while radon release from reclaimed phosphate mined lands was higher than from unmined lands, the measured levels of indoor radon concentration were still lower than levels routinely found in unmined areas of the northern or western United States. SENES (2011) also reported that analysis of the FDOH databases showed these levels found in buildings constructed over reclaimed lands were also within the range of values seen indoors in buildings constructed on undisturbed lands. SENES (2011) noted that the Florida Building Code is protective of this exposure pathway, which lowers risk of unacceptable exposure of indoor radiation. Maintaining a higher indoor ventilation rate decreases indoor exposure risk (Guimond and Windham, 1980).

Secondary Exposure Pathways

Soil represents a secondary exposure pathway through ingestion, such as a child eating soil, or contact during outdoor activities. Guidry et al. (1986, 1990) gathered data on radium-226 levels in Florida soils and concluded that reclaimed lands containing clays contained the highest radium-226 levels. These researchers concluded that the difference in radium-226 activities between mined and unmined lands was 5 pCi/g. The SENES (2011) analysis of FDOH data found that the difference was slightly lower, at 4 pCi/g. In contrast, USEPA reported that its review of 30 years of field measurements suggest that Florida phosphate mined areas can have surficial soil levels of radium from 20 to 45 pCi/g higher than unmined areas, which have activities of 1 to 2 pCi/g (Richards, 2012, personal communication). Statistical analysis of 3,087 core samples taken from the first foot of soil on unmined lands by the FDOH Bureau of Radiation Control indicated an average of 6 pCi/g radium-226, with a standard deviation of 6 and a maximum of 63 (Birky, 2011).

Water is another secondary exposure pathway. The primary drinking water standard for radium (inclusive of radium-226 and radium-228) is 5 pCi/L. This means that any municipal drinking water source cannot exceed this level. To assess private wells, Watson et al. (1983) compiled data on the radium-226

concentrations in various drinking water sources in the United States. Concentrations in Florida varied from 0 to 4.1 pCi/L for all municipal and private wells surveyed, except one which exhibited a range of 0 to 76 pCi/L. For surface waters, average values ranged from 0.06 to 5.1 pCi/L (Irwin and Hutchinson, 1976; Kaufman and Bliss, 1977; Fanning et al., 1982). A review of the most recent (2011) FDEP drinking water monitoring data (FDEP, 2011d) showed a range of 0 to 12 pCi/L for radium-226, and a range of 0 to 5.1 pCi/L for radium-228.

Ingestion of fish and waterfowl represent a third potential exposure pathway. Measurements of radium-226 in fish captured from lakes created through phosphate mine reclamation were examined by Grove (2002); no statistical difference in radium-226 was found when compared to fish from non-impacted lakes. Similarly, Montalbano et al. (1983) and Myers et al. (1989) studied the radium-226 dosage from the consumption of waterfowl. Waterfowl from phosphate mining-impacted areas and non-impacted areas were compared. Based on the amount of duck that would have to be consumed (1 to 2 kg per day) to achieve a dose equivalent to the daily consumption of water at the 5 pCi/L limit, the researchers concluded that this does not represent a significant exposure pathway compared to the consumption of ducks elsewhere.

A fourth internal exposure pathway is other food consumption. Guidry et al. (1986, 1990) concluded that plants grown on reclaimed lands exhibited a higher content of radioactive materials (5.2 piC/g radium-226, 8.5 pCi/g lead-210, and 7.5 pCi/g polonium-210 for reclaimed lands versus 0.6 pCi/g radium-226 and below detection for lead-210 and polonium-210 for the control lands) According to this study, a person consuming these plants would have an exposure increase of less than 1 mrem/yr compared to a person who did not consume them. Old clay lands that were not reclaimed had 16 pCi/g radium-226, 23 pCi/g lead-210, and 19 pCi/g polonium-210. A person who included as much food as possible from foods grown on this land (which include 21 crops) would still receive a dose of less than 3 mrem/yr. This increase in exposure is below the USEPA maximum recommended annual dose above background of 15 mrem/yr. This USEPA recommendation is relatively restrictive. In comparison, the maximum recommended annual dose above background is 100 mrem/yr based on recommendations advocated by FDOH, the International Commission on Radiological Protection (ICRP), NCRP, and the Agency for Toxic Substance and Disease Registry (ATSDR, 2006).

