

Rock Mining in the Everglades Agricultural Area: *An Inventory of Existing Resources and Assessment of Impacts*



Prepared by
Clean Water Fund
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Clean Water Fund (CWF) is a national 501 (c) 3 research and education organization that has been promoting the public interest since 1978. Clean Water Fund supports protection of natural resources, with a special emphasis on water quality and quantity issues. CWF's program builds on and compliments those of Clean Water Action. CWF's organizing has empowered citizen leaders, organizations and coalitions to improve conditions in hundreds of communities, and to strengthen policies at all levels of government, from local to national.

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Clean Water Action (CWA) is a national 501 (c) 4 environmental organization with more than 1.1 million members nationwide, including 25,000 in Florida. Clean Water Action works for clean, safe and affordable drinking water, prevention of health-threatening pollution, creation of environmentally-safe jobs and businesses, and empowerment of people to make democracy work. CWA organized strong grassroots groups, coalitions, and campaigns to protect our environment, health, economic well-being, and community quality of life.

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EXECUTIVE SUMMARY:

The Everglades Agricultural Area (EAA) is a valuable and highly sensitive region of Palm Beach County located directly south of Lake Okeechobee. Rock mining is a hotly debated and multi-faceted issue, one which has major long-term implications for Palm Beach County's drinking water supply, environmental health, and economy. In recent years, nearly 20,000 acres of rock mines have been approved in a piecemeal fashion without taking a comprehensive and scientific review of the impacts. As a result of pressure from the environmental community, Palm Beach County recently made the wise decision to enact a one-year moratorium on new rock mining initiatives effective September 2010. Clean Water Fund believes that now is the time to move forward with a thorough investigation and analysis of potential impacts of rock mining to assure that a set of amended zoning regulations or amendments to the land use code adequately ensure that new mines are sited in environmentally appropriate locations.

Given the extensive price of conducting a cumulative impact analysis - previously estimated by Palm Beach County to cost upwards of \$6 million - Clean Water Fund and its partners have conducted an analysis of the existing scientific data on the demonstrated and potential impacts of rock mining in the EAA. The goal of this project is to formulate a comprehensive bibliography provided by a wide range of stakeholders, and present a cohesive document that can aid in the county's decision-making process.

Among the potential threats posed by rock mining are damage to the aquifer, contamination of water supply, and interference with the investments in Comprehensive Everglades Restoration. Each of these topics have been researched and analyzed in this document to better determine what applicable information is already available as presented by the scientific community, and which further research projects would be most beneficial and cost-effective in order to achieve an appropriate groundwork of knowledge to enable smart decision-making. After reviewing existing scientific studies included in this report, Clean Water Fund believes that over the next year we may need to invest in a few targeted scientific studies to fill data gaps.

The results of this analysis have confirmed previous assessments that the issue of rock mining in the Everglades Agricultural Area is multifaceted and highly scientific. Findings of this project are as follows:

- Aquifer conditions in the EAA are unpredictably porous and prone to structural damage; it is difficult to forecast this structural damage on a case-by-case basis.
- Groundwater seepage flow through the limestone aquifer is a vitally important yet sensitive process that provides Floridians with clean drinking water; structural damage to the aquifer could interrupt this natural flow and cause regional harm.

- On average, existing rock mines in the EAA are approximately 40 feet deep; this level of intrusion will affect the interaction between groundwater and surface water, and can lead to dangerous increases in salinity levels that will leave drinking water for Palm Beach County at unacceptable levels by EPA standards.
- Excavated mines are not safe for water storage, as contamination is likely.
- The toxins used in rock mining can have serious – potentially even fatal – impacts on the Everglades ecosystem and its native wildlife.
- State and federal agencies have determined Everglades Restoration (CERP) projects to be of fundamental importance with regard to storing and treating water for the entire state. Palm Beach County must ensure that rock mining does not interfere with currently planned or future CERP initiatives.

This report has reaffirmed what the environmental community has been saying for several years; there is enough documented evidence in the available body of scientific research to determine that rock mining has a detrimental effect on our water supply and impedes Everglades Restoration. However, there are some critical data gaps that we need to fill before recommendations for zoning or land use changes are adopted.

Clean Water Fund's initial recommendations for further research based on these results are listed below. While we do not have the expertise to provide cost estimates for the completion of these analyses, it is clear that the information these studies will provide is vital to the creation of an adequate zoning regulatory framework.

