SECTION 8

MAINTENANCE REVIEW

CITY OF COCOA BEACH, FLORIDA
STORMWATER MASTER PLAN

PARSONS ENGINEERING SCIENCE, INC.

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SECTION 8
MAINTENANCE PROGRAM REVIEW

Stewardship of the City's assets, both man-made and natural resources includes the proper management of the stormwater infrastructure. **The stormwater management program should be set at a staffing level sufficient to support operations and maintenance activities that will protect the integrity of the infrastructure and allow continuous progress on designated program goals.** In Cocoa Beach, as in most Florida communities, a myriad of stormwater tasks must be executed in an effective and cost efficient manner using a very limited number of municipal employees.

The City's Stormwater Management Program considers that its primary mission is to "approach stormwater issues with respect to the 'big picture'- the protection of water resources". To meet that challenge, the program has been shifting from a "reactive" or maintenance mode to a more "pro-active" or preventative mode. The actual day-to-day operation and maintenance of the City's stormwater infrastructure and water resources must also reflect this same "progressive" program vision.

The purpose of this section is to review the City's stormwater management program goals, current maintenance program, proposed capitol improvements and recommended operational strategies that will ensure that the City's program goals and future improvement planning can be met.

8.1 PROGRAM GOALS

8.1.1 Stormwater Management Program Goals

Existing program management goals include the reduction of undesirable stormwater conditions that cause property damage, environmental damage and nuisance flooding. These goals are somewhat complicated by the existence of two distinct sets of drainage characteristics found within the city. Along the beach, a high sandy ridge is found to have superior drainage characteristics, even though some areas have almost 100% impervious coverage. Along the lagoon, the water table is high and the soil does not absorb well, having been created from spoil material at the time the canal system was excavated.

This existence of disparate infiltration rates has a significant impact on the type and size of stormwater facilities needed throughout the City, and to a lesser degree, the frequency of required maintenance activities. Since the start-up of the City's stormwater utility program, improvement has been made in all program goal areas and in all geographic areas of the city. Despite distinct drainage characteristics, an effective stormwater program for the City should provide for modest, but incremental annual gains in the following "goal" areas:

- **Quality:** Improvement-to a specified level- in the quality, and reduction in the volume, of stormwater runoff reaching City receiving water and protection of private and public lands from flood hazard
- **Enforcement:** Inspection and enforcement of applicable regulations, local policies and laws to ensure that development activities do not impair existing environmental conditions

- **Public Information:** Encouragement of responsible civic, business and government actions with regard to behaviors affecting water quality through an aggressive public education program
- **Funding:** Acquisition of alternative funding sources through grant and matching fund programs
- **Administration:** Development and consistent application of City stormwater policies, the use of best available information with regard to the administration of stormwater user charges and mitigation credits and improved record-keeping of stormwater management data
- **Capital Improvements:** Provide for the carefully prioritized, staged construction of capital projects, to enhance water quality/reduce flooding in an effective, cost-efficient manner in all areas of the City
- **Maintenance:** Perform regularly scheduled inspections and maintenance activities on all City-owned stormwater facilities in a manner that maximizes their operational effectiveness and protects their structural integrity.

8.2 REVIEW OF EXISTING STORMWATER MANAGEMENT PROGRAM

The Stormwater Master Plan has been developed to be one of the tools for documentation of the funding requirements that will advance the city's water quality goals. Achieving these goals is obviously a function of implementing a sound and diversified management program.

Management of the Stormwater Program for the City of Cocoa Beach with respect to maintenance, like most municipalities, has been divided into two (2) major categories; 1) Non-Maintenance and; 2) Maintenance. The City of Cocoa Beach's Stormwater Department has several "maintenance" and "non-maintenance" program activities in place. This sub-section of the master plan will review the current programs in-place for each of the two categories.

8.2.1 Non-Maintenance Program Activities

Many critical procedures and tasks must be provided to meet programmatic goals. Most of the programs listed below are not maintenance related, with respect to actual field maintenance activities, but are typically the responsibility of the stormwater program manager. Activities that are generally to be executed by the stormwater manager or other non-maintenance staff are offered for informational purposes only and will not be discussed in detail in this section. They include such responsibilities as the:

- Interpretation of stormwater policies, rules and regulations and interaction with designated code compliance officers
- Training of City staff, particularly maintenance staff, to serve as quasi-inspectors, so that staff will effective in providing documentation of possible code infractions to designated code compliance officers
- Design and presentation of local stormwater issues and pollution prevention strategies in an aggressive public information program targeted at civic, business school and government groups

- Advising City administrators and elected officials on areas of concern related to the stormwater management program
- Development and oversight of water quality programs
- Improvement of customer service response and tracking
- Project management, scheduling, coordination and budgeting
- Coordination and scheduling of inspection of BMPs
- Coordination and scheduling of monitoring program
- Tracking of drainage problem areas
- Acquisition of alternative funding sources through grant and matching fund programs
- Participation and/or attendance at appropriate seminars, workshops
- Review of development activity permits
- Coordination of user fee program
- Scheduling of maintenance activities

The following sub-section addresses those operations and maintenance activities that are delegated specifically to maintenance staff.

8.2.2 Maintenance Program Activities (The O & M Program)

The Maintenance Program of the overall stormwater program consists of the actual maintenance activities being performed in the field or particular non-field activities directly related to maintenance. These individual programs have also been divided into several categories. These categories are specific to the generalization of the type of maintenance program activities recommended for the overall system to achieve the overall goals. The two (2) main types of stormwater maintenance programs are Preventative Maintenance and Scheduled Maintenance.

8.2.2.1 Preventative Maintenance

The Preventative Maintenance program consists of a variety of functions and individual programs directed at preventative measures to reduce or eliminate sources of pollution rather than expensive programs to restore habitats. The basic goal of these types of programs is to keep sediment, debris and other pollutants out of the stormwater system. In addition, the quantity of preventative maintenance programs as it increases will in return minimize the amount or quantity of scheduled maintenance (O & M) that is required in the future.