Catastrophic Clay Settling Area Dam Failures

There have been a number of documented catastrophic dam failures associated with clay settling area dikes over the course of historical phosphate mining, and such events have been reported to have caused significant pollutant releases contributing to fish kills in impacted waterways. They also represent a risk to human health depending on the locations and circumstances.

The Florida Department of Air & Water Pollution Control, which was the precursor to FDER then FDEP, was established in 1969. Dam failure records since the formation of the agency have been maintained; FDEP provided the following summary of dam failures at phosphate mine clay settling areas, and the associated regulatory changes which have occurred over time:

- Prior to the formation of the agency, there were 26 documented clay settling area dike failures from 1940 through 1967.
- In 1971, a clay settling area owned the Cities Service Company located in Fort Meade, Polk County, failed catastrophically. It resulted in about 2.3 billion gallons of wastewater (historical records) being discharged into the Peace River causing a fish kill.
- In response to the Cities Service dam failure, in 1972, Florida adopted rule (Rule 17-9,F.A.C.) specifying the criteria for construction, operation, maintenance & inspection of engineered earthen dams.
- There were no recorded failures of such impoundments for the next 22 years.
- In October 1994, an internal dam in (IMC's Payne Creek Mine CSA PC-5 failed, which triggered a failure of an external dam wall. This resulted in the release of 2-3 BG of wastewater onto adjacent CF Industries Hardee Mine Complex property. Most of the wastewater was contained in CF Industries mine cuts but approximately 127 million gallons were discharged into Hickey Branch which flows into Payne Creek that empties into Peace River.
- In November 1994, a newly constructed dam at the IMC Hopewell mine failed. Approximately 482 MG were released into old mine cuts, thence over land and through various tributaries into the North Prong of the Alafia River.
- In response to the IMC CSA failures, the Department convened a Technical Advisory Forum (TAF) of experts to investigate the incidents and make recommendations. The TAF attributed the failure of the post-rule Hopewell dam to the construction methodology used in installing the decant spillway structure.
- As a result of the TAF recommendations, in 1999, Rule 62-672 (formerly 17-9) F.A.C., was amended to incorporate improvements in spillway design, an evaluation of all pre-rule dams, and BMPs for non-clay impoundment berms.

No catastrophic earthen dam failures associated with mines have occurred since the 1994 failure at the Hopewell Mine.

3.3.7.8 Recreation

Parks and other recreational facilities maintained by local, regional, and state agencies are important elements of the human environment that could potentially be impacted by phosphate mining and future mine reclamation activities. If proposed mine projects are near existing recreational facilities, effects could be manifested in any of the impacts of mining on the natural systems discussed in previous portions of this chapter. Direct impacts are unlikely because mine siting and mine planning normally avoid mine footprint contact with existing facilities. However, indirect effects could occur and as multiple mine projects are considered that overlap in operational periods, risk of cumulative effects on the physical, chemical, or biological integrity of park and recreational facilities having value to residents and visitors to the lands within the CFPD warrant review.

Recreational facilities in the CFPD generally include parks, boat ramps, campgrounds, golf courses, and other sports facilities such as ball fields and tennis courts. Hunting and fishing opportunities exist on private lands throughout the CFPD, including on the sites of the Applicants' Preferred Alternatives. The northern portion of the CFPD has a greater abundance of recreational facilities than the southern portion.