- Use of geophysical tools to provide specific and accurate images of the aquifer's structure within the potentially-affected radius of land surrounding proposed new mine locations. This will help ensure that those areas determined to be least stable, and thus most at risk for structural damage, be protected from excavation.
- Utilize spatial modeling programs to forecast cumulative impacts of mining over specific increments of time (five years, twenty years, fifty years). It is essential to understand the maximum amount of impact stress that the aquifer can handle before withstanding serious and irreversible structural damage.
- Further investigation into possible interference with CERP initiatives, not only considering availability of lands but also contamination of water supply that will be vital to restoring flow and ecosystem health to the River of Grass.
- Economic analysis of the value of a clean drinking water supply for Palm Beach County versus the economic gains of the rock mining industry. It is important to understand that while this business may boost local economy in the short-term, potential long-term damage to the County's primary source of drinking water will prove to be markedly more costly if chemical contamination does take place.

INTRODUCTION:

The Everglades Agricultural Area (EAA) is a valuable and highly sensitive region of Palm Beach County located directly south of Lake Okeechobee. This area historically formed the northern Everglades, and naturally transmitted floodwaters from the lake southward through a slow-moving water purification system referred to as the “river of grass.” Today, one-fourth of the total historic Everglades lands are in agricultural production within the 1,000 square mile EAA, where sugar cane and vegetables are harvested on the rich peat soils of drained sawgrass marshes (EPA 2007, p. 12).

The EAA is a hugely strategic location for water storage and treatment in connection with the Comprehensive Everglades Restoration Plan (CERP). As County staff has acknowledged, the Palm Beach County Master Plan contains inadequate and incomplete objectives and policies to balance the varying and competing interests at stake in the EAA. As the various demands on this critically important region increase, a more comprehensive method of planning and zoning for its future must be established.

In addition to the creation of a comprehensive vision and plan for the Everglades Agricultural Area, more stringent regulatory mechanisms are also needed to deal with both the approval and expansion of large-scale mining initiatives. Rock mining has the most potentially detrimental impacts among the existing activities within the EAA, and its long-term impacts are not yet fully understood. Cumulative impacts of mining - both above and below ground - are unknown and complex. However, County staff has previously deemed a thorough scientific analysis of these impacts too costly.

Despite the potential threats posed to the health of the EAA and the drinking water of Palm Beach County, mining continues to be the only activity in the region without a dedicated land use category. Currently, there is no framework in place that requires a comprehensive assessment of mining applications. Instead, mining operations are considered on a case-by-case basis. In recent years, nearly 20,000 acres of rock mines have been approved in this piecemeal manner.

Palm Beach County must act now to establish a comprehensive regulatory framework for the approval of new mines to ensure that the EAA and aquifer are not permanently impacted. However, the full impacts of multiple large-scale mining operations are not yet fully understood, and a cumulative impact study has not been conducted in the EAA. Nevertheless, a wealth of scientific information does exist that can guide the content of zoning regulations to govern the siting of new mines. Among the issues addressed by existing science are: hydrologic impacts of drilling into the porous aquifer, potential groundwater contamination that will adversely impact the health of the county’s drinking water supply, and conflicts with state and federal Everglades Restoration initiatives.

This document seeks to identify the potential cumulative mining impacts in the EAA. By reviewing existing science from a variety of sources, this report combines best available information into a single, cohesive document in the hopes that a more enlightened method of comprehensively planning and zoning for rock mining can be established.

AQUIFER SEEPAGE: EXISTING CONDITIONS AND POTENTIAL IMPACTS

An aquifer is an underground layer of water-bearing permeable rock from which groundwater can be extracted. In Florida, carbonate-rock aquifers consist of limestone and sandshell that are very permeable and of high transmissivity (USGS 2009). Aquifer conditions within the Everglades Agricultural Area are shallow, highly mineralized, and begin at a below surface depth of six to ten feet (EPA 2007, p. 34). Underground aquifers function as the reservoirs for Florida's natural water filtration systems, and provide nearly 100% of the state's drinking water (University of Florida 2003). One potential impact of large-scale rock mining - and one that has raised concerns with experts over recent years - is the potential for the cumulative impact of multiple mines to adversely and permanently alter the structure of the porous aquifer, resulting in seepage that may cause local or even regional harm.

There are uncertainties present with assessing vulnerability to the aquifer. For one, "an inherent assumption with a finite-difference ground-water model is that the aquifer can be treated as an equivalent porous medium; namely, the aquifer is formed of porous material, in which void space is uniformly distributed" (Renken *et al* 2005, p. 320). In actuality, the void space is not uniformly distributed and is difficult to accurately assess; thus, evaluations of water flow and aquifer structure can be marked with uncertainty. This difficulty is heightened by the fact that the extent of porosity is extremely difficult to determine on a site-specific basis. While visual examination, use of geophysical tools, or measurements of core samples can provide estimates, these may differ from the actual porosity levels and those used in water flow models (Renken *et al* 2005, p. 321).

