

REPORT
THE GRAEME HALL SWAMP
TECHNICAL VISIT
TO
SOUTH FLORIDA
U.S.A
April 10th – 12th 2005

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JUNE 2005

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1 PURPOSE

The purpose of the escorted tour to the South Florida Water Management District facilities was "TO EXAMINE USEFUL WETLAND AND STORMWATER MANAGEMENT SYSTEMS WHICH COULD BE INCORPORATED INTO THE EFFECTIVE MANAGEMENT OF THE DRAINAGE AT GRAEME HALL SWAMP".

2 INTRODUCTION

The Graeme Hall Swamp is the last remaining coastal wetland in Barbados. It covers 91 acres. The swamp is essentially divided into an eastern and western section by a causeway. The Barbados government owns the eastern section, which is 56 acres; the remaining western portion, which is 35 acres, is privately owned. The entire drainage basin for the Graeme Hall Swamp is 1156 acres.

Amity Lodge, a residential development, is located on the northwest boundary of the swamp. The northern boundary borders the footpath on the south side of the Ministry of Agriculture's experimental fields. The east and south boundaries of the government property borders the marl road constructed for the laying of sewage effluent pipes. Figure 1 illustrates this layout.

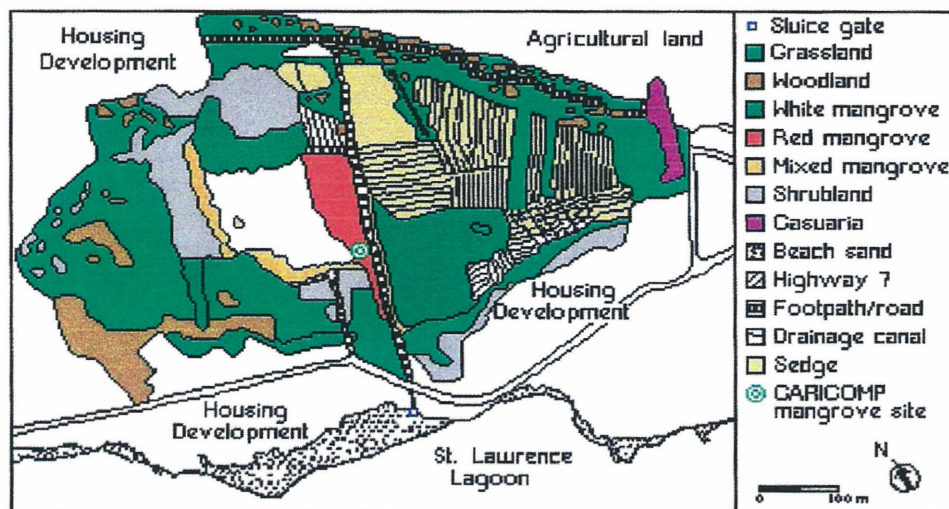


Figure 1 – Map of Graeme Hall Swamp



Figure 1 – Map of Graeme Hall Swamp

Currently, a wooden manually operated sluice gate exists on Worthing beach to regulate water levels in the swamp by facilitating the drainage of water from the swamp to the sea. Refer to Figure 2.

This sluice gate has however become warped and its functionality is compromised. In light of the necessity to devise an alternative to the sluice gate – as well as the associated issues and difficulties experienced in managing the Nature Sanctuary - management of the Graeme Hall Nature Sanctuary proposed the visit to South Florida to provide technical assistance to the Government of Barbados.



Figure 2 – Existing sluice gate at Worthing Beach

Prior to the trip, it was proposed that three (3) alternatives to the existing sluice gate should be considered:

- A real- time automated sluice gate which would be triggered when water levels surpassed a pre-determined level;
- An outfall across Worthing beach;
- The construction of retaining weirs on Government land to hold most of the drainage water from the watershed until it naturally drains into the sand and out to the sea. This creates a “holding wetland” – or detention facility - which would be planted with natural vegetation that would naturally clean polluted waters.

The solution has to be capable of adequately addressing the issues within the swamp inclusive of the control of the water levels within the sanctuary, which is critical to maintaining an environment that can sustain the marine life and the migratory birds that have found habitats on the privately owned portion occupied by the Graeme Hall Nature Sanctuary (GHNS).

Another major issue in the swamp is flooding on the eastern government-owned lands. Residents in surrounding areas are seriously affected by this flooding. Swift and efficient drainage of this portion of the swamp in high rainfall events would alleviate much of the flooding problems currently experienced in the area. It would also significantly reduce the mosquito health threat that exists in the swamp.