The following Florida Geographic Data Library (FGDL) databases were reviewed to identify the recreational facilities that currently exist within the vicinities (1-mile radius) of the Applicants' Preferred Alternatives:

- Golf Courses 2009 (par_golf_09)
- Florida Parks and Recreational Facilities 2009 (gc_parks_mar09)
- FFWCC Management Areas (fwcmas_2010)
- Florida Managed Areas – June 2011 (flma_jun11)
- Existing Recreational Trails in Florida – February 2012 (existing_trails_feb12)

Based on these databases, no recreational facilities currently exist within 1 mile of the Desoto Mine, Ona Mine, or South Pasture Extension sites. The database review indicated that the following three recreational facilities currently exist within 1 mile of the Wingate East Mine site:

- Duette Park – adjacent to the Wingate East Mine site
- Duette Park Trail – adjacent to the Wingate East Mine site
- Mason Jenkins Conservation Easement (Florida Managed Area) – adjacent to the Wingate East Mine site

As an element of its community service programs, Mosaic has worked on integrating land and lake reclamation strategies into recreational facilities valued by the counties. In a number of cases, these arrangements have resulted in positive outcomes where the industry reclamation objectives are met concurrently with development of lakes and associated park facilities supporting local and regional community use of the sites.

Examples of mine reclamation efforts leading to development of parks and recreational facilities are briefly summarized below:

- Hardee Lakes Park: This is a 732-acre park in Sections 1, 2, 11, 12, and 13; Township 33S, Range 23E in Hardee County. The area was mined from 1989 to 1992. Site contouring, grading, and revegetation occurred in 1992 and the reclamation project was released by the USACE and FDEP in 2000. The lands were donated to Hardee County as a recreational area, with a conservation easement placed on the wetlands adjoining the floodplain. The site includes two lakes totaling approximately 205 acres; boat ramps and nature paths/boardwalks were incorporated into the facility design to promote recreational uses.
- Bunker Hill Community Park: This project site occupies approximately 75 acres of reclaimed phosphate mine lands. The site is in Sections 23 and 25, Township 33S, Range 21E in Manatee County. Mined in 2003, the reclamation efforts were completed in 2005, and the reclamation project was released by FDEP and the county in 2010. Bunker Hill Park was designed in collaboration with the county Parks and Recreation Department to provide park facilities to the Duette Community. Facilities incorporated into the final design included a baseball field, soccer/open play field, a 19-acre lake, canoe launch and dock area, picnic areas, parking/paved driveway, restroom facilities, and an irrigation system to support the landscaping and sports field maintenance.
- Edward Medard Park: This park is the result of a non-mandatory phosphate mine reclamation currently owned and managed by Hillsborough County and SWFWMD. This recreational park consists of 1,284 acres, with a water control structure/reservoir that is available for canoeing, boating and catch and release fishing. It also provides flood protection along the Alafia River.
- Alafia River State Park: This state park in Hillsborough County is owned by the state and managed by the Florida Park Service. It consists of more than 6,000 acres of both mandatory and non-mandatory reclaimed phosphate mine lands that offer off-road bicycling trails as well as equestrian and hiking trails. The park also offers picnic pavilions, a playground, horseshoe pit, volleyball court, and a full-facility campground for both primitive and recreational vehicle (RV) camping.

Many who provided comments during the AEIS scoping process alluded to their use of mine reclamation sites to support fishing and hunting activities, and in at least some cases, recreational opportunities can take the form of the above types of broader facility development to support targeted communities.

3.3.7.9 Cultural/Historic Resources

This section provides an overview of cultural and historic resources studies that have been conducted in the CFPD at locations relevant to the Applicants' Preferred Alternatives. Some field investigations have included study areas within the boundaries of the sites of the Applicants' Preferred Alternatives or have included at least part of these sites. Others have been conducted at nearby phosphate mine locations in the CFPD.

Investigations performed by consultants working on behalf of Mosaic at the Desoto and Wingate East mine sites were submitted to the State Historic Preservation Officer (SHPO) for review. Surveys on the Wingate East Mine site identified areas that may have cultural resources potentially eligible for listing on the National Register of Historic Places (NRHP) that would likely be impacted by mining. The study recommended that Phase II documentation be conducted to determine eligibility. For the Desoto Mine site, the studies documented four sites eligible for listing on the NRHP; these sites would be avoided by any proposed mining activities. Site investigations at the Ona Mine site found one site (8HR880) identified as warranting further study. Similarly, investigations performed by consultants working on behalf of CF Industries were provided to and reviewed by the SHPO. One prehistoric archaeological site (Turkey Feeder Site) was identified as potentially eligible for listing in the NRHP. Phase II testing would be required if future work were to include disturbing this site; however, current mine plans prepared by CF Industries do not include disturbance of this area.

