SECTION 5

BMP EVALUATION

CITY OF COCOA BEACH, FLORIDA
STORMWATER MASTER PLAN

PARSONS ENGINEERING SCIENCE, INC.

OCTOBER 2001

SECTION 5
BMP EVALUATION

The previous sections of this Master Plan focused on the identification of the flooding and water quality problems that currently exist in the City of Cocoa Beach. Section 3 quantified the degree of flooding problem severity through the development and application of specific LOS criteria. In Section 4, a PLRG-based LOS was developed to assess the degree of water quality problems. The purpose of this section is to identify solutions for addressing the identified stormwater management problems. These solutions are addressed in the form of Best Management Practices (BMPs) for stormwater.

BMPs are structural controls, non-structural controls, and operation and maintenance (O&M) procedures that are used in stormwater management to reduce or attenuate runoff volume and provide a reduction in pollutant loads into receiving waters. Structural controls address runoff quantity and quality through a specific device or storage structure, whereas non-structural controls attenuate a pollutant at its source, prior to disposal into the stormwater system. An O&M program must be established to insure the stormwater controls operate per design over time.

During the course of this study, efforts were made to account for existing BMPs that currently influence runoff quantity and quality. Efforts were then made to identify the potential types and locations of future BMPs (conventional and innovative) that could be implemented to improve stormwater management in the City and meet PLRG and LOS goals. The BMP projects deemed applicable for implementation were then used as a starting point from which a prioritized CIP can be established. The following subsections provide background data on various BMPs detailing the effort undertaken in their evaluation.

5.1 BMP BACKGROUND AND SITE APPLICABILITY

The characteristics of the City of Cocoa Beach present many unique, site-specific opportunities and challenges in the implementation of BMPs. These characteristics affect the manner in which water quality and flooding problems can be addressed. Certain BMPs that may be of great benefit in other municipalities may not be of advantage to Cocoa Beach and visa-versa. Proper consideration to these site specific advantageous and constraints is critical to the development of a successful BMP implementation program.

The primary theme in the development of measures to address stormwater is that stormwater is a freshwater resource to be managed, not a nuisance commodity to drain away. This theme must prevail in the selection of BMPs that can utilize retention and/or infiltration to keep freshwater in the City while still alleviating flooding and reducing pollutant loads. This can provide a significant benefit from a water supply perspective, allowing potentially more water availability for reuse, storage, and/or aquifer replenishment.

As discussed in the Basin Characteristics section of the Master Plan, there are several noteworthy physical characteristics of the City that effect stormwater runoff. In general, the City has an east to west flow of stormwater. In the easternmost portion of the City adjacent to the beach, runoff flows to the ocean. However, the remainder travels east to west, eventually discharging into the Banana River Lagoon via storm sewer piping, sheet flow, or direct discharge. The ground elevations on the eastern side of the City tend to be higher, with more predominance of sandy, highly permeable soils.

From a BMP implementation standpoint, these east versus west characteristics affect the manner in which BMPs can be implemented. Foremost, is the fact that it is generally difficult or unfeasible to bring stormwater from the west to the east. This is a disadvantage in that most of the highly permeable soils that are conducive to infiltration are in the east and uphill. These areas would normally be good candidates for pond storage, but because of the limited accumulation of runoff in these areas, wide-spread, small scale infiltration or retention measures would be more suitable. In the west where the majority of cumulative runoff volume passes, the soils are less conducive to infiltration and the water table higher to the surface making retention and infiltration difficult.

Land use in the City also provides many challenges. The City is primarily built out with little vacant land for major BMP installation such as ponds. There are significant areas of commercial development and major roadways that have little green space available. The residential areas are unique in that the numerous "finger" areas have individual outfalls dictating wide-spread small scale measures rather that concentrated efforts.

The BMPs must be applied rather evenly across the City. BMPs in downstream locations are effective since they can provide treatment for a large area. However, upstream areas must also be addressed. Reduction in runoff in upstream areas through retention/exfiltration can reduce the downstream hydraulic velocity and the potential for scour associated turbidity problems in the canals/lagoon. Also, reducing upstream runoff volumes will reduce the incidence of flooding at low elevations and could even influence canal levels.

Lastly, consideration must be made to the implementation of BMPs at Cocoa Beach with respect to the IRL as a whole. BMP projects recommended for the City will be reviewed by SJRWMD and the IRL program for integration into the entire IRL improvement program. As such, recommended BMPs should be consistent with similar application in other municipalities associated with the IRL. In other words, all recommended BMPs should be "sanctioned" by the IRL program for improving the lagoon's overall health.

5.2 BMP DESCRIPTIONS AND CHARACTERISTICS

The following BMPs were identified for further evaluation as either existing in the City at present or of potential benefit to the City:

- **Swales**
- **Bioretention**
- **Exfiltration**
- **Stormwater Ponds**
- **Sediment Traps**
- **Canal Dredging**
- **Street Sweeping**
- **Public Education**
- **Dune Revegetation**
- **Aquifer Storage and Recovery**
- **Debris Baskets / Inlet Screens**
- **Vegetative Buffers / Revegetation**
- **Impervious Area Reduction Measures**
- **Canal Treatment and Enhancements**

Descriptions and general characteristics of these BMPs deemed applicable to Cocoa Beach are briefly described in the following subsections as a background to the existing and proposed BMP discussions later in this section. Following these descriptions, Table 5-1 provides a concise summary of the overall characteristics and relative advantages and disadvantages of each of these BMPs for reference purposes.

5.2.1 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. To promote temporary storage of stormwater in swales and increase pollutant removal, raised stormwater inlets or swale blocks can used to provide some level of retention. Other types of vegetation such as shrubs and small trees can be supplemented to provide additional pollutant attenuation. When combined with some degree of retention, the variation on vegetation in the swale can approach a bioretention type of BMP that can improve pollutant removal dramatically for average to low volume storm events.

Since swales rely on infiltration for their effectiveness, they provide a significant amount of aquifer recharge, particularly when slopes are low and swale blocks or some other type of retention promotion feature is used. In coastal areas such as Cocoa Beach, this source of recharge of freshwater to the aquifer can aid in the inhibition of saltwater intrusion in the subsurface. The overall high infiltration capacity of the sandy soils on the eastern portion of Cocoa Beach make these areas particularly suited for swales. The degree of infiltration is also proportional to the pollutant removal efficiency in that the more runoff that is infiltrated the more opportunity for pollutants to be trapped in the BMP and not released downstream. Based on the foregoing, swales can be considered a benefit to overall water supply in the City.

5.2.2 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.

Similar to swales and exfiltration, bioretention can provide a great benefit to Cocoa Beach from a water resource/supply standpoint. The more runoff that can be retained, infiltrated, and/or evaporated acts to reduce the overall freshwater impact to the receiving water body. The areas can be sized to treat the first flush of runoff from a particular subbasin, or the size increased proportional to the land available for additional treatment and infiltration. The BMPs is also aesthetically pleasing, and can easily be incorporated into a park or other area where landscaping can be of benefit.

5.2.3 Exfiltration

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.

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 typically the first 1-1.5 inches of runoff from the developed site, or other based on site constraints. Any volume that exceeds the maximum amount that can be treated by the exfiltration system is typically diverted to the nearest stormwater inlet.

Since exfiltration relies primarily on infiltration, these BMPs provide a significant amount of aquifer recharge. In coastal areas such as Cocoa Beach, this source of recharge of freshwater to the aquifer can aid in the inhibition of saltwater intrusion in the subsurface. The overall high infiltration capacity of the sandy soils on the eastern portion of Cocoa Beach along with the deeper relative water table depth make these areas particularly suited for exfiltration. Where additional space is available, these BMPs can be oversized beyond the first flush sizing to increase the amount of runoff volume infiltrated. Based on the foregoing, exfiltration can be considered a benefit to overall water supply in the City.

Conceptual plans of a bioretention enhanced exfiltration project are included in Appendix 5A. These plans are applicable to multiple locations and are intended for conceptual design purposes, **not for construction**.

5.2.4 Stormwater Ponds

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.

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.

Due to their storage characteristics, ponds can provide a significant benefit to water supply. This is both through aquifer recharge and providing storage for reuse. This source of recharge of freshwater to the aquifer can aid in the inhibition of saltwater intrusion in the subsurface. Ponds can act as reservoirs in that they can store water for some form of reuse. The use of pond storage for irrigation purposes has been successful in many parts of Florida. They can also be beneficial to technologies such as aquifer storage and recovery (ASR) systems where they can be used as temporary storage reservoirs prior to or after aquifer storage for later reuse. Wet ponds can also provide an aesthetic benefit when used as a part of a park or for recreational purposes.