Several other issues were also identified and discussed on a visit to the Graeme Hall Nature Sanctuary and the swamplands by the three (3) officers prior to the trip to Florida, in order to be sensitized to the issues of the last remaining wetland in Barbados.

Although unable to identify all the issues, some that were also noted and considered throughout the escorted tour of Florida included:

- a) Agricultural Run-off is leaching nitrates and phosphates into the wetlands, primarily the eastern wetlands, thus propagating extensive growth of the Red Mangroves relative to the White Mangroves.
- b) Potential pollution of the wetlands by small business enterprise – a private mechanic shop - where oil changes are done.
- c) Blockage of the Culvert(s) recharging the wetlands on the western side, namely the Graeme Hall Nature Sanctuary.
- d) To determine whether there is a need to dredge the water channel between the western and eastern lands.
- e) Reconstruction of the Sluice Gate, either as existing or upgraded.
- f) Repositioning of the Sluice Gate or the introduction of a New Sluice Gate or a Weir or some combination thereof.
- g) Development and management of the wetlands.
- h) To determine if, as a result of development, there would be a negative impact on the flora and fauna in the wetland.
- i) The potential impact on the foreshore of the beach.
- j) The potential impact on the users of the beach during the sluice gate operation.
- h) To determine if, as a result of development, there would be a negative impact on the flora and fauna in the wetland.
- i) The potential impact on the foreshore of the beach.
- j) The potential impact on the users of the beach during the sluice gate operation.

- k) To determine whether there is a need for security fencing to the swamp.
- l) To determine whether a levee or series of levees can be incorporated into the management of the swamp; if this is possible, can it be multi-faceted.
- m) The effect of a potential negative impact by an Emergency Discharge from the Sewerage Treatment Plant, located in the environs of the wetlands.
- n) Potential dumping of debris and garbage in the wetlands and its environs.
- o) Impact on the regenerating Seagrass Beds in the nearshore by runoff from the Swamp and Discharges by the Sluice Gate.

3 SUMMARY OF VISIT TO SOUTH FLORIDA

The Barbadian contingent comprised:

- a) Ms. Tia Browne, Coastal Zone Management Unit, Ministry of Housing, Lands and the Environment;
- b) Mr. Terrol Inniss, Drainage Unit, Ministry of Public Works;
- c) Mr. Philmore Watson, Projects Section, Ministry of Public Works.

Funding of the trip was provided by the Graeme Hall Nature Sanctuary for the two (2) officers of the Ministry of Public Works. Ms. Browne's trip was funded by the Coastal Zone Management Unit (CZMU).

The escorted tour to visit South Florida, USA, was of three (3) days duration, from Sunday April 10, 2005 to Tuesday April 12, 2005.

The contingent arrived at Miami International Airport on Sunday April 10, 2005 and we were met by Mr. Stuart Heaslet, the host on behalf of the Graeme Hall Nature Sanctuary. Mr. Heaslet escorted the group for the remainder of the visit.

A stop was made on April 10, 2005 to allow the group to tour the Arthur R. Marshall Loxahatchee National Wildlife Refuge, which is located in the northernmost portion of the Everglades.

On the second and third days - April 11, 2005 and April 12, 2005, the South Florida Water Management District offices in West Palm Beach and Fort Myers, respectively, facilitated the dissemination of information to the Barbados contingent through presentations and on-site tours. Along the route from West Palm Beach to Fort Myers, a stop was made at the Moore Haven Locks. This is the main navigable discharge point for Lake Okeechobee water into the Gulf of Mexico. This locks system (similar to that of the Panama Canal but on a much smaller scale) was observed in use.

Accommodation was provided at the Hampton Inn, West Palm Beach, on the night of April 10, 2005 and at the Hampton Inn, Fort Myers, on the night April 11, 2005.

3.1 A.R.M. LOXAHATCHEE NATIONAL WILDLIFE REFUGE

The Arthur R. Marshall Loxahatchee National Wildlife Refuge is located in the northernmost portion of the Everglades. The American alligator, the endangered Everglades snail kite, and as many as 257 species of birds use the refuge's habitats.

Recreational opportunities are incorporated into the Wildlife Refuge. These include walking trails, a canoe trail, bike trail, boat ramps, fishing platform, observation towers, a butterfly garden, and a visitor centre.