The list of documents reviewed and general study findings reported by the respective investigators are summarized in Tables 3-36 and 3-37. The tables identify the Florida Master Site File (FMSF) number, title of the report, author, date of the report, the county where the study was conducted, and the results of the study. The results column includes a brief description of the type of resources that were found. The final column in the table describes whether the archaeological resources (Table 3-36) or historic resources (Table 3-37) found were considered eligible or ineligible for listing on the NRHP.

While there have been numerous archaeological studies conducted in the CFPD, many of the studies listed in Table 3-36 were conducted prior to 1990, a period when standards of archaeological studies based on NRHP methods were not consistent. Many of these surveys were pedestrian, surface studies; no subsurface shovel tests were performed. New surveys would be conducted 1 year prior to the start of any construction at the Applicants' Preferred Alternatives.

Table 3-36. Representative Archaeological Site Studies in the AEIS Study Area						
FMSF Report #	**Title**	**Author**	**Date**	**County**	**Results**	**NRHP Eligibility* as determined by the FMSF**
Reports Pertinent to the Desoto Mine and/or Pine Level/Keys Tract						
493	Amax Pine Level Survey-An Archaeological and Historic Survey of AMAX Property in Manatee and Desoto Counties, FL	Raymond F. Willis	1979	Manatee and DeSoto	56 Sites tested; 6 known MA sites examined, 2 deemed non - existent; 1 DE site (burial mound - 8DE2) relocated; 11 new sites (numbered #1 – 11)	Mitigated burial mound (8DE2), Not evaluated; APLS Site #1 (8MA64), #4, #5, #8, and #9 eligible; 8DE14, eligible
898	Archaeological Testing and Evaluation of Seven Sites Located on AMAX Property, Manatee and Desoto Counties, FL	Piper Archaeological Research	1981	Manatee and DeSoto	8MA181, Site #15, #16, #18 tested; 8DE4, 8DE8, 8DE9 tested (Phase II)	#15 and 8MA181 eligible
18633	Photographs of Pine Level (APLS #29 and AMAX) Description of Photo Locations	Uebelhoer, Gary	1982			
5714	A Cultural Resource Assessment Survey of IMC-Agrico Company's Pine Level Mine Amendment DRI, Desoto Co, FL	Southeastern Archaeological Research, Inc.	1999	DeSoto	1 pre-historic site: 8DE445	Ineligible
19267	Additional Testing of Five Sites in the Desoto Mine	Janus Research	2012	DeSoto	8DE14, 8DE310-8DE34; new sites found: 8DE50 and 8DE51	8DE14 is eligible; 8DE31-34 should be preserved; 8DE50 and 8DE51 are not eligible
Reports Pertinent to the Ona Mine and/or Pioneer Tract						
60	Archaeological and Historical Resources of the Carlton Ranch, Limestone and Oliff Properties, Hardee Co, FL	Jerald Milanich	1975	Hardee	7 pre-historic, no site numbers given in report	8HR5 mitigated, excavated in 1982. 8HR31: Not evaluated by SHPO
65	Archaeological and Historical Resources of the Farmland Industries, Inc. Property, Hardee Co, FL	Raymond Willis	1977	Hardee	12 pre-historic; 8HR53-61, 8HR31, 38, 40	Not evaluated by SHPO
256	Archaeological and Historical Survey of Farmland's Phosphate Plant Site, Hardee Co, FL	Raymond Willis	1979	Hardee	No historic properties identified	N/A