The current preventative maintenance program includes such things as a public education program, a set of established pollution prevention regulations, street sweeping and other non-maintenance programs. These programs are described further as follows:

8.2.2.1.1 Public Education

The City of Cocoa Beach currently has a small public education program in place for the stormwater issues in the community. This education program obviously attempts to address the critical issues by informing and educating the public of the stormwater system and its overall purpose and impact on the community. The capabilities of this program are obviously limited to budget and available manpower. This program, as much as any, is

paramount to launching a long-term effort in educating the public with respect to measures which they can personally implement to contribute to the overall preventative maintenance program.

8.2.2.1.2 Pollution Prevention Regulation

The pollution prevention regulations currently in place for the City consist of land development pollution regulations. The program requires development to provide pond or swale volume for retention, facilities for peak discharge attenuation, as well as facilities for both sediment and erosion control. This pollution prevention program consists of both site inspection and rule enforcement activities in an effort to achieve the goals and objectives of the overall program.

8.2.2.1.3 Storm System Inspection

The current inspection program only consists of visual inspection and periodic cleaning of the surface stormwater features only. Another key function of the overall program, particularly the PM program, this program is clearly limited by the small number of staff members.

8.2.2.1.4 Street Sweeping

Water quality efforts begin with basic maintenance activities. Acknowledged by experts to be the single most effective water quality program, street sweeping is a non-structural BMP and generally considered a form of refuse removal.

The current street sweeping program consists of maintaining all curbed street within the City on a once per month basis. The current program also consists of maintaining all urbanized and treed area within the City on a once every two-month basis.

8.2.2.2 Scheduled Maintenance

The Scheduled Maintenance program consists of implementing a maintenance and rehabilitation program as an organized means of avoiding unscheduled or emergency action. The Scheduled Maintenance Program consists of listing and prioritizing.

The current scheduled maintenance program includes such things as a CCTV and cleaning program, stormdrain maintenance, structural repairs and other scheduled maintenance programs. These programs are described further as follows:

8.2.2.2.1 CCTV and Cleaning

The close-circuit televising (CCTV) and cleaning of the system is currently only performed on a minimal basis. The conveyance pipes needing this function are listed by the staff and prioritized based on need and costs. This function is not performed on a regular basis, as desired due to the limited staff and budget.

8.2.2.2.2 *Stormdrain Maintenance*

The structural repairs of the system are currently only performed on an "as-needed" basis. The repairs themselves are listed by the staff and prioritized based on need and costs. Even though this function is performed on a regular basis, the limited staff and budget only allows for this type of activity to be completed in a minimal capacity.

8.2.2.2.3 Structural Repairs

The structural repairs of the system are currently only performed on an "as-needed" basis. The repairs themselves are listed by the staff and prioritized based on need and

costs. Even though this function is performed on a regular basis, the limited staff and budget only allows for this type of activity to be completed in a minimal capacity.

8.2.2.2.4 Dredging

To date, only a few of the City's canals have been dredged and "reclaimed". The remaining canals are clogged with tons of muck sediment consisting of silt, clay, tiny amounts of organic matter, carbonate, and quartz sands. The source of this muck is generally thought to be poor erosion control practices in the lagoon's watershed. Proposed projects in the Master Plan are expected to reduce stormwater runoff's contribution of silt to the waterways, however, other contributions will continue, such as from wave and wind action. The presence of muck is a water quality concern because it is an efficient trap for bacteria, nutrients and toxic substances. When muck is disturbed by wind, waves or boat wake, it is easily re-suspended in the water column, creating large areas of turbid water and releasing trapped pollutants. In addition to its potential for degrading water quality and the aquatic environment the water supports, severe cases of muck deposits impede water flow, navigation and threaten adjacent property values.

8.3 RECOMMENDATIONS FOR FUTURE MANAGEMENT PROGRAM

This Stormwater Master Plan has also been developed to be one of the tools for planning up-dates, revisions and expansion of the current management program to advance and optimize the City's overall program. Again, achieving this goal will obviously be a function of implementing new sound and diversified management programs. Recommendations have been made for both the maintenance and the non-maintenance programs for the City of Cocoa Beach. The recommendations are intended to improve the effectiveness of the Department in its efforts to achieve the overall water quality goals for the community.

It is recommended that the City continue a pro-active approach to its facility and resource maintenance. It is further recommended that the Utility acquire and implement an asset management and facilities maintenance electronic record-keeping system to include inventory, scheduled maintenance, customer service, reporting, mapping and other automated approaches to management of its assets. Federal and State initiatives including GASB Statement 34, NPDES and CMOM are pushing local government to greater reporting capability, asset management, planning and reduction of paper files that can only be used minimally in decision-making. This electronic asset management and record-keeping system should be coordinated with other City departments for tracking inventory and maintenance.

8.3.1 Non-Maintenance Program Activities

As described previously in sub-section 8.2.1, the City's existing program currently has several small programs that are not directly maintenance related, but are extremely necessary. In addition to the existing functions of the "non-maintenance" program activities previously listed, there are a few more specific programs that are highly recommended.

8.3.1.1 Maintenance Record Keeping

Using available complaint or maintenance records, "hot spots" receiving multiple calls of visits should be analyzed to identify a constructive measure that would minimize reoccurrence of the problem and determine who is responsible for that action. Tracking the City's response to both internal and external customer complaints may be a necessary means to identifying progress made in this area. This process is not encouraged unless the entries are made in a consistent manner in both type and level of detail.