The overall high infiltration capacity of the sandy soils on the eastern portion of Cocoa Beach along with the deeper relative water table depth make dry retention in these

areas potentially feasible. These would likely not be suitable locations for larger ponds as they would be located upstream of the bulk of stormwater runoff to be treated. For the most part, however, the high relative water table, particularly in the western portions of the City by the lagoon, dictate the installation of wet pond systems.

5.2.5 Sediment 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.

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.

These BMPs function primarily to remove solids and do not provide any runoff infiltration or retention. As such, their usefulness for water resource/supply purposes is negligible. Their pollutant removal ability is also limited in that they are effective only with pollutant constituents associated with courser debris and sediments. For these reasons, sediment traps are typically the last resort BMP in areas where water supply and recharge is of concern, when no other BMP appears feasible because of land availability and/or access constraints.

Conceptual plans of sediment trap layouts are included in Appendix 5A. These plans are applicable to multiple locations and are intended for conceptual design purposes, **not for construction**.

5.2.6 Canal Dredging

Canals existing in inter-coastal waterways can provide a natural buffer between an urbanized environment and sensitive receiving waters. Man-made canals such as are present at Cocoa Beach were generally designed for recreational navigation and are typically repositories for the bulk of stormwater discharges. Oftentimes the extended lengths of the canals act as settling basins, allowing a great deal of pollutant settling prior to the primary receiving water. When the canals are subject to a routine dredging program to remove the build up of sediments, this in effect represents a water quality BMP. This type of treatment would be similar in nature to a detention pond system with an open discharge.

Canal dredging can provide numerous benefits that would help the City of Cocoa Beach. A comprehensive dredging program could help the City meet permit requirements and be worked into pollutant reducing program to assist in meeting permit goals. The dredging would create cleaner, healthier canals that could increase property values. The

removal of built up sediments would also have the benefit of aiding navigation within the City. It should be noted however that removing the upland sediments prior to discharge into the canals would improve the health of the canal system and lower the frequency of dredging.

5.2.7 Street Sweeping

Street sweeping is a non-structural BMP that relies on source control via debris removal to aesthetically enhance the appearance of roads. At the same time, street sweeping reduces the amount of pollutants that accumulate on impervious areas and enter the stormwater system in runoff. This aids in reducing the sediment loadings to downstream BMPs, allowing them to function more efficiently, lessening maintenance requirements and increasing their useful operational life. This preventive measure is particularly effective in lowering pollutant loading for largely urbanized areas since it does not require land area and/or a permanent structure like other BMPs do. It can be implemented successfully on various roadways, particularly when curb and gutters are present.

5.2.8 Public Education

Education programs are non-structural BMPs that can inform public sector employees, business, and residents of methods or alternatives for reducing the pollutant loading impacts on receiving waters. This can include educating residents on how stormwater contributes to water quality degradation and what practices can reduce the potency of runoff. This can include runoff reducing / pollutant reducing practices such as proper disposal of yard wastes and revegetation to reduce erosion and sediment wash off.

Public outreach can occur on a local or watershed basis. Partnerships with County, SJRWMD, and other cities can be established to share information and materials, and produce regional articles and publications. Local governmental agencies can sponsor public presentations, school programs, and mailings aimed at children and adults. Business employees can learn to properly perform operations, handle and store materials and dispose of wastes through training courses, videotape presentations, and seminars. Businesses, municipalities, and homeowners can also learn how to use and dispose of fertilizer and pesticides correctly to maintain their lawns and gardens without polluting the water. Although difficult to quantify, this BMP is a valid method for reducing pollutant loadings.

5.2.9 Dune Re-vegetation

Dune re-vegetation is a structural BMP used to minimize the loss of sand within the coastal barrier dunes and reduce the transport of sediments into the stormwater conveyance system. Re-vegetation takes the form of the controlled planting of native grasses and shrubs naturally adapted to a beach environment. This vegetation must be drought tolerant, exist on a limited nutrient supply, be resistant to sand blasting and saltwater flooding. This is best accomplished by using native dune vegetation such as sea oats for the fore dune and shrubs such as saw palmetto and sea grape for the back dune. It should be noted that it is these taller shrubs which keep sand from blowing onto City streets and impacting the drainage system and lagoon. This measure will in time reduce the City's dredging needs. Notices may be posted around the dunes to alert beach visitors of dune vegetation existence and of their restricted access. To protect the dunes from being damaged by foot and vehicular traffic, wooden crosswalks and beach access areas can be designated. The fragile nature and erodibility of dunes makes their stabilization very difficult, thus management and monitoring programs are an essential part of success in re-

establishing sand dune vegetation. The locations considered suitable for dune re-vegetation projects are shown on Figure 5-9. These locations should be evaluated and a plan should be drafted for the design, prioritization and implementation of these dune improvements.

The qualitative benefit of this type of BMP is obvious as a method of reducing sediment loads that would enter the storm sewer system. The specific pollutant reduction ability (i.e., removal efficiency) is not so easily quantifiable, however, as there is limited research and/or available data into its use as a pollutant reduction tool. To estimate sediment reduction from this BMP, some type of field measurement would be necessary, or potentially the use of erosion/soil loss equations with assumptions made for soil types, wind conditions, vegetative cover, etc.

5.2.10 Aquifer Storage and Recovery

Aquifer Storage and Recovery (ASR) is a process by which groundwater aquifers are utilized for temporary storage of water. Typically, this technology is conceptualized for wastewater treatment system discharges but can also be applied to stormwater runoff. In this process stormwater runoff could be collected at a centralized (or several different) locations and pumped into the aquifer using deep well injection. Once stored, this water can then be utilized on an "as need" basis for irrigation or other purposes. This technology could provide a significant benefit to water quality in reducing freshwater and pollutant discharges to the Banana River.

The feasibility of this technology could only be justified through extensive study and design. The application of ASR would require significant capital for the surface management of the stormwater along with the collection, distribution, and pumping systems. Proper characterization of the aquifer is critical to avoid loss of the water resource or cross-contamination into drinking water supplies. Since this technology is new and fairly un-established, permitting may be difficult if not prohibitive. Cocoa Beach may have an advantage in that there is currently a reuse system established in the City for delivering water to end users. Some type of treatment would generally be required either prior to aquifer storage, prior to end use, or both.

The application of ASR could provide a major impact to the water supply situation of Cocoa Beach. It would be a more direct benefit to wastewater and reuse by securing a "commodity", but could then be applied to stormwater at a time in the future when money and technology can be applied to its implementation. The application of ASR can utilize stormwater ponds for a mutual, cost-effective benefit for future collection and supplementation of the ASR system. Since the City has limited land area to secure these types of "reservoirs", decisions made now on stormwater pond projects can greatly impact the City's water supply options in the future

5.2.11 Debris Baskets / Inlet Screens

These installations consist of a small metal woven basket that is a prefabricated inserted into stormwater inlets and catch basins. These trap large debris such as trash, leaves, and other large wastes minimizing the build up of material in manholes. These would generally be best suited for residential areas with inlets that do not have some other type of buffer treatment such as a swale.

5.2.12 Vegetative Buffers / Revegetation

Sediment erosion is one of the primary contributors to TSS loadings into the storm sewer system. Where possible, re-vegetation of roadside or other areas associated with inlet structures can be performed using sod or other plants or landscaping to minimize

erosion. In addition, some consideration should be given to providing a freeboard allowance between the pavement and grass/landscaping in some roadside areas with chronic erosion problems. This may aid in reducing the suspension of sediments during runoff along the roadside.

Vegetated buffer strips of grass or native plantings can be provided in key area to keep runoff from directly flowing to stormwater drainage system or the canals/lagoon. Vegetative buffers can be placed along the curbing, sidewalks, seawalls and any other areas where runoff can be intercepted prior to flowing to a canal or lagoon outfall. This type of BMP application can work in concert with impervious area reduction measures to increase infiltration and pollutant removal in various areas of the City.

5.2.13 Impervious Area Reduction Measures

With regard to stormwater runoff, the less impervious area that exists – the less runoff is generated and more runoff is able to be infiltrated. The City can take a holistic look at its current land development design and seek to find areas which can be made pervious. Example of such areas can be parking lots/garages, under shops/offices, paved roadside areas, etc. Many methods can be employed to decrease the impervious area including grassed overflow parking, grass areas between curb and sidewalk, use of pavers and pervious pavements, and vegetative buffers as described above. Policies and ordinances can be drafted for new development or re-development that encourage use of pervious surfaces where feasible and offer flexibility for new technologies and ideas.

5.2.14 Canal Treatment and Enhancements Options

There are numerous canal treatment and/or enhancement options that can be applied including the following:

- **Canal Filtration / Aeration:** Adding filtration and/or aeration to low-flushing canals can add oxygen, lower algae and bacteria formation and generally improve the health of a canal just as it can improve the health of a detention pond. This technology generally consists of a series of blower and bubbler tubing (aeration) or intake piping and pump (filtration) systems installed with a small control enclosure. A routine operations and maintenance schedule must be maintained to insure proper working order. The success of this technology is site specific, and is best proven through a small-scale demonstration project to monitor before/after conditions prior to a large scale implementation. Operations and maintenance of such systems can be aided through "adopt a canal" or similar type programs where residents adopt some of the routine maintenance of the filtration/aeration system.