Table 3-36. Representative Archaeological Site Studies in the AEIS Study Area

FMSF Report #	Title	Author	Date	County	Results	NRHP Eligibility* as determined by the FMSF
5078	Limited Excavations at 8HR5 and Archaeological Sites Located on Mississippi Chemical Corporation Property in Hardee Co, FL	Piper Archaeological Research	1982	Hardee	8HR5	Mitigated, Not evaluated
2502	Cultural Resource Assessment Survey of a 1000 Acre Addition to Agrico Chemical Company's Proposed Phosphate Mining Area, Hardee Co, FL	Robert Austin	1990	Hardee	6 pre-historic sites identified; 8HR87-92	8HR87-HR91 Ineligible: 8HR92 Insufficient information
4690	Archaeological Investigations at Two Sites (8HR82 & 8HR87) on IMC/Agrico Company's Fort Green Mine Southern Reserve, Hardee County, FL	Janus Research	1995	Hardee	2 sites tested	8HR82 & 8HR87 Ineligible
FMSF number unknown	Phase II Study of Site 8HR87 at Agrico Chemical Company's Proposed Phosphate Mining Area, Hardee Co, FL	Janus Research	1995	Hardee	8HR87 testing	Ineligible
5096	Assessments of Past Cultural Resource Surveys of the Pine Level and Ona Mines in Hardee, Manatee, and DeSoto Counties, FL	Janus Research	1997	Hardee and DeSoto	Review of past reports	N/A
5709	A Cultural Resource Assessment Survey of IMC-Agrio's Co.'s Ona Mine DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	1999	Hardee	Sites 8HR702-712 identified. 8HR445 and 8HR762 identified.	8HR702-HR712 Ineligible
6121	A Cultural Resource Assessment Survey of Six Additions to IMC-Agrico Company's Ona Mine DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	2000	Hardee	2 prehistoric sites identified 8HR733 and 8HR761	Ineligible
FMSF number unknown	Final Report, Ground Penetrating Radar (GPR) Survey IMC Agrico Ona Mine Site Hardee Co, FL	Janus Research	2000	Hardee	Multiple anomalies from GPR	N/A

Table 3-36. Representative Archaeological Site Studies in the AEIS Study Area

FMSF Report #	Title	Author	Date	County	Results	NRHP Eligibility* as determined by the FMSF
6160	Cultural Resource Assessment Survey of the Special Phase I Historical and Archaeological Survey for the Ona Mine Areas, Hardee Co, FL	Janus Research	2001	Hardee	22 prehistoric sites identified, 8HR767-777,779-783, 790-793, 795, 797-799	8HR767-768: Not Evaluated; HR769-HR77, HR779-HR783; HR797-HR799: Ineligible
Reports Pertinent to the Wingate Creek/Wingate East Mine						
16538	Archaeological Testing at the Pizo 1113 Site 98MA125) in Manatee County	PanAmerican Consultants	2008	Manatee	8MA125 lacks research potential	8MA125 ineligible
DHR Project File No. 992549	Phase II Archaeological Testing at the Marinkovic-Rosorough Mound (8MA1013), Manatee Co, FL	Janus Research	1999	Manatee	Phase II testing	8MA1013, Human remains
6958	A Cultural Resource Assessment Survey of the Moody and Badcock Properties, Manatee Co, FL	Southeastern Archaeological Research, Inc	2002	Manatee	2 prehistoric sites identified, 8MA1243-1244	Ineligible
14643	A Cultural Resource Assessment Survey of the Texaco Tract for the Wingate Corridor Project, Manatee Co, FL	Southeastern Archaeological Research, Inc	2007	Manatee	No historic properties identified	N/A
14873	A Cultural Resource Assessment Survey of the Texaco Tract, Manatee Co, FL	Southeastern Archaeological Research, Inc	2007	Manatee	5 pre-historic sites identified, 8MA1513-1517	Ineligible
Reports Pertinent to the South Pasture/South Pasture Extension						
334	An Archaeological and Historical Survey of the CF Industries Inc. Property in Northwestern Hardee Co, FL	Lewis N. Wood, Jr.	1976	Hardee	12 pre-historic: 8HR9-12, 8HR14-20	8HR9, 8HR15-19; refer to testing results conducted in 1994: Ineligible
6825	Cultural Resource Assessment Survey of 438.7 Acres Located in the South Pasture Area of the CF Industries, Hardee Phosphate Complex Property, Hardee Co, FL	Archaeological Consultants, Inc.	2001	Hardee	No historic properties identified	N/A