A log of entries should include the date, location address, associated event (storm, spill, etc.), customer contact information, City's immediate response and prescribed follow-up. Prior to close out of each complaint, the parcel identification number should be added to the file so that the incident can be accurately mapped for future reference. Systematically, those complaints that could be avoided through the adjustment of maintenance activities should be worked into the operations and maintenance schedule.

8.3.1.2 Water Quality Monitoring

NPDES permits generally call for the reduction of specific pollutant loadings to receiving water bodies through the use of conventional BMPs. The cost of water quality ...

For example, the EPA has determined that many of the heavy metals of concern in urban stormwater runoff should be regulated based on dissolved forms present in ambient waters. The dissolved forms of heavy metals and many other constituents are not removed to any significant extent by conventional BMPs.

As the need to find the real culprits responsible for water quality impairment approaches, properly trained non-technical personnel, such as maintenance staff, can provide the use of low-cost observation techniques to trigger the collection of forensic evidence.

Costs for identification of these impairment-causing constituents is significant, but can be reduced through the use of additional "watch dogs" and field inspectors who are trained to know what to look for in the "field".

Ideally, the training of maintenance personnel should include inspection techniques to determine physical, biological and chemical indicators of pollution to receiving waters. The physical presence of maintenance personnel in the field and the cross-training of other City "field personnel" is recommended so that these additional "eyes and ears" can provide a first line response to problem areas as they develop.

Training should include general observation skills that would lead to early detection of stormwater-related problems and the failure of BMPs. Visual inspections related to the following questions might be covered in training:

- Is there obvious toxicity reflected in the presence of dead or dying aquatic species?
- Is there excessive aquatic weed growth in the stormwater runoff waters?
- Are there litter and debris derived from stormwater runoff?
- Is the receiving water for the stormwater runoff excessively turbid during a runoff event?
- Is there an accumulation of oil and grease in the receiving waters that is aesthetically unpleasing and/or adverse to aquatic life?

Although not highly technical in nature, the observation of these warning signs can be a valuable indicator that preventative maintenance must be increased to avoid moving the maintenance program back to a reactive mode.

8.3.2 Maintenance Program Activities: The Operations and Maintenance Program

As noted previously, the overall "Maintenance Program" is divided into several categories. These categories are specific to the generalization of the type of maintenance program activities recommended for the overall system to achieve the overall goals. The two (2) main types of stormwater maintenance programs are Preventative Maintenance and Scheduled Maintenance.

8.3.2.1 Preventative Maintenance

As noted above, the Preventative Maintenance program consists of a variety of functions and individual small programs directed at preventative measures to reduce or eliminate sources of pollution rather than expensive programs to restore habitats. The basic goal of these types of programs is to keep sediment, debris and other pollutants out of the stormwater system.

The current preventative maintenance program includes such things as a public education program, established pollution prevention regulations, street sweeping and other non-maintenance programs. The existing programs are doing well at maintaining with the staff at hand. However, to improve the overall Level of Service and approach a point of attaining the overall program goals additional Preventative Maintenance Programs must be developed above and beyond the current programs. These programs are described further as follows:

8.3.2.1.1 Public Education & Outreach

It is recommended that the City continue public education efforts and coordinate with neighboring local governments and SJRWMD for consistency and cost savings. **Concentrate on those practices and discharges that create severe water quality problems. Work with businesses on modifying their operations for pollution prevention.**

Stormwater staff might consider surveys of the community to measure understanding and compliance with pollution prevention regulations. It is recommended that Public Education remain and in-house effort, perhaps utilizing the City's existing public information office, and coordinating with Brevard County local government for consistent cost-effective outreach.

8.3.2.1.2 Pollution Prevention Regulation

It is recommended that under the program for Pollution Prevention Regulations, the City staff implement code and policy changes recommended in Regulatory Review section of plan. Enhance regulations through staff training (Stormwater, Public Works, Water Reclamation, Development Services, Police, Fire, etc.) and by designating a Compliance Officer who can enforce regulations through citations and stop-orders.

Staff training will allow employees to examine their own practices and spot violations within the community. Designating an official Compliance Officer to enforce the regulations will, in the end, prove a cost-effective measure. Pollution prevention violations can be effectively monitored through this sort of teamwork effort. A consistent approach must be used for compliance.

A strong pollution prevention effort will eventually reduce more cost-intensive stormline cleaning and dredging. This activity is best accommodated through existing in-house staff including public relations.

8.3.2.1.3 Storm System Inspection

One of the most important advances recommended for the Storm System Inspection program is to implement an automated record-keeping (asset management) system. This function along with a continued frequent inspection of all storm facilities should occur. Frequent inspection can lead to less intensive and costly maintenance. This maintenance is most likely best left in-house for infrastructure knowledge. Therefore, it is recommended that the City increase the budget to allow for additional man-hours to perform a minimal level of stormwater systems inspections. The "asset management" system will continually optimize the management of the individual programs as well as the overall program itself.

8.3.2.1.4 Street Sweeping

It is important to re-iterate that in addition to its effectiveness in the water quality program, street sweeping is a highly visible activity that continually reminds both the public and elected officials that the stormwater management program is at work. Street sweeping is currently accomplished through a contract agreement that is negotiated on an annual basis. **In most jurisdictions, the outright purchase of a street sweeper can be a cost effective strategy, but in Cocoa Beach, the continued out-sourcing of this task is recommended for the following reasons:**

New street sweepers/vacuum systems range in cost from $185,000 to $450,000 and the annual maintenance cost ranges from $3,700-$9,000. The City contracts for street sweeping services at an annual cost of $25,500.

The combination of sweeping up beach sand and salty water typically causes severe damage to the hopper body, shortening the useful life of this type of equipment and increasing annual maintenance costs related to its upkeep;

The U.S. EPA has adopted stringent air quality standards (Rule 413 pertaining to Fugitive Dust) and test protocols (Rule 1186 pertaining to the Certification of Street Sweeper Compliance Testing) that will be increasingly difficult for the City to meet in order to continue the lawful use of the equipment; and Providing this service "in-house" would require that the City add a two-person street sweeping crew to the existing staff.