- **Canal Treatment:** Adding soil microorganisms to canals has been demonstrated to reduce the turbidity in the canal by feeding on the nutrients and algae. This can also reduce the volume (increase density) of muck through digestion. This type of application is relatively new, and success would be on a site-specific basis. As such, this type of improvement could be performed on a small demonstration scale first to establish its success rate prior to a more widespread application. If successful, this coordinated with a dredging program can help reduce costs, energy, and timeline of the dredging.

- **Circulation Improvements:** Many water quality problem can result or be magnified by poor circulation. Lack of circulation can cause the stagnation of water

that can lead to the development of undesirable conditions such as algae formation and eutrophication. Methods of improving circulation within Cocoa Beach's canal system could provide a benefit to the City. Examples of poor circulation areas are the residential canals to the north and south of Minuteman Causeway and north of 4th Street South. The installation of culverts under the roads which connect the water bodies could improve the circulation and provide a flushing effect which could lead to improvement of water quality conditions (algae formation, oxygen levels & eutrophication) in the canals. The actual benefit of this type off action is difficult to quantify without further study, but could be an improvement considered for the future after major projects in CIP are addressed.

5.3 EXISTING BMP IDENTIFICATION

Prior to engaging in the evaluation of BMPs to address the flooding and water quality problems, an analysis of existing BMPs of significance was performed. In the case of flooding, this exercise was not deemed critical as existing features of importance were incorporated into the flooding model. The primary purpose of this existing BMP identification analysis exercise was to provide data from which to generate the *EXISTING BMP* pollutant loading case for the PLRG process for water quality improvement described in Section 4.

A cursory analysis of the City was performed during the data collection phase of the Master Plan to note the presence of distinct BMPs, stormwater management features, or processes that functionally act as BMPs. Although not exhaustive, the existing BMPs identified are considered to represent the more significant BMPs in relation to the pollutant loading modeling performed as part of the water quality assessment. For example, if a surface depression was identified as likely functioning as a swale by providing some level of runoff treatment but was not located within a reasonable proximity to a model node receiving runoff it was not included in the analysis. Thus, the *EXISTING BMP* pollutant loading case is somewhat conservative.

The site inspections identified numerous swales and retention/detention areas that were considered significant enough and therefore applicable to the existing BMP analysis. In addition to these BMPs, the canal locations which act as sediment removal areas when coupled with the dredging activities (as discussed in Section 5.2.6) were incorporated. Also, included were the areas that currently receive street sweeping (See Section 5.2.7) from a vacuum assisted unit contracted to the City. This essentially represents all of the curb and guttered streets in the City along with other significant roadway sections. Lastly, credit was assigned for public education (see Section 5.2.8) as a BMP to account for measures currently implemented by the City's Stormwater Program.

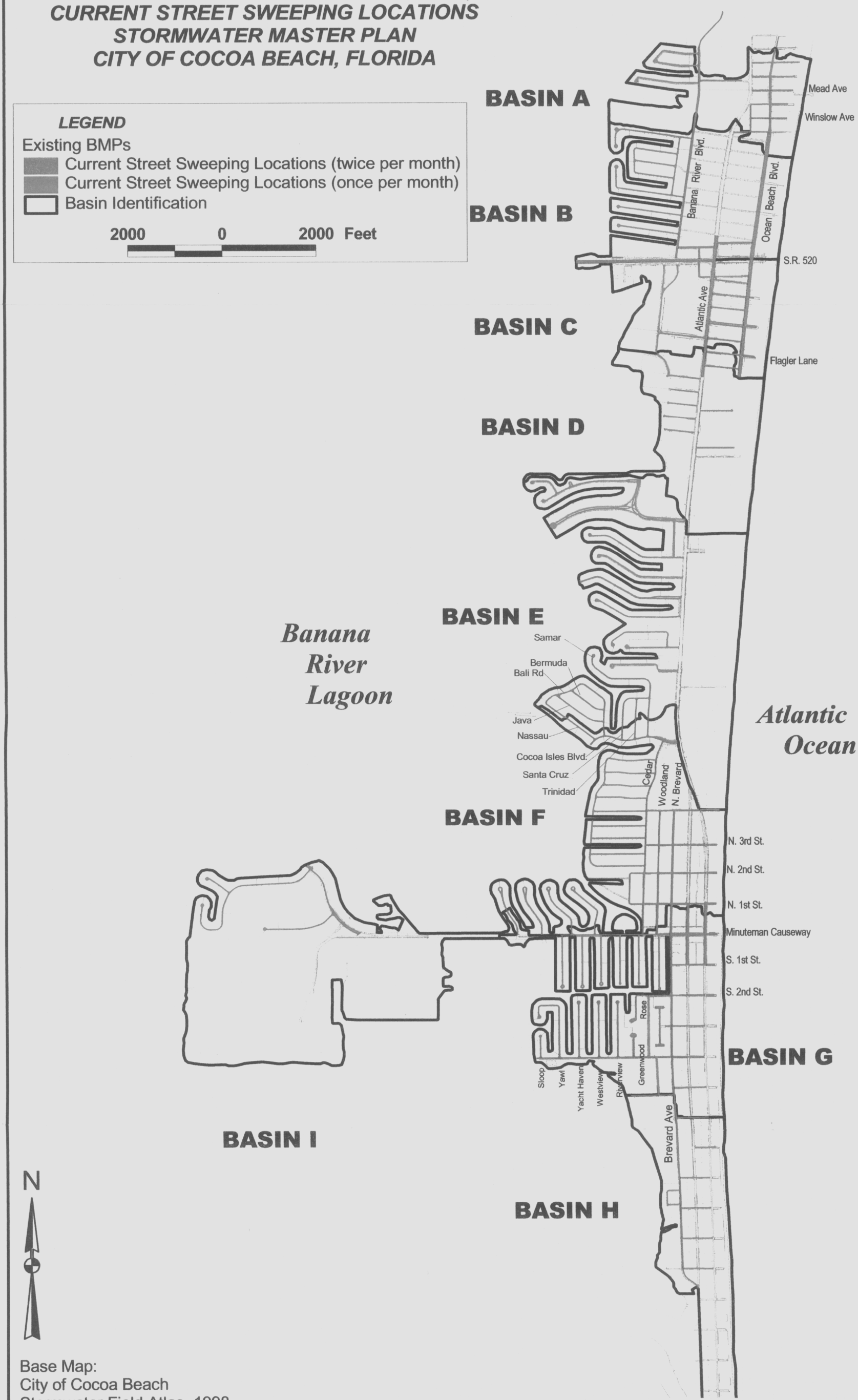
The existing swale and pond BMPs identified are listed in Table 5-2. The locations of these existing BMPs, as well as the canal dredge areas and street sweeping are shown on Figures 5-1, 5-2, and 5-3, respectively. These BMPs were incorporated into the *EXISTING BMP* and *FULL BMP* pollutant loading analysis cases, described in Section 5.6.

TABLE 5.2
EXISTING BMPs USED IN MODELING - SWALE AND STORMWATER POND LOCATIONS
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA

BASIN	OWNERSHIP	SWALES
E	Private	Interior Swale Between Antigua and June
E	Private	Interior Swale Between June and Esther
E	Private	Interior Swale Between Holiday and Samar
H	Private	Indian Village Trail
I	Public	Golf Course Swales
BASIN		**STORMWATER POND AREAS**
A	Private	Church Property Retention
C	Private	Retention Rock Point Condos North
C	Private	Shopping Center Retention Pond
C	Private	Retention Condos at Banana River and St. Lucie
D	Private	Depressional Retention From Contributing Area - Surf Drive And A1A
D	Public	Depressional Retention Fisher Park
D	Private	Retention Diplomat Boulevard
D	Private	Retention Condos At Escambia and Banana River
D	Private	Retention Banana River Shopping Center and Wendy's
D	Private	Retention Rock Point Condos South
D	Private	Retention Church Property Between Escambia and Pinellas
D	Private	Retention Property Adjacent to Pinellas
D	Private	Retention Condos South Of Seminole Lane
E	Private	Retention Property SE Of Cocoa Isles Blvd. and A1A
E	Private	Retention Property East Of Cocoa Isles Blvd. And A1A
E	Private	Retention Condos Banana River and St. Croix
E	Private	Retention Cape Royal Drive
E	Public	Depressional Retention Lori Wilson Park North
E	Public	Depressional Retention Lori Wilson Park South
E	Private	Retention - Denny's Pond
F	Private	Retention Cedar and Cocoa Isles Blvd. SE
F	Private	Retention Post Office and Adjacent Properties
F	Private	Retention Cedar And Cyprus
H	Private	Retention Condos Between 6th and 8th, Orlando and Brevard
H	Private	Indian Village Trail Pond
H	Private	Retention Condos South of Ramp Road
H	Private	Retention Condos Brevard and 8th
H	Public	Depressional Retention Surrounding Brevard and Harbor Circle
H	Private	Retention New Development NW of Brevard and 11th
I	Public	Golf Course Retention
I	Public	School Property Retention