Table 3-36. Representative Archaeological Site Studies in the AEIS Study Area

FMSF Report #	Title	Author	Date	County	Results	NRHP Eligibility* as determined by the FMSF
11335	A Cultural Assessment of 40 Acres located in the South Pasture Study Area of the CF Industries, Hardee Phosphate Complex Property, Hardee Co, FL	Archaeological Consultants, Inc.	2002	Hardee	No historic properties identified	N/A
9175	A Cultural Resource Assessment Survey of CF Industries, Inc.'s South Pasture Mine Extension DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	2003	Hardee	1 pre-historic site identified: 8HR831	Ineligible
Reports Pertinent to Other CFPD Areas						
FMSF number unknown	Test Excavations at the Little Payne Mining Tract Site (8PO207). Located on the Gardinier Fort Meade Mine Extension, Polk Co, FL	Piper Archaeological Research	1990	Polk	Phase II testing	8PO207 Ineligible
106	Archaeological and Historic Resources within the Little Payne Mining Tract	Batcho & Milanich	1978	Polk		8PO207 Not evaluated
2765	Cultural Resources Assessment Survey of the IMC-Fertilizer Four Corners Mine Substantial Deviations DRI Number 198 Project Area, Manatee Co, FL	Piper Archaeological Research	1991	Manatee	1 pre-historic site identified; 8MA806	Ineligible
3298	Cultural Resources Assessment of Five Additional Parcels to be Added to the IMC Fertilizer Inc., Hillsborough Co Mines DRI #213, Hillsborough Co, FL	Piper Archaeological Research/Janus Research	1992	Hillsborough	3 pre-historic sites identified: 8HI5014-5016	Ineligible
DHR Project File No. 986804	Phase II Investigations of 8HI3792 and 8HI3797, Hillsborough Co, FL	SouthArc Inc.	1998	Hillsborough	Phase II testing of 8HI3792 and 8HI3797	Ineligible
2426	Cultural Resource Assessment Survey of IMC Fertilizer IMC Extension	Piper Archaeological Research	1990	Hillsborough	8HI3786 through 8HI3868	

Table 3-36. Representative Archaeological Site Studies in the AEIS Study Area

FMSF Report #	Title	Author	Date	County	Results	NRHP Eligibility* as determined by the FMSF
5256	Cultural Resource Assessment Survey of the IMC-Agrico Company's Four Corners Mine DRI Amendment Areas in Manatee Co, FL	Janus Research	1998	Manatee	9 prehistoric sites identified, 8MA1010-1018; human remains found at 8MA1013	8MA1011-12 & 8MA1014-18 Ineligible, 8MA1013 Human remains
5620	A Cultural Resource Assessment Survey IMC Reynolds Property Hillsborough Co, FL	Archaeological Consultants, Inc.	1999	Hillsborough	No historic properties identified	N/A
9362	Cultural Resource Assessment Survey of the South Fort Meade Mine, Hardee Co Extension, Hardee Co, FL	Janus Research	2003	Hardee	27 prehistoric sites identified, 8HR140-144, 372-373, 698, 803-821	Ineligible
10916	Cultural Resource Assessment Survey of the Jaeb Property IMC Hopewell Mine Site, Hillsborough Co, FL	Janus Research	2004	Hillsborough	2 prehistoric sites identified, 8HI9706-9707	Ineligible
10749	A Cultural Resource Assessment Survey of the Lipman and Lipman Property, Four Corners Mine Site, Manatee Co, FL	Janus Research	2004	Manatee	8MA1359	Ineligible
12039	Addendum to the Archaeological and Historical Survey of the Mosaic 9 Parcels DRI Project Area in Hillsborough Co, FL: An Archaeological and Historical Survey of Mosaic Parcel 4b	PanAmerican Consultants, Inc.	2006	Hillsborough	No historic properties identified	N/A
14640	Cultural Resource Assessment Survey of the South Fort Meade Mine, Second Addendum, Hardee Co, FL	Janus Research	2007	Hardee	1 prehistoric site identified, 8HR868	Ineligible
16363	An Archaeological and Historical Survey of the G&D Farms Project Area in Manatee Co, FL	PanAmerican Consultants, Inc.	2008	Manatee	8MA1463	Ineligible