Street sweeping is frequently found in the sanitation budget. As a cross-purpose function, street sweeping is commonly recovered on either the refuse collection bill or in the stormwater user-charge.

It is recommended that the City continue existing contractual program, allowing flexibility for special situations and events (parades, festivals, construction, tropical events). Street sweeper costs are not cost-effective at this time for the City to consider purchasing equipment or hiring dedicated staff for in-house street sweeping at this time. In the future,

the City may consider cost sharing with neighboring municipalities for an in-house street sweeping program.

8.3.2.1.5 Maintenance of Ground Cover

To prevent major maintenance for ground cover installations, the primary maintenance task is preventative inspection of the facilities. **Primary maintenance for ground covers should be regularly inspected to maximize their effectiveness:**

- Hard surface ground covers including pavement, concrete, and other cast surfaces. Where these surfaces are used in conjunction with a stormwater conveyance facility, it is importing that the surface is regularly inspected to determine that water is not able to undermine the ground cover. Liners on channel slopes should be checked for accelerated erosion and high water velocities at the toe and top of hard-surfaced slopes and at the outlets from hard surfaces.
- Semi-hard surfaces including riprap, modular pavement and gabion mattresses that are commonly used to line channels and cover moderate to steep slopes. High water velocities can wash away semi-hard surfaces. Inspection that finds small particles filling voids would indicate property installation and maintenance. Flexible channel liners should match surrounding surfaces to ensure that water will flow into the channel with erosion.
- Soft ground cover such as vegetative ground covers, are commonly used on moderate slopes and flat areas to provide inexpensive, long-term protection with moderate maintenance. Mulches require more frequent maintenance than vegetative covers, but are very effective in providing erosion control. On flatter slopes, mulches can be tacked by spraying with a tacking agent to prevent the mulch from being washed or blown away. On steeper slopes, mulches must be overlaid with netting or mats which both require additional All ornamental shrubs and some grasses require special soil conditions, application of nutrients and watering, an extended root zone and a high level of maintenance.

8.3.2.2 Scheduled Maintenance

The Scheduled Maintenance program consists of implementing a maintenance and rehabilitation program as an organized means of avoiding unscheduled or emergency action. The proper management of the Scheduled Maintenance Program will consist of a detailed listing and prioritizing of the required activities.

The current scheduled maintenance program includes such things as a CCTV and cleaning program, stormdrain maintenance, structural repairs and other scheduled maintenance programs.

However, as the City continues to implement more programs and install more BMPs, additional scheduled maintenance programs will have to be implemented as well. The following sub-sections describe some modifications and up-dates to the existing scheduled maintenance program, as well as some newly proposed scheduled maintenance activities.

8.3.2.2.1 CCTV and Cleaning

This is a current program, but operated on a limited basis. **It is recommended that the City continue a prioritized schedule but also improve operations through automated record keeping. Tracking it in this fashion can allow staff to reduce upstream causes and coordinate it with other rehabilitative work.** It appears that this activity is not being performed on a regular basis due to time and equipment

constraints. Stormlines have been filling with sediment and debris over decades and once brought back to full capacity, can remain this way if upstream sources of material are minimized. Stormwater staff should make an effort to list and prioritize clearly all stormlines needing cleaning so that an understanding of the long term time and cost needs can be realized. This effort should be approached in the same manner as the stormline replacement program. Once stormline cleaning needs are understood, a decision on whether in-house or contractual service is the best approach can be evaluated.

8.3.2.2.2 Stormdrain Maintenance

It is recommended that with regards to the stormdrain cleaning program, the City continues to improve operation through more comprehensive program and planning. Use automated tracking to fine-tune frequency and type. Integrated inventory and record keeping with Public Works, Water Reclamation and other relevant departments can allow for better project coordination, cost appropriation and valuation of assets. It is recommended that this remain as an in-house activity.

As-needed maintenance activities include the cleaning of obstructions from the stormwater conveyance system. As a part of the maintenance program for cleaning catch basins and manholes, the city should continue to collect inventory information. It now tracks which structures collect more sediment, allowing the city to identify those that need more frequent maintenance.

8.3.2.2.3 Structural Repairs

It is recommended that with this existing program, the City continue a prioritized schedule but improve operations through automated record keeping. Tracking it in this fashion could reduce major refurbishment needs and allow staff to track probable causes of some degradation. Activity should remain in-house.

In addition, the City uses the best available technologies in materials and methods for system integrity and durability. Seek out training in structural rehabilitation, attend industry exhibits and shows for the newest technologies, and use the web and stormwater/public works forums to network with other local government. Minor structural repair can be accomplished in-house on a consistent and cost-effective basis. The City may want to consider evaluating contractual service for future major stormdrain and manhole rehabilitation although it does not appear warranted at this time.

8.3.2.2.4 Dredging

An effective water quality program will see a reduction in pollutants reaching the City's waterways. A strategic plan for waterway shoreline maintenance is recommended, however, to re-claim the original canal cross sections through the removal of muck sediment and the. A full-time program would be required to oversee stormwater facility maintenance of the City's, nine miles of canals and sixteen miles of marked channels. The major component of the shoreline program would be the scheduled dredging of the City's 37 canals through a program that meets the guidelines of the City's five-year FDEP/ACOE permit. This would allow for dredging activity to satisfy both navigational concerns and water quality improvements in all of the City's canals.