FIGURE 5.3

EXISTING BMPs
CURRENT STREET SWEEPING LOCATIONS
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA

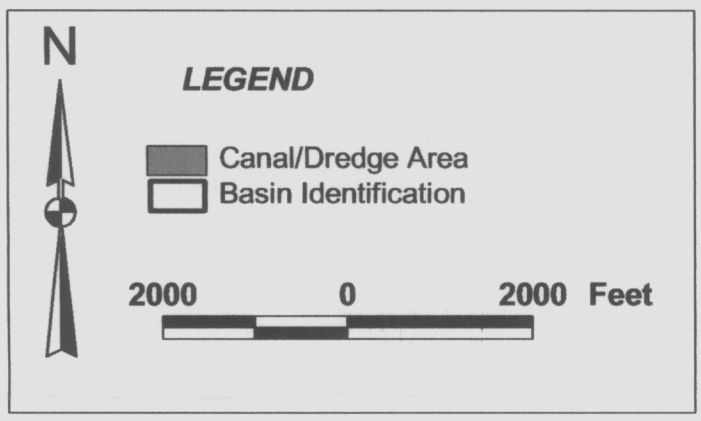


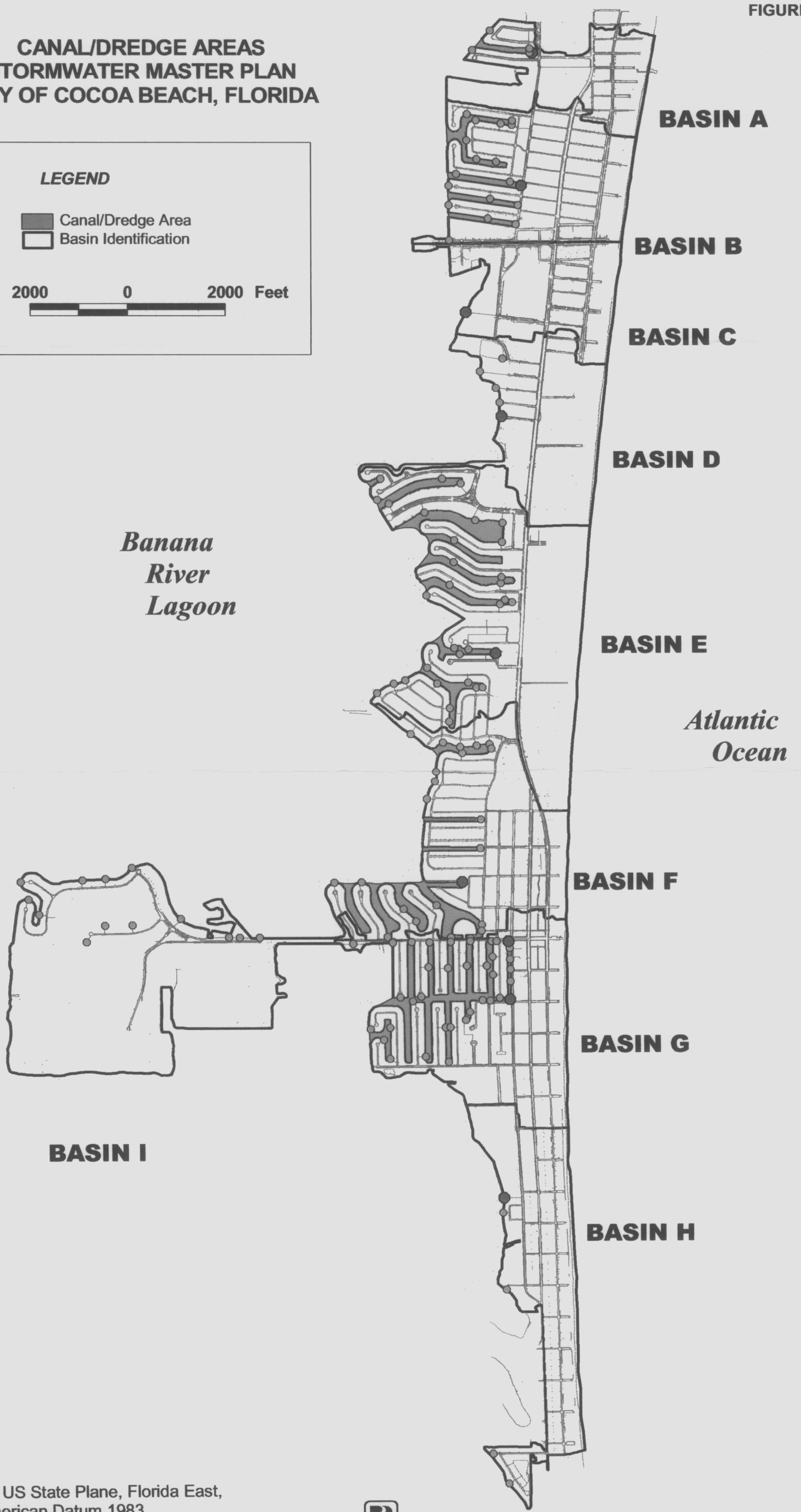
Base Map:
City of Cocoa Beach
Stormwater Field Atlas, 1998

PARSONS ENGINEERING SCIENCE, INC.

FIGURE 5.2

CANAL/DREDGE AREAS
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA





Note:
Map is in US State Plane, Florida East,
North American Datum 1983

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5.4 BMP IMPLEMENTATION TO ADDRESS FLOODING PROBLEMS

As summarized in the Flooding Assessment section, the flooding problems identified in Cocoa Beach are generally associated with areas of reported nuisance flooding and long-standing water. In addition, several areas were identified through the modeling as having the potential for concern based on the LOS criteria. These areas are generally functioning at a borderline or slightly below borderline LOS, as such a costly flooding-focused assessment of most of these locations does not appear warranted at present. Rather, the BMP evaluation for flooding purposes focused on the potentials for the identified projects to improve the conditions at these areas to the extent that they may no longer be a concern. The consideration of the possible runoff volume reduction potential of the identified BMPs was used in this evaluation.

The implementation of a CIP that targets the TAPLRG discussed in the Water Quality Assessment (Section 4) is predicted to approach a ~30% reduction in runoff volume as a conservative estimate. This is based on the reliance of a widespread implementation of infiltration and retention focused BMPs (exfiltration, swales, etc.) to reduce runoff quantities. **These BMPs in upstream areas would aid in reducing the runoff to the downstream portions of the storm sewer system, reducing peak volume and flow. BMPs in the downstream portion may alleviate some of the tailwater influence and reduce hydraulic heads. Based on this and the predominance of near borderline LOS with the majority of flooding problem areas, a deferred problem solution approach may be appropriate.**

As many of the BMPs are implemented to address the water quality problems, re-evaluation of these marginal flooding areas can be preformed on a site by site basis to determine if additional engineered controls are necessary. Many of the areas may not present further problems that would warrant study, which would represent a cost savings to the City. If problems persist, focused small area studies could be performed incorporating the new BMPs to address the lingering flood issues. The hydraulic model developed for this Master Plan (Section 3) could be utilized as a tool for these studies thereby saving effort.

Table 5-3 reiterates the problem areas from the Flooding Assessment, with final recommendations provided addressing each area. In general, recommendations are made for further addressing flooding issues if they persist beyond the CIP BMP project implementation.