Note:

Some FMSF numbers unknown = file report provided by Applicants.

Table 3-37. Summary of Representative Historical Structure Site Investigations in the AEIS Study Area

FMSF Report #	Title	Author	Year	County	Results	NRHP Eligibility
Reports Pertinent to the Ona Mine and/or Pioneer Tract						
5709	A Cultural Resource Assessment Survey of IMC-Agrico Co.'s Ona Mine DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	1999	Hardee	Historic structure	Not eligible
5709	A Cultural Resource Assessment Survey of IMC-Agrico Co.'s Ona Mine DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	1999	Hardee	Historic Windmill	Not eligible
5709	A Cultural Resource Assessment Survey of IMC-Agrico Co.'s Ona Mine DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	1999	Hardee	3.3.8 Historic Bridge	3.3.9 Not eligible
5709	A Cultural Resource Assessment Survey of IMC-Agrico Co.'s Ona Mine DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	1999	Hardee	Historic Tram	Not eligible
5791	A Cultural Resource Assessment Survey of Two Additions to IMC-Agrico Co's Ona Mine DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	1999	Hardee	Historic House	Not eligible
Reports Pertinent to the South Pasture/South Pasture Extension						
5673	A Cultural Resource Assessment Survey of CF Industries, Inc's South Pasture Mine Extension DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	1999	Hardee	Windmill in Ruinous Condition with Cistern; HR 714	Not eligible
5673	A Cultural Resource Assessment Survey of CF Industries, Inc's South Pasture Mine Extension DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	1999	Hardee	Intact windmill with cistern; HR 715	Not eligible
5673	A Cultural Resource Assessment Survey of CF Industries, Inc's South Pasture Mine Extension DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	1999	Hardee	Windmill (Frame only); HR 716	Not eligible
5673	A Cultural Resource Assessment Survey of CF Industries, Inc's South Pasture Mine Extension DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	1999	Hardee	Windmill (dismantled, portion of frame remains); HR 717	Not eligible
5673	A Cultural Resource Assessment Survey of CF Industries, Inc's South Pasture Mine Extension DRI, Hardee Co, FL	Southeastern Archaeological Research, Inc	1999	Hardee	Intact Windmill; HR 718	Not eligible

Table 3-37. Summary of Representative Historical Structure Site Investigations in the AEIS Study Area

FMSF Report #	Title	Author	Year	County	Results	NRHP Eligibility
Reports Pertinent to Other CFPD Areas						
6958	A Cultural Resource Survey of the Moody and Badcock Properties, Manatee Co, FL	Southeastern Archaeological Research, Inc	2002	Manatee	ca 1920s frame vernacular house, 8MA1242, Moody and Badcock Property	Not eligible
6958	A Cultural Resource Survey of the Moody and Badcock Properties, Manatee Co, FL	Southeastern Archaeological Research, Inc	2002	Manatee	Old Highway/Carlton Road; 8MA1245; Moody and Badcock Property	Not eligible
10936	Cultural Resource Assessment Survey Of The Gooch Property: IMC Hopewell Mine Site, Hardee Co, FL	Janus Research	2004	Hardee	Windmill built; 1950, 8h19708, Gooch Property	Not eligible
1209	An Archaeological and Historical Survey of the Mosaic 9 Parcels DRI Project Area in Hillsborough County, FL	PanAmerican Consultants	2005	Hillsborough	Earl Reynolds Sugar Cane Syrup House; 8HI9969	Eligible under Criterion C
7323	Cultural Resources Survey (Section 106 Review) East Wauchula Tower Site 3419, State Road 64 East Wauchula, Hardee County, Florida	Access Environmental Associates, Inc.	2002	Hardee	No historic properties identified	N/A
9362	Cultural Resource Assessment Survey of the South Fort Meade Mine, Hardee Co Extension, Hardee Co, Florida	Janus Research	2003	Hardee	HR750; HR751, 27new sites 8HR140-144; 8HR372-373; 8HR698, and 8HR803-821	Not eligible
9142	Cultural Resource Reconnaissance Survey Section 106 Review Proposed Myakka City Communication Tower Site, Manatee County, Florida	Archeological Consultants, Inc.	2003	Manatee	8MA863	Eligible under Criterion A