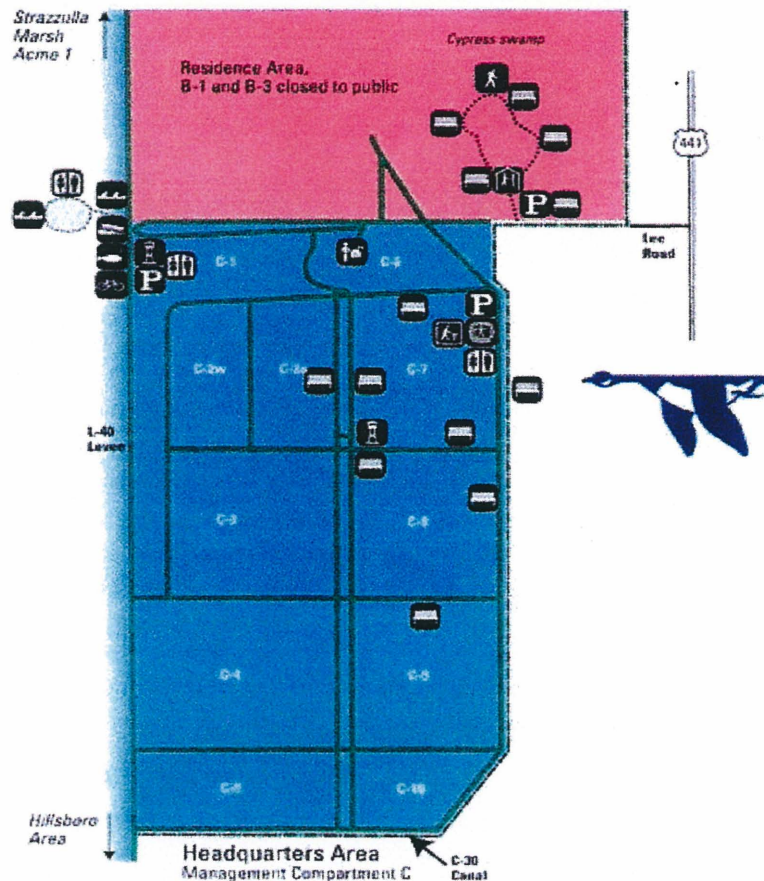


Figure 3 – Map of the Arthur R. Marshall Loxahatchee National Wildlife Refuge

A four hundred acre cypress swamp is the largest remaining remnant of a cypress strand that once separated the pine flatwoods in the east from the Everglades marshes. A boardwalk into the swamp allows visitors to comfortably have an up-close swamp experience.

A four hundred acre cypress swamp is the largest remaining remnant of a cypress strand that once separated the pine flatwoods in the east from the Everglades marshes. A boardwalk into the swamp allows visitors to comfortably have an up-close swamp experience.



Figure 4 – A part of the boardwalk in the Cypress Swamp

The refuge is open to the public from sunrise to sunset daily. Exact times are posted at each entrance and change with the hours of daylight. The refuge visitor centre hours of operation are weekdays from 9:00am to 4:00pm and on Saturday and Sunday from 9:00am to 4:30pm.

Visitors are asked to pay at the entrance to the Wildlife Refuge. A fee of US\$5.00 is charged to private vehicles entering the refuge. When the fee booth is unmanned, visitors are subject to the honour system and should pay at the fee shelter next to the fee booth. However, for those needing change, they may get change from the Visitor Centre and pay at the centre without having to return to the fee shelter. Fee waivers may be obtained for educational groups and official visitors.

Alternative payment for entrance to the Wildlife Refuge includes passes, passports and stamps. These may be valid for varying periods of time - for instance, one month, one year, or a lifetime - and may be applicable to various categories of persons, such as the elderly, the handicapped or residents of Florida.

A levee and canal system was observed at the site which manages the water flowing through the area. The levees are multi-functional, with recreational uses such as boating, fishing, bike and walking trails and observation towers along the trails.