TABLE 5.3
FLOODING PROBLEM AREA BMP EVALUATION
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA

Problem ID	Problem Location	Problem Description	Lowest LOS in Area	Recommendation
A3	Model Node SA025I - Ridgewood Avenue	Modeling indicates possible deficiency	C	No action at present, not identified as historical problem, runoff volume reducing BMPs (median swales/exfiltration) to be implemented upstream at SA015I/SA016I
B1	Ocean Beach Blvd.from California Ave.to E. Columbia La.	Nuisance flooding, standing water, supported by modeling	F	Recommend evaluating effectiveness of runoff volume reducing BMPs (median swales/exfiltration) to be implemented upstream at this area to reduce hydraulic loading, re-evaluate after BMP implementation
C4	Model Node SC125M - Belt Road	Modeling indicates possible deficiency	C	No action at present, not identified as historical problem, borderline LOS, FDOT roadway
E1	Intersection of S. Banana River Blvd. and Banana River Blvd.	Nuisance flooding, standing water, supported by modeling	D	Recommend evaluating effectiveness of runoff volume reducing BMPs (median swales) to be implemented upstream at this area to reduce hydraulic loading in concert with existing private retention, re-evaluate after BMP implementation
E4A/B, E5	Internal swale areas in Basin E	Nuisance flooding, fences and structures impeding swale flow	A	Modeling indicates acceptable LOS for flood stage, but model indicates long duration standing water. Drainage path inhibited due to structures and other obstructions. Evaluate for maintenance and/or grading improvements, possible structural upgrades and/or BMP imlementation.
E7	Between Samar and A1A	Nuisance flooding in yards behind businesses	n/a	Recommend evaluating effectiveness of runoff volume reducing BMPs (swales) to be implemented at this area to attenuate and better route hydraulic loadings, re-evaluate after BMP implementation
F4	Lookout Point Apts.1st St. N. and Cedar Ave.	Stormwater from apts. causing flooding at residents to west	n/a	Evaluate code enforcement or other action to coerce property owner into compliance.
F5	Minutemen Cswy. Between Crystal River Dr. and Danube River Dr.	Nuisance flooding, standing water, supported by modeling	D	Recommend evaluating effectiveness of runoff volume reducing BMPs (roadside swales) to be implemented at this area to reduce hydraulic loading, re-evaluate after BMP implementation
F6	Model Node SF024I - N. Orlando Ave.	Modeling indicates possible deficiency	D	No action at present, not identified as historical problem, borderline LOS, runoff volume reducing BMPs Recommend evaluating effectiveness of runoff reducing BMPs to be implemented (swales/exfiltration), FDOT roadway
F7	Model Node SF057I Woodland, Yard/Open Space	Modeling indicates possible deficiency	C	No action at present, not identified as historical problem, borderline LOS, upstream BMPs (swales/exfiltration) Recommend evaluating effectiveness of runoff reducing BMPs to be implemented for upstream areas along A1A
F8	Model Node SF050M - N. Brevard, N. 2nd St, Yard/Open Space	Modeling indicates possible deficiency	D	No action at present, not identified as historical problem, borderline LOS, upstream BMPs (swales/exfiltration) Recommend evaluating effectiveness of runoff reducing BMPs to be implemented for upstream areas along A1A
G2	A1A at Minutemen Cswy. and 1st St. S.	Nuisance flooding, standing water, supported by modeling	F	Recommend evaluating effectiveness of runoff volume reducing BMPs (exfiltration/roadside swales) to be implemented at this area to reduce hydraulic loading, FDOT roadway, re-evaluate after BMP implementation
G3	A1A near 3rd St. S.	Nuisance flooding, standing water	n/a	Recommend evaluating effectiveness of runoff volume reducing BMPs (exfiltration/roadside swales) to be implemented at this area to reduce hydraulic loading, FDOT roadway, re-evaluate after BMP implementation
G9	Model Node SG059I - S. 4th St.	Modeling indicates possible deficiency	C	No action at present, not identified as historical problem, borderline LOS, runoff volume reducing BMPs Recommend evaluating effectiveness of runoff reducing BMPs to be implemented for downstream areas
G10 / G11	Model Nodes SG077I / SG076M - N. Brevard, S. 2nd St, Yard/Open Space	Modeling indicates possible deficiency	D	No action at present, not identified as historical problem, borderline LOS, upstream BMPs (swales/exfiltration) Recommend evaluating effectiveness of runoff reducing BMPs to be implemented for upstream areas along A1A and Brevard Ave.
H1	A1A and 8th St. S.	Nuisance flooding, standing water	n/a	Recommend evaluating effectiveness of runoff volume reducing BMPs (exfiltration/roadside swales) to be implemented at this area to reduce hydraulic loading, FDOT roadway, re-evaluate after BMP implementation
H2	11th St. S. and Brevard Ave.	Nuisance flooding, standing water, supported by modeling	E	Recommend evaluating effectiveness of runoff volume reducing BMPs (exfiltration/roadside swales) to be implemented at this area to reduce hydraulic loading, re-evaluate after BMP implementation
H3	A1A and 11th St. S., 12th St. S., and 13th St. S.	Nuisance flooding, standing water	n/a	Recommend evaluating effectiveness of runoff volume reducing BMPs (exfiltration/roadside swales) to be implemented at this area to reduce hydraulic loading, FDOT roadway, re-evaluate after BMP implementation
H4	13th St. S. and S. Orlando Ave.	Nuisance flooding, standing water	n/a	Recommend evaluating effectiveness of runoff volume reducing BMPs (exfiltration/roadside swales) to be implemented at this area to reduce hydraulic loading, FDOT roadway, re-evaluate after BMP implementation
H5	A1A and 14th St. S., 15th St. S., and 16th St. S.	Nuisance flooding, standing water	n/a	Recommend evaluating effectiveness of runoff volume reducing BMPs (exfiltration/roadside swales) to be implemented at this area to reduce hydraulic loading, FDOT roadway, re-evaluate after BMP implementation
H6	S. Orlando Ave. and 16th St. S. and Indian Village Trail	Nuisance flooding, standing water	n/a	Recommend evaluating effectiveness of runoff volume reducing BMPs (exfiltration/roadside swales) to be implemented at this area to reduce hydraulic loading, FDOT roadway, re-evaluate after BMP implementation

Notes:
Refer to Flood Prone Area Figure for problem identification and physical location
NA - Not applicable

5.5 BMP IMPLEMENTATION TO ADDRESS WATER QUALITY PROBLEMS

5.5.1 Pollutant Load Reduction Goals

The PLRG / LOS process described in the Water Quality Assessment Section (Section 4) provides an excellent way in which to evaluate current water quality problems and future solutions. The Provisional PLRG (PPLRG) development relies on an accurate representation of existing conditions to compare with the historical "pristine" condition as a water quality target. To accurately represent existing conditions, existing BMPs must be accounted for in the pollutant load calculations. Based on the existing BMP identification summarized in Section 5.3, the *EXISTING BMP* pollutant loading case can be developed by applying the pollutant reduction effects of the identified BMPs to the pollutant load modeling results.

As discussed in Section 4, the PPLRG is unrealistic given the land changes and site constraints present in Cocoa Beach. Given this, a more realistic approach was considered to evaluate PLRGs not simply based on a calculated PPLRG, but also on target goals based on technological factors and site-specific constraints. In other words, determine what pollutant load reduction could realistically be achieved given the current characteristics of the municipality. This involved developing a "Technically Achievable" PLRG or TAPLRG. This TAPLRG would provide a realistic goal on which to implement a series of BMP projects to address water quality under a focused CIP.

In order to define the TAPLRG, an exhaustive identification of potential BMP applications throughout the City was required. In this regard, an intensive study was performed on the City of Cocoa Beach to determine the most practical upper limit of the implementation of BMPs that could be technically feasible considering land constraints, but without consideration to time and economic constraints. The resultant pollutant loads calculated in this *FULL BMP* pollutant loading case with all feasible BMPs incorporated were compared to the *EXISTING BMP* case loadings to establish a TAPLRG. As this TAPLRG is tied to technology-based criteria, it is of particular benefit in establishing actual reduction targets and evaluation procedures used in the development of the CIP detailed in Section 6.

The following subsections provide discussions summarizing the BMPs identified for potential future implementation.

5.5.2 BMP Recommendations

The BMPs discussed in Section 5.2 were evaluated for placement. The locations of potential BMPs include City owned property or right-of-way, private property, FDOT right-of-way, and the municipal golf course. The primary BMP recommendations consist of the implementation of swale, exfiltration, ponds, and sediment traps. These are discussed in detail in the following subsections.

5.5.2.1 Swales and Exfiltration

Swales are generally the easiest BMP to implement, as they require minimal surface preparation and can easily fit into wide right-of-way and median areas. The shallow slopes in many of these proposed locations would promote the use of swale blocks or raised inlets to provide some retention ability. Exfiltration can also be applied in many areas that can accommodate long runs with little width such as right-of-ways and medians. Exfiltration does require significant forethought in design, as it is primarily underground installation that requires proper utility clearances and attention to the water table depth. Swales are relatively easy to maintain with routine mowing and minor grading. Exfiltration does require

more attention and routine maintenance to maintain its effectiveness. Swales and exfiltration have the potential to be installed in concert with each other in order to increase overall effectiveness. These installations could also be enhanced with bioretention features for increased runoff and pollutant reductions as well as increased aesthetic appeal. Locations that were identified for implementation of these BMPs are shown on Figure 5-4.

5.5.2.2 Stormwater Ponds

Stormwater ponds are the most difficult to site because of the land requirements. Due to the fully developed nature of the City, vacant areas or properties that can be purchased are few. In many cases it was considered of benefit to locate ponds as close to the major outfalls as possible to provide the maximum benefit for the cost. Locations that were identified for potential implementation of these BMPs are shown on Figure 5-5.