The recommended waterway maintenance program would include ongoing dredging projects, funded by dedicated sources so that needed staff and equipment are not competing with other infrastructure needs. In addition to labor and equipment costs related to the actual dredging, a comprehensive program would require the crew to work back

upstream to address storm line replacement, swale reconstruction and storm drain repair and maintenance. The costs would be considerable. Funding for three full-tine maintenance employees and the acquisition of additional equipment would be required. Through the implementation of a full-time waterway maintenance program, however, certain costs might be reduced through effective planning, resource sharing and intergovernmental coordination. An immediate benefit that could be expected would be the reduction in high mobilization and permitting costs related to non-scheduled dredging projects.

In the past, the dredging program has been funded by the stormwater utility budget and a contribution of general funds from the City. In addition, some costs have been reduced by the contribution of design and equipment fabrication by other City departments.

It is well documented that water quality benefits are gained through dredging. Canal restoration projects that have occurred were also the result of pressure brought by residents who cited navigation difficulties. Therefore, it is recommended that a three person dredging crew be added to current staff. By taking certain administrative initiatives, an portion of dredging costs might be recovered fro the parcels that receive special benefit from each dredging project (adjacent property owners). A cost-sharing approach will provide an equitable distribution of maintenance costs.

The Stormwater Utility cannot implement capital projects and needed operations and maintenance tasks without a supportive dredging program that includes a separate crew equipment and materials. These costs may be appropriately funded by the utility program. Prior to consideration of additional staff positions, it is recommended that a schedule of dredging goals and staffing requirements be submitted to the appropriate management level for consideration. The projected water quality benefits that would result from a full time dredging program should be clearing communicated to other staff and to elected officials.

8.3.2.2.5 Debris Collector baskets

With regards to Debris Collector Baskets (minor BMP) Maintenance, it is recommended that the staff keep these types of BMPs in heavy debris areas that are inspected often. There might be a handful of additional locations where these are cost effective. It is recommended that the City minimize the number of debris collector baskets throughout the City due to their intensive maintenance requirements. Maintenance should remain in-house and the frequency should continue as is.

8.3.2.2.6 *Storm Pipe Lining & Restoration*

The staff appears to have a firm handle on this capital activity and it is recommended that this activity remain in-house and approached in the existing manner. Although there are a handful of stormlines with challenging characteristics (shallow, surcharged, arch), it is probably not cost effective for the Utility to contract these few difficult jobs out. Each of these must be carefully evaluated and approached in the manner suited to individual conditions. The Utility should also investigate pipe types other than steel (clay, PVC, concrete) to be confident that these lines will be structurally sound for the next few decades.

8.3.2.2.7 Median & Roadside Swales

Vegetated swales are structural BMPs with broad, shallow channels that can be used to address both stormwater quality and quantity. Swales are generally used for roadside or

proper line drainage of stormwater runoff prior to discharge to other stormwater management features such as catch basins, retention ponds, canals, etc. The vegetation in the swale, usually in the form of grass, allows for soil stabilization and water quality treatment. The grass attenuates pollutants by reducing the flow velocity, thereby promoting runoff infiltration and uptake of suspended solids and some nutrients.

Swale design is governed by site specific characteristics and by local code. Generally, this consists of accommodating the volume from a low return period storm, whole providing slope which does not allow for the development of erosive velocities. O&M typically consists of mowing, watering, reseeding, and removing debris and accumulated sediment. Approximately 20,000 linear feet of City swales proposed (not counting FDOT) in the City.

The primary use of swales is to provide infiltration. Biofiltration through a vegetative medium increases the swales ability to reduce stormwater pollutants downstream while allowing the transport of runoff downstream. Swales adjacent heavy traffic areas receive a large amount of transportation-related constituents and maintenance should include a frequent swale inspection task. Conditions that might require a change in the maintenance plan or frequency would include:

- Excessive compaction of soil pores
- Presence and tracing of accumulated sediments or other trash/debris to their sources
- Presence of standing water 72 hours after a storm event
- Presence of nuisance vegetation, roots or rocks

The use of existing swales to include new retention swale construction will taper off as all areas are enhanced. Construction labor will be replaced with a less demanding, but added maintenance requirement. Initially, as many of 240 crew-hours will be required for the scheduled dressing and mowing of retention swales.

The literature suggests that vegetated swales represent a practical and potentially effective technique for controlling urban runoff quality. While limited quantitative performance data exists for vegetated swales, it is known that check dams, slight slopes, permeable soils, dense grass cover, increased contact time, and small storm events all contribute to successful pollutant removal by the swale system.

The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely. The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover. Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid the transport of resuspended sediments in periods of low flow and to prevent a damming effect from sand bars. The application of fertilizers and pesticides should be minimal. Another aspect of a good maintenance plan is repairing damaged areas within a channel. For example, if the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location.

Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements.

8.3.2.2.8 Dry Retention Ponds

Dry retention ponds are structural BMPs that can provide water quality and quantity control by removing pollutants, reducing peak flow rates, and diluting and storing runoff. Stormwater ponds function as either detention or retention ponds. Detention ponds are designed to detain a certain volume of runoff for peak attenuation and pollutant treatment prior to discharge to receiving water or storm sewer system. Detention ponds are generally designed with a permanent pool of water that can provide an aesthetic, recreational, or reuse benefit. This permanent pool of water also aids in the removal of suspended particulates through settling and soluble nutrients through biological uptake, or consumption of pollutants by plants, algae and bacteria in the water. Retention ponds are designed to retain and infiltrate a design runoff volume within a specified recovery time. These are generally dry ponds and are typically only applicable to high recharge, low water table areas. Underdrains are often supplemented in dry ponds to aid in the volume recovery time. Total three areas of dry retention are proposed.

Ponds can operate in either an on-line configuration where the runoff is entirely routed through the pond, or in an off-line configuration where a design treatment/attenuation volume is routed to the pond using a diversion structure. To control overflow from the stormwater pond, a permanent flood control device such as a weir or drop structure is used. The outlet must be sized to provide adequate time for pollutant removal, yet discharge the stormwater before the next storm occurs. Detention ponds are typically designed for first flush treatment (i.e., first 1-1.5 inches from developed area) similar to exfiltration or swales. Retention areas are typically designed to retain a certain storm events (i.e., 25 year / 24 hour storm) based on the applicable LOS criteria of the location.