Hillsboro Area

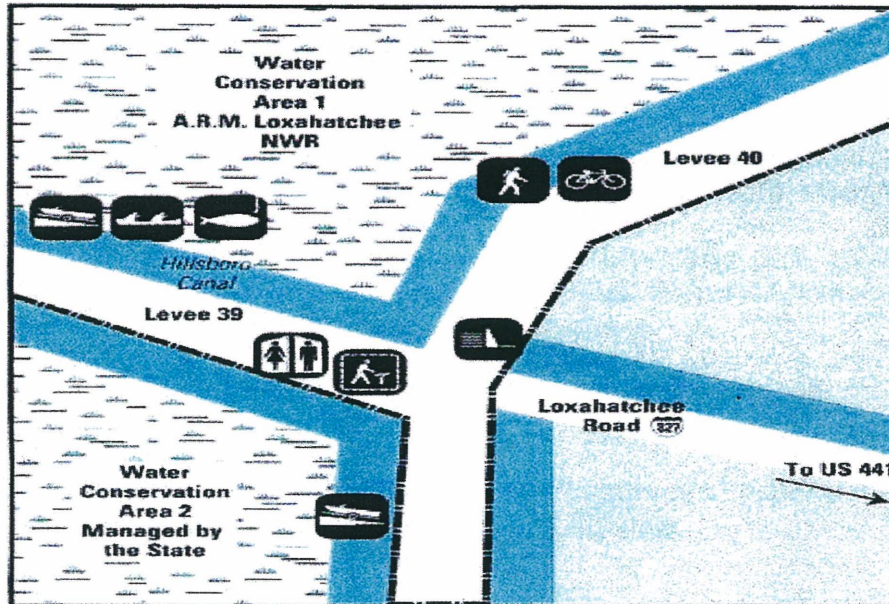


Figure 5 - Levee and Canal System in the Hillsboro Area

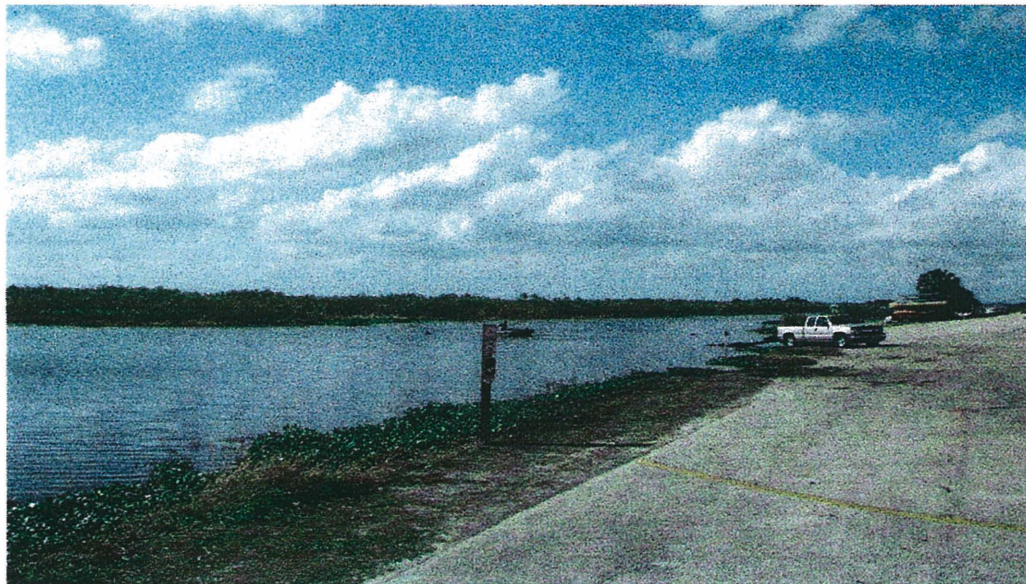


Figure 6 – The canal system where fishing and recreational boating occurs



Figure 6 – The canal system where fishing and recreational boating occurs

3.2 SOUTH FLORIDA WATER MANAGEMENT DISTRICT

The South Florida Water Management District (SFWMD) is a regional agency of the State of Florida, and is charged with managing and protecting the water resources of the region by balancing and improving water quality, flood control, natural systems and the water supply. SFWMD's boundaries extend from central Florida to Lake Okeechobee, and from coast to coast, from Fort Myers to Fort Pierce, south through the sprawling Everglades to the Florida Keys and Florida Bay. The agency's responsibilities also include revitalising and restoring one of the most diverse ecosystems in the world – stretching 240 miles from Orlando to the Florida Keys. The SFWMD operates and maintains approximately 1,800 miles of canals and levees, 25 major pumping stations and about 200 larger and 2,000 smaller water control structures.

The agency's responsibilities may be sub-divided into the following sections:

Canal & Structure Operations

A network of 1,800 miles of canals and levees, and hundreds of water control structures, helps to protect regional water supplies and alleviate flooding.