Of the numerous potential pond sites that were identified, four were considered critical based on their location. Each could be of great benefit from a water supply and/or reuse standpoint. These are as follows:

- **Northend Pond:** This pond could be located at the vacant State-owned parcel in Basin A between Brightwaters Drive and Banana River Boulevard. This pond could receive the runoff from the primary oufall in Basin A, which includes some A1A drainage and commercial areas. Future investigations are warranted regarding the feasibility of Basin B Fairview outfall.

- **Seminole Lane Pond:** This pond could be located at the vacant parcel adjacent to the Banana River at the west end of Seminole Lane. This pond could receive runoff from the primary outfall in Basin D, which is mostly comprised of A1A and adjacent commercial areas.

- **Cocoa Isles Pond:** This pond could be located at the vacant parcel between the Econolodge and Denny's and A1A and Samar Drive. This pond could receive runoff from the primary outfall in Basin E, which is mostly comprised of A1A and adjacent commercial areas.

- **City Hall Pond:** This pond could be located at the City Hall parking lot or adjacent old library site at the southeast corner of Minuteman Causeway and Brevard Avenue. This pond could receive runoff from one of the primary outfalls in Basin G which is mostly A1A and adjacent commercial areas.

The City Hall pond would be located on City owned land and which would be not difficult to secure. The Northend pond site would be on State owned land that could be leased at a nominal cost. The Seminole Lane and Cocoa Isles pond sites are private property that would require significant action on the part of the City to secure. Although land and acquisition costs are likely very expensive at these locations, their utilization as stormwater pond locations would be of tremendous importance to the City with regard to improving water quality.

Another potential use of ponds is to utilize existing private developments to supplement the City's stormwater management needs. Many developments are appropriately located to be of benefit if an agreement can be made with the property owner for usage. These private development partnerships would require legal arrangements, confirmatory design, and strict performance guidelines to be successful. Two locations

where this may be feasible are the Rock Point condominiums pond in Basin C and the River Lakes development pond in Basin H.

5.5.2.3 Sediment Traps

Sediment traps were determined to be of benefit at numerous locations, typically associated with a major outfall. These would act as end of the line BMPs treating the stormwater runoff from upstream areas. Many of these areas have other BMPs recommended such as swales or exfiltration. Sediment traps are relatively easy to place with minimal adjustments, but would generally require some type of easement to accommodate the unit footprint and piping. They do require significant forethought in design, as they are primarily underground installations that require proper utility clearances and attention to the water table depth. Sediment traps do require more attention and maintenance to maintain their effectiveness.

In many potential sediment trap locations recommended, potential pond locations are also recommended. From an implementation standpoint, however, there would be little additional benefit from having both BMPs so it would make sense only to install one or the other. Since ponds offer better pollutant removal potential and benefits from a water supply and reuse standpoint, there would be little reason to install a sediment trap in lieu of a pond unless land is simply not available or routing of stormwater is not feasible. The sediment trap installations do not provide for flexibility in design. If regulatory conditions change and become more stringent, the BMPs may not be able to be modified and would have to be replaced or abandoned.

Locations that were identified for potential implementation of these BMPs are shown on Figure 5-6. Potential sediment trap locations that coincide with potential pond locations are distinguished on the Figure.

5.5.3 Additional BMP Considerations

This subsection provides brief discussions of other potential BMPs that may be of benefit to the City. These were not included in the discussions in the previous subsections as the benefit of their application was not quantifiable for the areas modeled in the flooding and water quality assessments. These BMPs are summarized below with brief discussions of their potential applicability. Refer to Section 5.2 for further details on each of these BMPs.

1. **Dune Revegetation:** Based on the discussion provided in Section 5.2.9, there are numerous beach access road locations where this type of BMP would be of great benefit. Locations that have been identified are shown on Figure 5-7.

2. **Aquifer Storage and Recovery:** The actions discussed in Section 5.2.10 could be evaluated for implementation. The responsibility for an ASR implementation would not rest with the Stormwater Utility. The greatest utilization of this type of technology is in the wastewater reuse potential. Stormwater management could be benefited by this by providing an alternate source of water for storage. Stormwater ponds could also feasibly be used for temporary storage and treatment purposes. Based on the foregoing, the evaluation of the feasibility of ASR would entail an inclusive Public Works effort with sensitivity to the potential benefit from and to the Stormwater Utility.

3. **Debris Baskets / Inlet Screens:** These types of BMPs are currently being installed at various locations throughout the City. These actions (discussed in Section 5.2.11) could continue to be evaluated for implementation on a site by site basis for residential areas or other areas that generate larger yard or trash waste materials.

4. **Vegetative Buffers / Revegetation:** The actions discussed in Section 5.2.12 could be evaluated for implementation on a site by site basis for existing developments and right-of-ways. City owned sites could be first targeted along with roadway right-of-ways within FDOT or County jurisdiction. These projects could be implemented in concert with impervious area reduction measures.

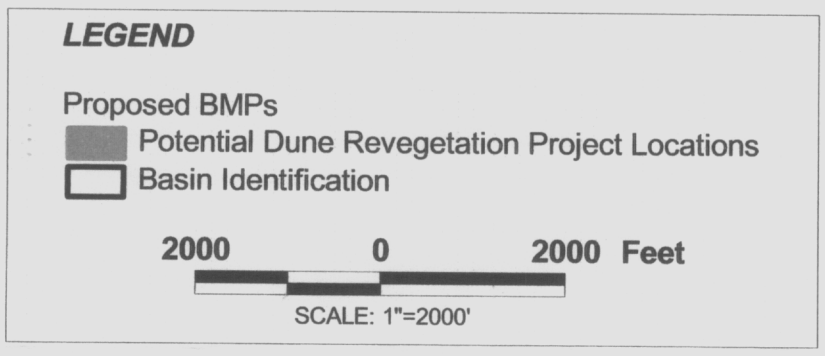
5. **Impervious Area Reduction Measures:** The actions discussed in Section 5.2.13 could be evaluated for implementation on a site by site basis for existing developments, and through the new development plan review process. These projects could be implemented in concert with vegetative buffer / revegetation measures. Similar to revegetation efforts, City owned sites could be first targeted along with roadway right-of-ways within FDOT or County jurisdiction.

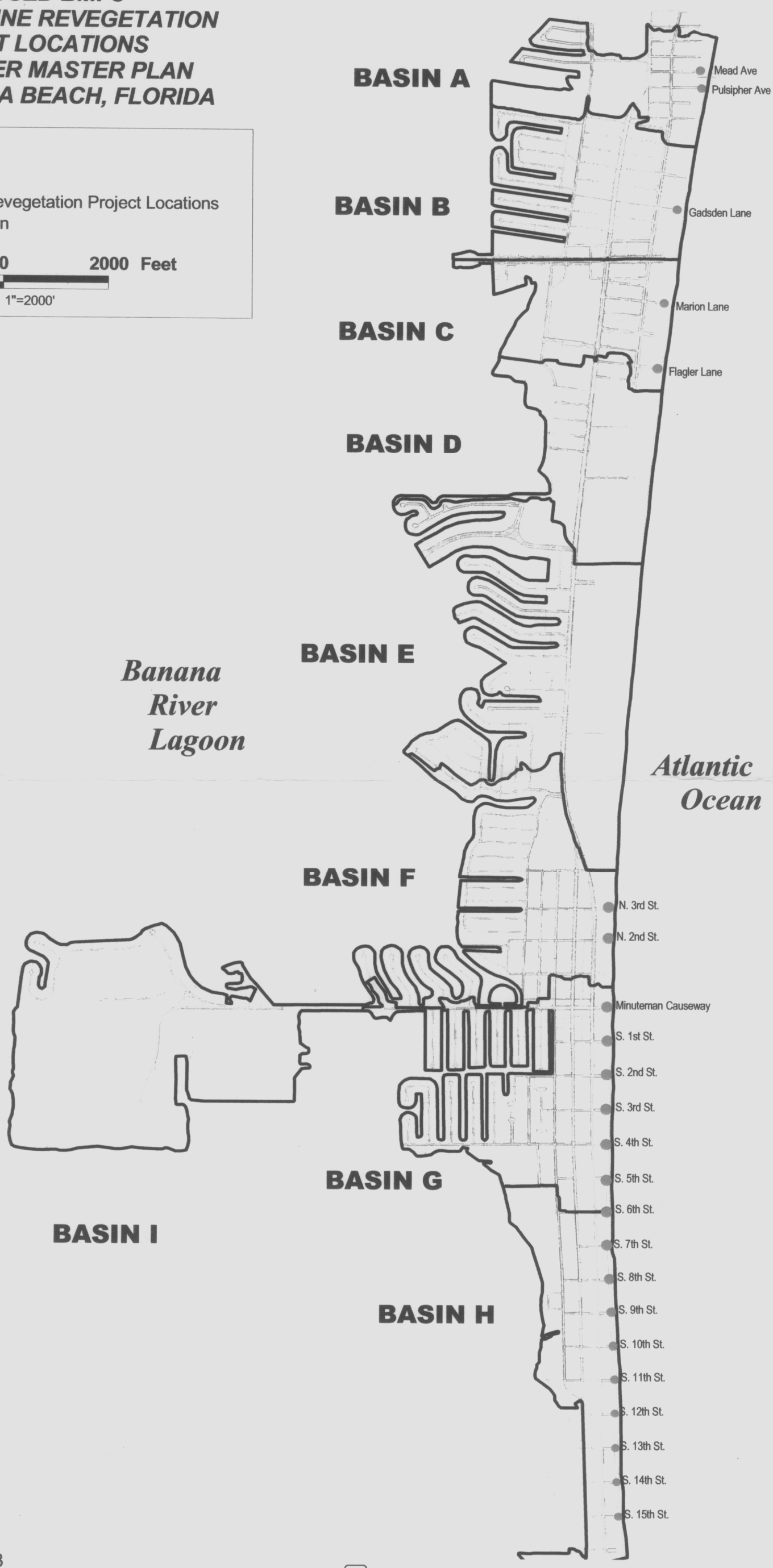
6. **Canal Treatment and Enhancement Options:** These include the aeration and microbiological treatment and circulation improvement BMPs discussed in Sections 5.2.14. Prior to determination of the possible success of any of these measures, a small-scale pilot study or limited implementation would be recommended and studied prior to determinations the feasibility of widespread application.