8.3.2.2.9 Wet Retention Ponds

Wet retention ponds are structural BMPs that can provide water quality and quantity control by removing pollutants, reducing peak flow rates, and diluting and storing runoff. Stormwater ponds function as either detention or retention ponds. Detention ponds are designed to detain a certain volume of runoff for peak attenuation and pollutant treatment prior to discharge to receiving water or storm sewer system. Detention ponds are generally designed with a permanent pool of water that can provide an aesthetic, recreational, or reuse benefit. This permanent pool of water also aids in the removal of suspended particulates through settling and soluble nutrients through biological uptake, or consumption of pollutants by plants, algae and bacteria in the water. Retention ponds are designed to retain and infiltrate a design runoff volume within a specified recovery time. These are generally dry ponds and are typically only applicable to high recharge, low water table areas. Underdrains are often supplemented in dry ponds to aid in the volume recovery time. Four (4) public and two (2) private partnership wet ponds are proposed in the City.

Ponds can operate in either an on-line configuration where the runoff is entirely routed through the pond, or in an off-line configuration where a design treatment/attenuation volume is routed to the pond using a diversion structure. To control overflow from the stormwater pond, a permanent flood control device such as a weir or drop structure is used. The outlet must be sized to provide adequate time for pollutant removal, yet discharge the stormwater before the next storm occurs. Detention ponds are typically designed for first

flush treatment (i.e., first 1-1.5 inches from developed area) similar to exfiltration or swales. Retention areas are typically designed to retain a certain storm events (i.e., 25 year / 24 hour storm) based on the applicable LOS criteria of the location. O&M consists of regular inspections, removal of sediment on a regular basis, periodic mowing, and regular cleaning and repair of inlets and outlets.

The primary pollutant removal mechanism in a wet detention pond is sedimentation. Significant loads of suspended pollutants, such as metals, nutrients, sediments, and organics, can be removed by sedimentation. Other pollutant removal mechanisms include algal uptake, wetland plant uptake, and bacterial decomposition.

Wet detention ponds function more effectively when they are regularly inspected and maintained. Routine maintenance of the pond includes mowing of the embankment and buffer areas and inspection for erosion and nuisance problems (e.g. burrowing animals, weeds, odors). Trash and debris should be removed routinely to maintain an attractive appearance and to prevent the outlet from becoming clogged. In general, wet detention ponds should be inspected after every storm event. The embankment and emergency spillway should also be routinely inspected for structural integrity, especially after major storm events. Embankment failure could result in severe downstream flooding. When any problems are observed during routine inspections, necessary repairs should be made immediately. Failure to correct minor problems may lead to larger and more expensive repairs or even to pond failure. Typically, maintenance includes repairs to the embankment, emergency spillway, inlet, and outlet; removal of sediment; and control of algal growth, insects, and odors. Large vegetation or trees that may weaken the embankment should be removed. Periodic maintenance may also include the stabilization of the outfall area (e.g. adding rip-rap) to prevent erosive damage to the embankment and the stream bank. In most cases, sediments removed from wet detention ponds are suitable for landfill disposal. However, where available, on-site use of removed sediments for soil amendment will reduce maintenance costs.

8.3.2.2.10 Exfiltration Pipes

Exfiltration pipes or trenches generally consist of a shallow excavation backfilled with coarse media and large diameter piping which provides subsurface storage of a specified volume of stormwater runoff for infiltration directly into the subsurface. This acts to not only reduce runoff volume loading downstream, but provides for pollutant attenuation as well. These structures are commonly lined with a geotextile filter fabric to inhibit clogging of the pipe and course materials from fine sediments. Routine maintenance and periodic clean out of the exfiltration piping can be made more efficient if the design is coupled with large, easy to access sumps. Approximately 15,000 linear feet of exfiltration is proposed in the City.

These BMPs are generally designed to capture and treat the "first flush" runoff from storm event which generally contain the majority of pollutant loads. The criteria for determining the first flush volume are based on site-specific characterizations and local code. This is called Infiltration Trench but we have been calling them exfiltration (the term "infiltration" is often used when drying to drain water *from* an area) ALSO design is important in these systems i.e. a sump or baffle is a MUST to keep sediment & debris OUT of the system so long-term maintenance is greatly reduced. Sump/baffle is vacuum cleaned much like stormdrains, catchbasins & sediment traps – altogether there might be

approximately 40-60 sump/baffles constructed that need to be cleaned maybe 2x/year minimum.

Exfiltration trenches function similarly to rapid infiltration systems that are used in wastewater treatment. Pollution removal efficiencies may be improved by using washed aggregate and adding organic matter and loam to the subsoil.

Infiltration, as with all BMPs, must have routine inspection and maintenance designed into the life performance of the facility. Maintenance should be performed as indicated by these routine inspections. The principal maintenance objective is to prevent clogging, which may lead to trench failure. Infiltration trenches and any pretreatment BMPs should be inspected after large storm events and any accumulated debris or material removed. A more thorough inspection of the trench should be conducted at least annually. Annual inspection should include monitoring of the observation well to confirm that the trench is draining within the specified time. Trenches with filter fabric should be inspected for sediment deposits by removing a small section of the top layer. If inspection indicates that the trench is partially or completely clogged, it should be restored to its design condition. When vegetated buffer strips are used, they should be inspected for erosion or other damage after each major storm event. The vegetated buffer strip should have healthy grass that is routinely mowed. Trash, grass clippings and other debris should be removed from the trench perimeter and should be disposed properly. Trees and other large vegetation adjacent to the trench should also be removed to prevent damage to the trench.