Additionally, "any measure of permeability is a function of the size of your test" (Van Lent 2009, p. 68). Thus, the impacts of a mine on the aquifer are not be determined by the porosity of lands directly being mined alone. Rather, the porosity of land adjacent to these mines is just as important - if not more so - to predicting the outcome of allowing multiple deep mining operations over long periods of time. This is the most effective indicator of the vulnerability of the aquifer's structure given its uneven distribution of void space. When land directly impacted by mining is removed, it is essential to know what the aquifer makeup of the surrounding area looks like in order to make a determination of what the integrated effect will be (Van Lent 2009, p. 70). It is difficult if not impossible to predict which particular mine will cause the fundamental damage to the aquifer that will inevitably occur if long-term mining continues to blast its unevenly porous structure:

"It's very difficult to make a determination on every single action. It's the equivalent of if you were in an airplane, and the rivets are invaluable, and you start ripping off the rivets. It's hard to know whether any given rivet will be the one that will cause the plane to crash. I do know that if I have enough rivets removed, the plane will crash. I'm focused on the end state: removing a lot of rivets will cause a pretty serious impact" (Van Lent 2009, p. 72).

Because of the difficulty in accurately determining the vulnerability of the aquifer, the need for a comprehensive analysis of this issue is particularly important. Each individual rock mine, with an average depth 40 feet, will interact with the aquifer and thus with Palm Beach County's valuable drinking water supply (Palm Beach Aggregates 2001). What remains unclear, however, is the collective toll that many deep rock mines will have on the porous aquifer over an extended period of time; it is exceedingly difficult to accurately predict regional impacts on a case-by-case basis.

If large-scale mining continues, potential structural damage to the aquifer can result in the modification of groundwater seepage flow through the pores of limestone and sandshell. The natural seepage rate of an aquifer system can be estimated if the soil's intrinsic permeability and hydraulic conductivity are known (Bear 1972). However, without fully understanding the structural impacts that mines will have on the aquifer, it is not possible to calculate how this essential flow of water will be impacted. The continuation of the natural seepage rate is essential to maintaining balance for the health of EAA and the supply of clean drinking water for Palm Beach County. If deep portions of land continue to be excavated in the mining process, the natural seepage rate could see a significant increases, resulting in "potential increased demand for water on the regional system, possibly adversely affecting marsh hydro-periods and depths in nearby wetlands" (Van Lent 2008, p. 3). Increased seepage was witnessed as an impact of rock mining in Miami-Dade's Lake Belt; this serves as a strong indicator of potential outcomes in the EAA (Fish and Stewart 1991; Scott 1977; Van Lent 2010).

While uncertainties remain regarding the potential long-term aggregate impacts of rock mining to the aquifer, two important facts are known:

- 1) The limestone aquifer system in the Everglades Agricultural Area is highly porous and thus potentially prone to structural damage from continued excavation.
- 2) Increased seepage flow is a possible outcome of this structural damage and would directly impact local or even regional water supplies in Palm Beach County.

The only way to appropriately account for these potentially devastating impacts is through comprehensive, regional planning that utilizes the best available scientific data in the decision-making process to ensure protection of the county's water supply.

WATER QUALITY IMPACTS

Mining can "significantly impact the quality of water used for domestic and municipal water supplies," and these impacts may include "transport and deposition of sediment, acid-rock drainage, and release and transport of dissolved metals and other associated mine contaminants" (Wireman 2001, p. 40). Given the vital importance of ensuring clean drinking water for Palm Beach County, mining impacts on its regional water supply must be well understood as part of a truly comprehensive framework for mining regulation.

The scientific community generally concurs that “mining activities inevitably disrupt pre-existing hydrological pathways within the host strata” (Younger and Wolkersdorfer 2004, p. 2). Numerous scientific sources have determined that the continued presence of rock mining operations may pose significant and specific threats to the health of our most valuable resource - water. Among the leading concerns are:

1) Increased concentrations of mercury, sulphate, phosphate and nitrate.

These chemicals pose significant threat to the health of drinking water to residents, as well as to the fragile Everglades ecosystem and its wildlife. Groundwater connection from the mines will result in decreased effectiveness of stormwater treatment areas (STAs). Scientific analysis has shown that at 50 feet below ground in the EAA, sulfate concentrations are 250-400 mg/L, compared to 3-30 mg/L in lakes. Sulphate is transformed into methylmercury when exposed to mercury, which naturally occurs in the atmosphere; “the effects of methylmercury exposure on wildlife can include mortality, reduced fertility, slower growth and development and abnormal behavior that affects survival. Additionally, methylmercury contributes to eutrophication and toxic algae accumulation” (Naja 2010).