7. **Increased Street Sweeping:** The existing frequency and extent of the existing street sweeping activities (see Section 5.2.7) can be evaluated to determine any additional benefit could be realized. Also, the removal of curb stops at several locations (particularly near the beach) would allow for easier access for street sweepers and increase sediment removal efficiency.

FIGURE 5.7

PROPOSED BMPs
POTENTIAL DUNE REVEGETATION
PROJECT LOCATIONS
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA





Base Map:
City of Cocoa Beach
Stormwater Field Atlas, 1998

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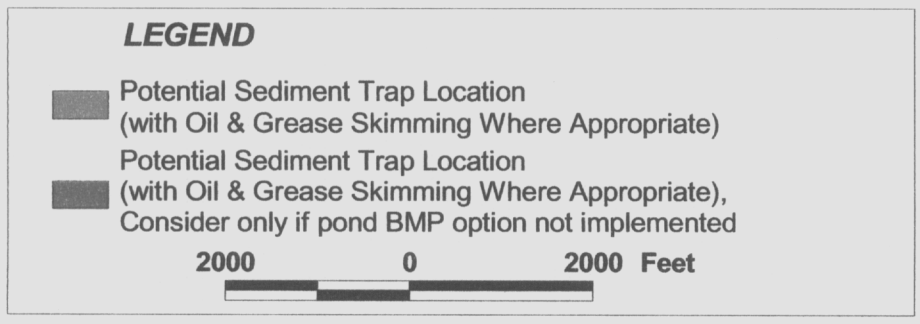
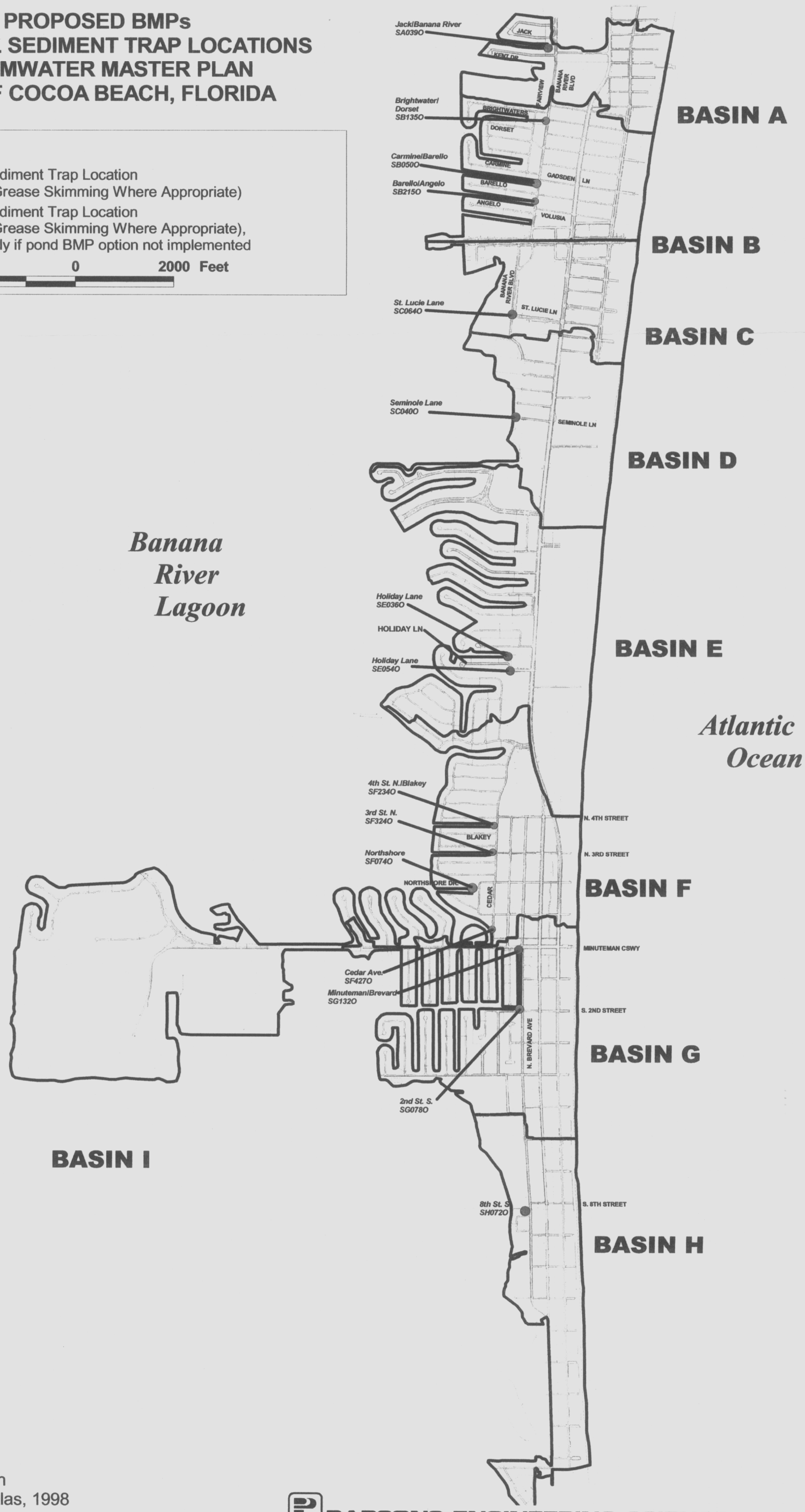
FIGURE 5.6

PROPOSED BMPs
POTENTIAL SEDIMENT TRAP LOCATIONS
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA



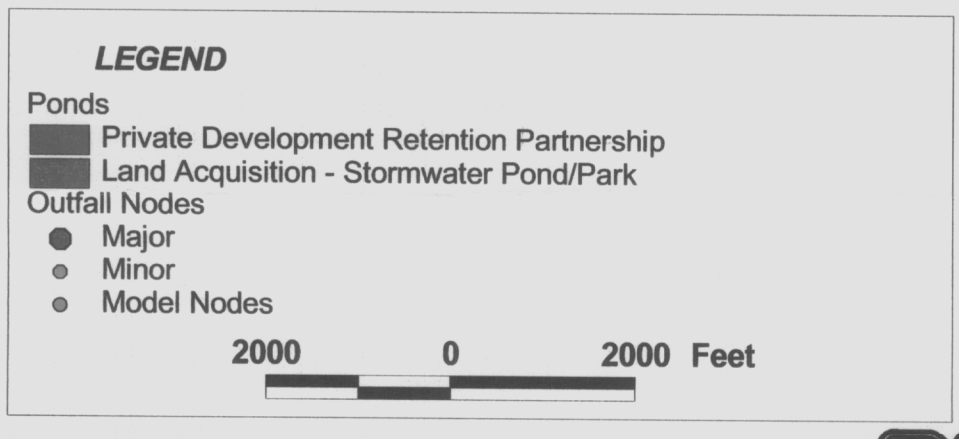


Base Map:
City of Cocoa Beach
Stormwater Field Atlas, 1998

PARSONS ENGINEERING SCIENCE, INC.