Routine maintenance much is like sediment traps consisting of vacuum cleaning in-house or contracted out if equipment rental & scheduling is constrained. Expected lifespan is probably 20 – 30 years depending on maintenance performed.

8.3.2.2.11 Bioretention

Bioretention is a BMP that utilizes soils and both woody and herbaceous plants to remove pollutants from stormwater runoff. Stormwater runoff is conveyed as sheet flow to the treatment area, which consists of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. As runoff passes first over or through the sand bed, the runoff's velocity is slowed allowing it to distribute evenly along the length of the ponding area that is graded to a center depression. Water is ponded to a depth of ~6 inches and gradually infiltrates into the bioretention area or is evapotranspired. Bioretention provides stormwater treatment that enhances the quality of downstream water bodies. Runoff is temporarily stored in the BMP and released over a period of four days to the receiving water. The BMP is also able to provide aesthetic properties including shade and wind breaks, noise adsorption, and improvement to an area's landscape.

Bioretention typically treats stormwater that has run over impervious surfaces at commercial, residential, and industrial areas. Bioretention is an ideal stormwater management BMP for median strips, parking lot islands, and swales. These areas can be designed or modified so that runoff is either diverted directly into the bioretention area or conveyed into the bioretention area by a curb and gutter collection system. The site must be graded in a manner that minimizes erosive conditions as sheet flow is conveyed to the treatment area, maximizing treatment effectiveness. Similar to other infiltration type BMPs, bioretention is not an appropriate BMP at locations where the water table is high.

Bioretention removes stormwater pollutants through physical and biological processes, including adsorption, filtration, plant uptake, microbial activity, decomposition,

sedimentation, and volatilization. Adsorption is the process whereby particulate pollutants attach to soil (e.g., clay) or vegetation surfaces. Filtration occurs as runoff passes through the bioretention area media, such as the sand bed, ground cover and planting soil. Plant growth is sustained by the uptake of nutrients from the soils. Microbial activity within the soil also contributes to the removal of nitrogen and organic matter. Sedimentation occurs in the swale or ponding area as the velocity slows and solids fall out of suspension. Volatilization also plays a role in pollutant removal as pollutants such as oils and hydrocarbons can be removed from the wetland via evaporation or by aerosol formation under windy conditions.

Although the use of bioretention is new, results from performance studies for other infiltration type BMPs can be used to estimate bioretention's performance. The BMP could potentially achieve greater than 90 percent removal rates (similar to exfiltration) for total suspended solids, organics, and bacteria. This performance is dependent on the size and sloping of the area used. As with other infiltration/retention BMPs, the more land area available to the more effective the BMP can be. Recommended maintenance for a bioretention area includes inspection and repair or replacement of the treatment area components. Trees and shrubs should be routinely inspected to evaluate their health with pruning and weeding performed as necessary to maintain the treatment area's appearance. Mulch replacement is recommended when erosion is evident or when the site begins to look unattractive. Approximately 6,200 linear feet of bioretention (not biofilter) proposed

Bioretention removes storm water pollutants through physical and biological processes, including adsorption, filtration, plant uptake, microbial activity, decomposition, sedimentation and volatilization.

Recommended maintenance for a bioretention area includes inspection and repair or replacement of the treatment area components. Trees and shrubs should be inspected twice per year to evaluate their health and remove any dead or severely diseased vegetation. Diseased vegetation should be treated as necessary using preventative and low-toxic measures to the extent possible. Pruning and weeding may also be necessary to maintain the treatment area's appearance. Mulch replacement is recommended when erosion is evident or when the site begins to look unattractive. Spot mulching may be adequate when there are random void areas; however, once every two to three years the entire area may require mulch replacement. This should be done during the spring. The old mulch should be removed before the new mulch is distributed. Old mulch should be disposed of properly. The application of an alkaline product, such as limestone, is recommended one to two times per year to counteract soil acidity resulting from slightly acidic precipitation and runoff. Before the limestone is applied, the soils and organic layer should be tested to determine the pH and therefore the quantity of limestone required. When pollutants reach toxic levels which impair plant growth and the effectiveness of the BMP, soil replacement may be required.

8.3.2.2.12 Sediment Oil / Grease Traps

A sediment trap, sometimes referred to as a water quality inlet, is a structural control used for pretreatment of the runoff volume resulting from the first flush event. This multi-chambered device is used to collect debris and coarse sediments prior to discharge to a stormwater outlet pipe. Some configurations allow for the trapping of oils & greases from runoff. These materials are trapped in the unit allowing for removal and disposition under a

routing maintenance program. Modifications can be made to the system by adding diffusion baffles at the inlets to prevent turbulent flow from entering the unit and causing pollutants to re-suspend. Four small, three medium sediment traps and five large, three super sized sediment oil/grease traps proposed.

Because of restraints caused by land requirements and cost, sediment traps are often used as alternatives to other larger BMPs. However, their storage size limits their ability to provide stormwater quantity control. These units are typically used in an off-line configuration where a baffle system is used so that only a portion of the runoff is diverted to the unit. To maintain optimum efficiency, O&M consisting of sediments and debris removal, and visual inspection of the units must occur on a periodic basis. Special care must be taken during the removal process since the residuals may include toxic hydrocarbons that need to be disposed of according to local hazardous waste regulations. Initial testing should be conducted for metals and hydrocarbons to ensure proper disposal of the sediment material.

Sediment oil / grease traps are primarily utilized to remove sediments from storm water runoff. Grit and sediments are partially removed by gravity settling within the first two chambers. Hydrocarbons associated with the accumulated sediments are also often removed from the runoff through this process.