CERP/Everglades Restoration

Efforts to restore and protect the historic Everglades ecosystem are being led by the District and the U.S. Army Corps of Engineers, and many other federal, state, local and tribal partners.

Ecosystem Restoration

Estuaries, lakes, rivers and wetlands are all part of the greater Everglades system. The South Florida Water Management District (SFWMD) is working to restore ecosystems all across the central and southern Florida region.

Emergency Management

The aim is to prevent or minimize, prepare for, respond to, and recover from emergencies or disasters that threaten life or property within the boundaries of the South Florida Water Management District. Flood and drought, hurricanes and wildfires are typical emergencies experienced within the district.

Environmental Monitoring

Historical information about weather, rainfall and changes in vegetation or land-use is recorded and forms a foundation for present and future planning, operations, research and restoration initiatives.

Real-time data, especially when combined with historic data, helps SFWMD to make effective, informed water resource management decisions. Information about how natural and man-made systems are working or not working - both individually and interactively - is essential to short and long-term water resource management and restoration.

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Land Acquisition & Management

SFWMD endeavours to restore, preserve and manage water resources, the lands beneath or bordering lakes or rivers; bays or estuaries; or low-lying wetlands also needed to be preserved and managed. This may require the District or other state, local or federal governments to buy lands, and retain ownership or access on behalf of the public.

Permitting

The South Florida Water Management District (SFWMD) protects the supply and the quality of water resources by regulating the management and storage of surface waters and the dredging or filling of wetlands with environmental resource permits.

Ground and surface water withdrawals by major users such as water utilities, agriculture and nurseries, golf courses, mining and other industrial users are regulated. Right of way occupancy permits are issued to protect the SFWMD's ability to effectively and safely use the canal and levee rights of way of the Central and Southern Florida Flood Control Project, the related water conservation areas, the works of the Big Cypress Basin, and certain other canals and rights of way; all this whilst providing for compatible public and private uses. The District also issues water well construction permits, and Surface Water Improvement and Management (SWIM) "Works of the District" permits to property owners working to reduce nutrient/pollution flows into areas such as Lake Okeechobee and the Everglades.

Water Supply

The SFWMD works to safeguard the region's water quality to ensure enough useable water fifty (50) years from now.

3.2.1 SOUTH FLORIDA WATER MANAGEMENT DISTRICT: WEST PALM BEACH

The headquarters of the South Florida Water Management Unit (SFWMD) is located in West Palm Beach at 3301 Gun Club Road.

A team of persons from the SFWMD met the Barbados contingent and Mr. Stuart Heaslet. The team comprised Mr. Henry Dean, Executive Director; Jessica Morales, Public Relations Outreach Specialist of the Public Information Section; and Larry Gerry, Interim Department Director of the Ecosystem Restoration.

Mr. Dean welcomed the group to the SFWMD and turned the meeting over to Ms. Morales who presented "Who We Are and What We Do", the content of which has been outlined in Section 3.2 of this report.

Mr. Larry Gerry presented "Biscayne Bay Coastal Wetlands Project". This focused on a previous SFWMD project, which was viewed as similar in nature to the Graeme Hall Swamp project owing to its proximity to the coastline. The estimated project area is 13,600 acres which is much larger than the Graeme Hall Swamp. The project comprises a coastal outfall, primary canals, secondary drainage and wastewater treatment plants.

Following the presentations, the visiting group was taken on a tour to the STA-1W Observation Tower and Pump Station G-310. Mr. Craig Wilson, Section Leader in Construction at the SFWMD, conducted this tour.

On the way to the tower, a stop was made to examine the stainless steel sluice gate in Figure 7, which can be operated manually via a wheel or automatically via external controls.



Figure 7 – The stainless steel sluice gate

From the observation tower, various vegetated water treatment cells were seen. Marsh plants such as the water hyacinth (as especially found in the pond at Bayfield, St. Philip in Barbados) and cattails were some such vegetation utilised. It was highlighted that the water hyacinth is controlled through chemical treatment, namely, sprayed.



Figure 8 – Marsh plants in stormwater treatment cells

The mechanical operations of the pump house were described. Water can be pumped from various canals in heavy loading situations such as heavy rainfall, in order to prevent over-spilling of the canals and subsequent flooding. The water can be re-channelled to other canals experiencing less loading or can be directed to other waterways such as rivers.