2) Increased levels of salinity.

EPA drinking water standard requires a chloride maximum of 250 mg/L. Chloride concentrations in water at 50 feet below ground range from 350-1000 mg/L, far exceeding EPA drinking standards. The presence of multiple rock mines can increase interactions between groundwater and surface water, causing dangerous levels of dissolved chloride concentrates (Naja 2010).

3) Post-mining flooding of mined voids and discharge of untreated water.

In surface mines such as those in the EAA, “water quality can deteriorate when backfilled materials are initially saturated after restoration,” and “the flooding of open pit mines to form pit lakes can also cause water quality to deteriorate” (Younger and Wolkersdorfer 2004, p. 23). This could lead to dangerous results if excavated mines are used for water storage, or if these vacant mines become filled with water and then overflow due to extreme rainfall or hurricanes.

4) Inability to accurately depict geochemical makeup and therefore impacts.

As discussed previously, it is difficult to precisely identify the porosity of the aquifer at a specific location. After conducting a thorough analysis of water quality at rock mining locations across the United States, it was determined that “the lack of adequate geochemical characterization is the single most identifiable root cause of water quality prediction failures” (Kuipers 2001, p.8). This demonstrates the level of risk associated with making decisions based on uncertain data at any location, and thus suggests great caution in the approval of new mines.

CERP INITIATIVES: INTERFERENCE WITH THE RIVER OF GRASS

It is vitally important that Palm Beach County ensure its mining approvals do not interfere with ongoing federal and state programs to restore the River of Grass, including reasonably potential future adaptive management projects in the EAA. The U.S. Environmental Protection Agency has stated:

“The Everglades Agricultural Area is critically located for Everglades restoration; thus; any proposed new land uses for this area should be closely scrutinized for their potential to interfere with both currently planned and potential future restoration efforts” (U.S. EPA 2009).

These efforts include the potential creation of Stormwater Treatment Areas (STAs) on two tracts of land purchased by the South Florida Water Management District in August 2010 as well as additional potential STAs and water reservoirs on land which the District has acquired an option to purchase from the U.S. Sugar Corporation. Federal and state agencies are actively planning for the next steps of this essential restoration initiative.

Restoration planning will continue at a steady pace, as the South Florida Water Management District has a time-limited option to purchase additional lands in the EAA. It is safe to predict that Everglades Restoration planning will be completed before the existing supply of available mining land dwindles to a critical level. This is particularly true given the County’s prior approval of over 20,000 acres of rock mines, which Palm Beach County’s planning staff project will provide ample product over the next seventy years. This timeframe far exceeds the horizon for the completion of CERP planning.

SUMMARY OF FINDINGS

The results of this analysis have confirmed previous assessments that the issue of rock mining in the Everglades Agricultural Area is multifaceted and highly scientific:

“Rock mining in the Everglades Agricultural Area is extremely complex. The potential for mining activities to impact regional water resources and restoration projects is highly site specific, dependent on the particular geomorphology of the area and condition upon the implementation of requisite technical and engineering solutions” (South Florida Water Management District 2009).

It is essential for Palm Beach County to utilize the best information available to create a comprehensive zoning framework for the approval of new and expanded rock mining projects. Findings of this report are as follows:

- Aquifer conditions in the EAA are unpredictably porous and prone to structural damage; it is difficult to forecast this damage on a case-by-case basis.
- Groundwater seepage flow through the limestone aquifer is a vitally important and sensitive process that provides clean drinking water; structural damage to the aquifer could interrupt this natural flow and cause regional harm.

- Existing rock mines in the EAA are, on average, approximately 40 feet deep; this level of intrusion will affect the interaction between groundwater and surface water, and can lead to dangerous increases in salinity levels that will leave drinking water at unacceptable levels by EPA standards.
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- State and federal agencies have determined Everglades Restoration (CERP) projects to be of fundamental importance with regard to storing and treating water for the entire state. Palm Beach County must ensure that rock mining does not interfere with currently planned or future CERP initiatives.

This report has reaffirmed the message that the environmental community has been preaching for years; we know enough from the available body of scientific research to determine that rock mining has a detrimental effect on our water supply and impedes Everglades Restoration. However, there are some critical data gaps that we need to fill before recommendations land use changes are adopted.

Clean Water Fund's initial recommendations for further research based on these results are listed below. While we do not have the expertise to provide cost estimates for the completion of these analyses, it is clear that the information these studies will provide is vital to the creation of an adequate zoning regulatory framework.

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