Sediment oil / grease traps are also called Water Quality Inlets. The key to the performance of WQIs (Water Quality Inlets) is maintenance. When properly maintained, WQIs should experience very few separation, clogging, or structural problems. Basic maintenance should consist of regularly checking and cleaning out the sediment that has accumulated in the WQI. A lack of regular clean-outs can lead to the resuspension of collected sediments; therefore, WQIs should be inspected after every storm event to determine if maintenance is required. At a minimum, each WQI should be cleaned at the beginning of each season. The required maintenance will be site-specific due to variations in sediment and hydrocarbon loading. Maintenance should include clean out, disposal of the sediments, and removal of trash and debris. The clean out and disposal techniques should be environmentally acceptable and in accordance with local regulations. Since WQI residuals contain hydrocarbon by-products, they may require disposal as hazardous waste. Many WQI owners coordinate with waste haulers to collect and dispose of these residuals. Since WQIs can be relatively deep, they may be designated as confined spaces. Caution should be exercised to comply with confined space entry safety regulations if it is required. Oil/water separator tank units can be fitted with sensing units that will indicate when the units need to be cleaned. Because most of oil/water separator tank units are designed for specific industrial applications, their maintenance schedule should be closely tied to the industrial process schedule. However, these units should also be inspected after rain events.

8.3.2.2.13 Storm Drain Inlets

Inlet inserts can include trays, bags and baskets. In each instance, debris must be cleaned from the filter media or screen and the openings designed to allow for high flows should be cleared so that flows would be unimpeded.

Inserts require high maintenance and must be closely monitored during rain events to ensure that they are not clogged or bypassing flow. Such a level of maintenance is impractical for most installations. Tray-type inserts are generally not effective in trash or solids removal. Bag- and basket-type drain inlet inserts can be effective in removing gross

pollutants (trash) if they are well maintained. For areas with a limited number of inlets where trash removal is the desired objective, these types of inserts can be a useful BMP.

It is estimated that the removal of debris from existing screen basket collectors and maintenance of curb inlet protectors will require 240 crew-hours annually. In the downtown area, existing structural BMPs include at least 16 inlet protectors with debris collection baskets.

8.3.2.2.14 Media Filter

A variety of media filters are currently in use, including sand, compost, sand peat, and perlite/zeolite products which are proprietary. Sand filters are widely used, but are generally limited to low-turbidity waters and operate through a combination of straining and adsorption. They are among the most efficient conventional treatment devices, achieving good removal of particulates and modest removals of bacteria and dissolved metals.

The purpose of the sedimentation chamber is to remove the solids that can settle to do so rather than to rapidly clog the filter. Sand filters require relatively high maintenance compared to other BMPs. Operation and maintenance costs are difficult to estimate on a general basis, because variables such as maintenance access and constituent load are site-specific.

8.4 RECOMMENDATIONS FOR FUTURE STAFFING

The Stormwater Master Plan has also been developed to be one of the tools for planning the needs for the Stormwater Department staffing. Most of the recommendations of this section are for minimum levels of maintenance and therefore in an increase in staffing levels must be provided to at least meet those needs.

In general, the current level of staffing and funding is not quite sufficient for achieving the level of preventative and scheduled maintenance desired. In addition, more annual training will be needed to educate City staff to detect illicit discharge and monitor pollution prevention violations. With the amount of preventative maintenance and scheduled maintenance needed annually, time is not available for the current staff to perform other functions such as inspection and water quality monitoring.

Partial funding of a Compliance Officer is recommended. Officer can monitor Code compliance associated with environmental issues and other land development regulations. This position can be funded through a combination of Water Reclamation, Public Works, Development Services and Stormwater monies.

Dredging, if approached comprehensively, will need a full-time staff of 3-maintenance crew. These positions can be funded through the combined financing of Stormwater and General Fund dollars. If deemed cost effective, special assessment dollars (MSTUs) can also be utilized. Once the waterways are comprehensively cleaned and upstream measures are taken to eliminate pollutant loading, dredging needs and the program structure will greatly be reduced.

With the addition of new Capital Assets or BMPs will eventually come the need for additional maintenance staff for both preventative and scheduled maintenance. Operational activities will need to be evaluated as to whether certain activities are best contracted out rather than increasing staff. It is anticipated that these needs will be great by year 3 or 4. The City will need to seriously look at performing long-term maintenance contractually after 10 or 15 years. It is also anticipated that methods for short and long-term maintenance will

be greatly improved through technology as more of these systems go on-line throughout the nation.

Storm drain maintenance is expected to exceed 250 crew-hours annually, based on a prescribed maintenance schedule that has been previously developed. More extensive, rehabilitation of storm drains can be expected to require a minimum of 100 crew-hours. In addition, the use of the VacCon and the television inspection of lines will exceed a total of 320 crew-hours. Restorative maintenance has included the slip-lining of pipe and outfall reconstruction. Restoration of pipe capacity is achieved through the slip-lining of deteriorating pipe. This program is expected to require approximately 200 crew-hours until all areas of the City have been restored. Crew hours are based on the use of a three-member maintenance crew. Increases in pipe efficiency are expected to see a decrease in build-up of sediments and may reduce the hours required in other maintenance areas.

One three-person field maintenance crew consisting of a supervisor and two crewmembers currently provides all current operations and maintenance activities, including inspection. In addition to the field crew, the salary of the administrator and 10% of a director's time is itemized in the stormwater expenditure budget for costs related to operations. The total FY2001 Personnel budget for these five employees was $187,500, an increase of $17,035 from the FY2000 budget. Actual overtime expenses in FY2000 occurred at a level 2.7 times greater than had been budgeted, yet the FY01 budget reduced overtime hours by 62%. At the current funding level, additional maintenance activities are impossible. Any enhancements will require additional resources and a prioritization of stormwater management goals. A comprehensive dredging program would require the addition of three maintenance staff positions.

In summary, it is recommended that the City fund additional staff and budget in the future to a level to maintain and meet the program goals. The review of the existing program notes many needed activities. The ultimate indicator for staffing will be based on the level of service grade attained each year.