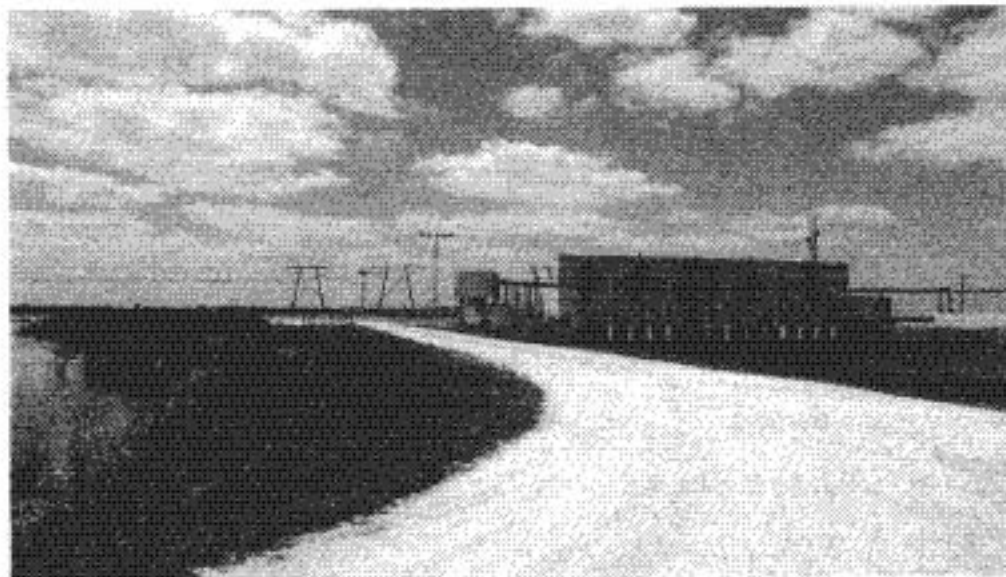


Figure 9 - The Pump House

3.2.2 SOUTH FLORIDA WATER MANAGEMENT DISTRICT: FORT MYERS

Mark White, Senior Regulatory Supervisor, Environmental Resource Compliance, at the Fort Myers office of SFWMD and Jeanette A. Dandenault, Senior Supervising Engineer, Environmental Resource Compliance, facilitated the tour on April 12, 2005.

The focus of this aspect of the tour was Fort Myers' management of their flood prone lands through a system of retention and detention ponds (Refer to Figure 10) with canal systems controlled by a system of weirs and sluice gates. These ponds are constructed to facilitate stormwater detention by detaining and attenuating the incoming runoff from urbanised areas.

In Fort Myers, the roads and highways are graded to allow efficient and adequate surface runoff into the ponds. The water table in the area is so high, however, that the seepage rate of surface water into the ground is slow. Hence, the ponds must also be designed to detain some volume of water for short periods of time. When the detained water surpasses a pre-determined level it flows through an outlet into a pipe system and eventually reaches the canal network before discharge to the ocean.



Figure 10 – Retention/Detention Pond

3.2.2.1 Briarcliff-Fiddlesticks Ditch

The tour continued along the Briarcliff-Fiddlesticks Ditch. This is essentially a canal network with weirs and sluice gates strategically engineered along the length of the network. The network is designed to accommodate surface runoff. The water eventually flows to the ocean. The weirs and sluice gates are in place to control the rate at which this is achieved to prevent shock loading - namely flooding - at the exit to the ocean. The network is a gravity flow system and the weirs are all graded at successively lower heights travelling in the direction of the coast. In most cases, the sluice gates are placed on both sides of the weirs to permit greater flow capacity past a point in instances of increased volumes of water in the canal network. They are also placed to facilitate ease of maintenance of the system.



Figure 11 - Sluice gate and weir system (a)

Water flows over the weir to a lower level. The sluice gates are located in the concrete casings on either side of the weir and are usually closed. The gates are opened to drain the retention system so that maintenance on the weir can be done. The gates are also opened when the flow rates increase substantially so that additional water can flow past a particular point. The rocks (riprap) lining the embankment further reduce the energy of the water's velocity, thus preventing scouring (erosion) of the embankment.



Figure 12 - Sluice gate and weir system (b)

The weir in Figure 12 is curved. This allows a greater volume of water to bypass per unit time. The canal narrows at this point.