Note:

Some FMSF numbers unknown = file report provided by Applicants.

The NRHP criteria are designed to guide state and local governments and federal agencies in evaluating potential listing in the NRHP. The significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess

integrity of location, design, setting, materials, workmanship, feeling, and association and that meet one or several of the following criteria:

- Criterion A: Are associated with events that have made a significant contribution to the broad patterns of our history; or
- Criterion B: Are associated with the lives of persons significant in our past; or
- Criterion C: Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- Criterion D: Have yielded, or may be likely to yield, information important in prehistory or history.

Ordinarily, cemeteries, birthplaces, or graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years are not considered eligible for the NRHP (National Park Service, 2012).

These studies have documented widespread evidence of man's historical use of the study area for temporary hunting sites and more permanent camps. These results are not surprising considering the broad range of historical habitation of the Florida peninsula by Native Americans and European settlers over time. Many of these sites are found along or near natural waterways supporting hunting and fishing activities. Most of the sites in the CFPD have been determined as ineligible for inclusion on the NRHP.

A review of historic structures reports on sites located in the CFPD was conducted to determine whether any NRHP-eligible structures would potentially be impacted by offsite alternatives. The historic structures reports reviewed and the findings of the surveys are listed in Table 3-37. One structure in the study area was determined NRHP-eligible under Criterion C. On the basis of this review, there does not appear to be a high probability of the presence of significant historical structures in the AEIS study area that will need to be protected from phosphate mine development in the future. Prior to future construction, a survey may be needed to determine whether any structures exist in the project area that have reached 50 years of age since the last surveys were conducted.

3.3.7.10 Aesthetics

The CFPD study area is characterized by prevailing flat terrain. The aesthetic quality of the area is defined primarily by land use and land cover, vegetation, and historic resources, and is described in the context of those resource categories. Minimal aesthetic impact concerns are anticipated for any of the

Applicants' Preferred Alternatives so long as adequate berms and setbacks or buffers are maintained. Relative impacts of phosphate mining are discussed further in Chapter 4.

3.3.7.11 Transportation

Phosphate mining operations require development and maintenance of infrastructure corridors connecting the active mine cut areas to the beneficiation plant to which the mined matrix is conveyed via pipeline and hydraulic pumping of slurried materials. These corridors include access roadways and dragline walking paths. Thus, internally within the subject mines, a transportation plan is part of the overall mining and reclamation plan. Most of the roadway networks in the mines consist of dirt or shellrock roads.

At times, mining operations abut and cross over existing county or state highways. Under those situations, close industry coordination with the applicable county or regional transportation planning and management agencies is required. Crossings requiring disruption of existing vehicular traffic patterns are minimized to the extent practicable; local and regional transportation impacts from the mining operations themselves are not viewed as a major issue.

Where new mining operations are planned that are relatively independent of past mining activities, changes in local and regional traffic patterns and vehicle trip totals will occur. In some cases, new phosphate mines will require siting, design, and construction of new railroad connections to allow effective transport of phosphate rock generated through beneficiation out of the area to the applicable fertilizer manufacturing facilities.