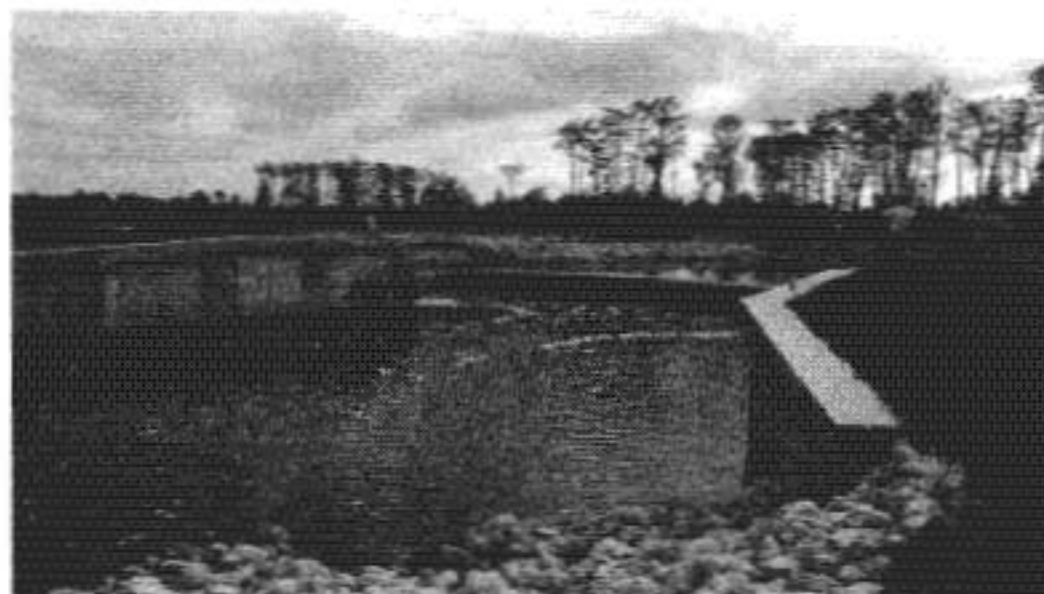


Figure 13 - Sluice gate and weir system (c)

The wings extend at an angle as the canal widens again.



Figure 14 - Sluice gate and weir system (d)

The sluice gate is located within the concrete casing. The grills at the top can be removed to permit cleaning or maintenance.

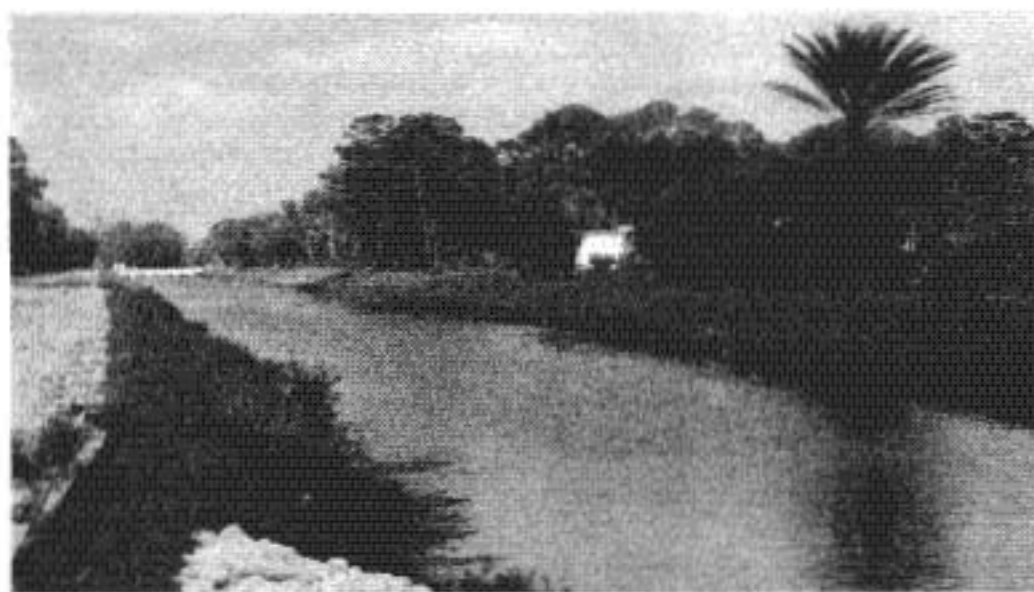


Figure 15 – A part of Fort Myers' - and by extension South Florida's - extensive canal network

4 RECOMMENDATIONS OF THE TOURING PARTY

The Graeme Hall Swamp over time has become a nuisance to the residents of St. Lawrence and this should have been avoided. Lack of maintenance over time has escalated the situation to present levels. The following recommendations are geared to offer relief to those residents and to enhance the environmental difficulties as they now exist. These recommendations also lend to improved utilization and management of the wetlands:

1. It is recommended that there be further development of the lands of the eastern section of the swamp to become more than just an unkempt wetland but potentially a recreational area and an attraction to both locals and tourist.
 2. It is recommended that a berm be built around the southern and eastern sides of the swamp to protect the residential areas from the rising swamp level during rainfall events, thus managing the waterflows exiting the swamp.
 3. That the berm around and throughout the swamp be used as a track for joggers, bicyclists, walkers and tranquil naturalists.
 4. That boardwalks be built in a specified area to allow for persons to visit and observe.
 5. That there is construction of a weir to maintain the water level in the swamp to a maximum acceptable level.
 6. That the swamp level be allowed to rise – supported by the weir construction – to a level which allows for the fish species to navigate to now inaccessible areas, thus controlling the larvae population and eliminating mosquito breeding.
 7. That the swamp be allowed to have cells, created by berms, which would accommodate vehicular access for agencies' monitoring of the ecology; also, it can cater for primary, secondary and possibly tertiary treatment for the emergency outfall from the sewage treatment plant.
 8. That there be the construction of a low flow drain to accommodate the stormwater drainage for the St. Lawrence residents.
 9. That the sluice gate offer from GHNS be accepted in a form approved by MPW.
 10. That a secondary sluice gate be erected to support and maintain the development on the western side of the swamp.
 11. That the management of the entire wetland be a public/private sector marriage.
- IVLE vv.
10. That a secondary sluice gate be erected to support and maintain the development on the western side of the swamp.
 11. That the management of the entire wetland be a public/private sector marriage.

4.1 Concerns of the Coastal Zone Management Unit

Of primary concern to the Coastal Zone Management Unit (CZMU) is the inevitable discharge from the swamp to the sea.

The Unit has previously indicated to the Ministry of Public Works that it is in favour of regular discharges to achieve upstream flushing of the swamp and to improve the water quality in the swamp, hence ultimately improving the quality of the water that enters the nearshore when the sluice gate is opened.

The following guidelines were issued to MPW for the maintenance of the sluice gate in 1994.

1. The gate should be opened daily at low tide occurring after 3:00 pm;
2. The gate should be closed before the effects of high tide are experienced;
3. The optimum time for clearing the channel and the sand berm at the sluice gate would be just prior to the occurrence of low tide.

The Unit conceded that the creation of a channel for drainage would require the use of an excavator and MPW did not have the resources to deploy an excavator for daily use at this site.

The Unit is still in favour of discharges to the beach via a sluice gate, and still holds fast to the opinion that this should be performed regularly, whilst duly noting that the expanse of beach fronting the sluice gate is a hindrance.

The Worthing beach had an accreting trend from 1984, which resulted in a wide beach in front of the sluice gate. Consultants from Delcan in a report 'Littoral Regime Report for Barbados' suggested that the most likely cause of this accretion appears to be the construction of the St. Lawrence Apartments groyne in 1975. Although data from 2000 to 2004 suggest that the beach is now experiencing an erosion trend, the average beach width for 2004 was quite wide at 79.65m.

One major objection the CZMU has is to the construction of an outfall across the Worthing beach. This outfall would act as a groyne and hence alter the natural littoral transport along that stretch of coastline. This could result in unfavourable erosion at some points along the stretch of coastline.

5 CONCLUSION

The government officials from the Ministry of Public Works and the Coastal Zone Management Unit visited South Florida with the intention of gaining technical knowledge relevant to the effective management of the drainage at Graeme Hall Swamp, with consideration given to wetland and stormwater management systems, under which the existing sluice gate at Worthing Beach falls.

The purpose of the visit was therefore achieved through the experiences of those three (3) days in Florida. The knowledge and information gained must now be complemented by further research. Any use of the technical applications observed in South Florida cannot be direct - owing to some differences in the two environments - and would obviously have to be adapted to meet the needs of the Graeme Hall Swamp.

The replacement of the existing sluice gate appears to be a suitable option, with the installation of an additional one - be it in conjunction with a weir, or separately - at the Graeme Hall Nature Sanctuary. Whatever steps are taken should be a part of a broader management plan for the swamp.

However, as was stated in a recent meeting of the Graeme Hall Stewardship Programme, the comprehensive list of major issues facing the swamp must all be clearly identified before a comprehensive management plan can be formulated and implemented to adequately address these issues.

APPENDIX

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