FIGURE 5.5

PROPOSED BMPS
POTENTIAL STORMWATER POND LOCATIONS
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA



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Base Map:
City of Cocoa Beach
Stormwater Field Atlas, 1998

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5.6 BMP POLLUTANT LOADING IMPACT

Using the existing BMPs identified in the City, the *EXISTING BMP* pollutant loading case can be established as outlined in Section 5.3. Likewise, the *FULL BMP* pollutant loading case can be developed using the BMPs proposed for implementation outlined in Section 5.5. This section summarizes the details of the pollutant load calculation methodology and results for these cases and how they relate to the overall PLRG process presented in the Water Quality assessment in Section 4 of this Master Plan.

5.6.1 BMP Pollutant Removal Efficiencies

In order to determine the effect a particular BMP may have on pollutant loading, a BMP specific pollutant reduction efficiency must be defined. This allows the impact of various BMPs to be quantified, either along or in combination with other BMPs. These reduction efficiencies, reported in terms of a percent reduction, must be established for each pollutant of concern.

Various references have documented pollutant removal efficiencies for various pollutants including TSS, TN, and TP. Selected references were reviewed to determine appropriate pollutant removal efficiencies for the above mentioned BMPs. A summary of pollutant reduction ranges and averages was provided in the BMP summary in Table 5-1. Table 5-4 present a summary of the specific values utilized in the BMP pollutant loading impact calculations performed in this Master Plan.

Stormwater ponds and exfiltration generally have the highest removal efficiencies across the board. These along with swales are likely the most studied BMP types, with the most accurate estimates. Sediment traps are highly variable in construction and performance so the values shown are the most approximate. Establishing a percent reduction to public education is highly subjective and difficult to quantify. A conservative approach was taken in this analysis in assuming 5% removal efficiency for all three parameters. Canal dredging as a BMP was considered to closely approximate pond detention; therefore, stormwater pond values were used as a reasonable approximation. Because of the inherent variability in site specific characteristics and implementation constraints, all these values should be considered approximate for study and master planning purposes only. They may be refined in the future if more accurate, site-specific data becomes available.

5.6.2 BMP Freshwater Reduction Efficiencies

BMP reduction values for runoff volume were estimated for evaluating the benefit of a BMP for reducing freshwater discharges to the Banana River. This also aids in determining which combination of BMPs will benefit flooding areas. The estimated annual runoff reduction values were developed to quantify the benefit of certain BMPs with respect to volume reduction. The values of 80% for swales and exfiltration assumes that the BMPs will capture and infiltrate 80% on average of the rainfall that occurs assuming that they will be designed to treat the first 1-1.5 inches of runoff. The 80% value was used from a statistical analysis of the rainfall period used for the water quality model (1990-1993) in which approximately 80% of the rainfall occurred in events of approximately 1 inch or less. The value for the stormwater ponds of 10% is a conservative estimate of infiltration and evaporation losses assuming the typical installation will be a detention pond with bleed off. The other BMPs listed would be expected to have no or insignificant ability to reduce runoff volume. These values are also summarized on Table 5-4.

TABLE 5.4
BMP POLLUTANT REMOVAL EFFICIENCIES
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA

BMP TYPE	POLLUTANT REMOVAL EFFICIENCY (%) ANNUAL BASIS	TSS	TN	TP	ESTIMATED ANNUAL RUNOFF VOLUME REDUCTION (%)****
SWALE	REFERENCE RANGE	0-100	0-40	0-100	- -
	REFERENCE AVERAGE	60	10	20	- -
	USE	60	10	20	80
EXFILTRATION *	REFERENCE RANGE	45-100	0-100	40-100	- -
	REFERENCE AVERAGE	75	55	60	- -
	USE	90	55	60	80
SEDIMENT TRAP	REFERENCE RANGE	10-95	5-55	5-10	- -
	REFERENCE AVERAGE	55	30	5	- -
	USE	55	30	5	0
STORMWATER POND	REFERENCE RANGE	50-90	10-90	20-90	- -
	REFERENCE AVERAGE	80	55	65	- -
	USE	80	55	65	10
CANAL DREDGING **	REFERENCE RANGE	- -	- -	- -	- -
	REFERENCE AVERAGE	- -	- -	- -	- -
	USE	80	55	65	0
STREET SWEEPING	REFERENCE RANGE	30-70	20-45	10-20	- -
	REFERENCE AVERAGE	50	35	15	- -
	USE	50	35	15	0
PUBLIC EDUCATION ***	REFERENCE RANGE	- -	- -	- -	- -
	REFERENCE AVERAGE	- -	- -	- -	- -
	USE	5	5	5	0

NOTES:

* Higher than average value used for TSS due to predominance of high recharge soils.

** No data available, considered analogous to stormwater detention pond so pond values used as an approximation.

*** No data available for TN and TP, conservative estimates used as an approximation.

**** Refer to text for discussion of value derivation.

- Indicates BMPs utilized in *EXISTING BMP* case.

REFERENCES:

1) CAiCE Software, *Visual SWMM Users Guide*, 2000.

2) CH2M-Hill, *Cost Assessment Procedures for Watershed Management Activities*, Fulton County Watershed Management Projects Memorandum, 2000.

3) Harper, H., *Stormwater Chemistry and Water Quality: Estimating Pollutant Loadings and Evaluation of BMPs for Water Quality Improvements*, Environmental Research and Design, Inc., 1999.

4) USDOT, *Urban Design Manual - Hydraulic Engineering Circular #22*, US Department of Commerce, 1996.

5) USEPA, BMP Technology Fact Sheets - EPA 832-F-99-006,007,011,012,017,018,025,029,042,048, Office of Water, 1999.

6) USEPA, *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. Office of Water, Washington, DC. 840-B-92-002, 1993.

7) Wanielista, M. and Yousef, Y., *Stormwater Management*, Wiley & Sons, Inc., 1993.

5.6.3 BMP Pollutant Removal Calculation Methodology

For the simulation of the pollutant reduction effects of BMPs, they were incorporated into a spreadsheet in the form of point specific pollutant reduction efficiencies (based on Table 5-4) applied to the current pollutant loading modeling results. These reductions were applied to the specific subbasin pollutant result the BMP would impact. For example, if a roadside swale was present along a residential road, the swale specific pollutant reduction was applied to only the results from the subbasin(s) where the BMP is located. Where BMPs exist in downstream areas that have multiple subbasins contributing to the stormwater flow, the applicable BMP reduction was applied to the total combined flow at that point. For example, the pollutant reduction of an in-line stormwater pond located just upstream of the outfall would be applied to all of the contributing runoff volume routed to that point. In some instances, multiple BMPs would affect a given subbasin. In these cases, the pollutant reduction for both BMPs was plied to simulate a cumulative pollutant reduction effect. The modified pollutant loading results were then summed by pollutant type from the individual basins into major basin totals then into a total for the whole City.

Duplicate spreadsheets were set up to evaluate the different pollutant cases of interest. Using the existing BMP information identified in Section 5.3, the *EXISTING BMP* pollutant loading case was developed in the spreadsheets. Likewise, the *FULL BMP* case was developed using the proposed BMP information from Section 5.5. As described in the Water Quality Assessment section, a *CIP BMP* case was also calculated, the rationale and results of which are discussed in further detail in Section 6. Copies of these BMP pollutant loading impact spreadsheets are included in Appendix 5B, C, and D to this section for reference.

5.6.4 BMP Pollutant Removal Results

The results of the *EXISTING BMP* and *FULL BMP* cases are shown on Table 5-5 and Figure 5-8. Reiterated for comparison are the 1943 and *EXISTING BASELINE* cases.

As can be seen from the data, the differences in resulting loadings for the *EXISTING BMP* case compared to the *EXISTING BASELINE* case are significant. Over 73% difference in loadings is indicated for TSS while close to 55% for both TN and TP. Compared with the 1943 case, *EXISTING BMP* case does not appear to provide a significant benefit over the *EXISTING BASELINE* case as the percentages are still approximately 87-91%. This does not accurately reflect the benefit of using the *EXISTING BMP* case, however, as the 1943 values are of such small proportion regardless of the analysis scenario. From this analysis, a realistic PPLRG (difference between the *EXISTING BMP* AND 1943 cases) can be considered to be reduce annual loadings of TSS from 58,546 to 6,806 pounds (~88%), TN from 3,386 to 453 pounds (~87%), TP from 531 to 50 pounds (~91%), and Freshwater from 306 to 54 million gallons (~82%).

The results indicate an increase of approximately 12-14% in additional pollutant reduction from the *EXISTING BMP* to the *FULL BMP* case for TSS, TN, and TP. Of more significance is the impact on runoff volumes in the *FULL BMP* case with ~25% difference in additional volume reduced as compared to the *EXISTING BMP* case. The difference between the *FULL BMP* case and the 1943 case levels varies from approximately 74-87%. From this analysis, a realistic TAPLRG (difference between the *FULL BMP* and *EXISTING BMP* cases) can be considered to reduce annual loadings of TSS from 58,546 to 33,257 pounds (~43%), TN from 3,386 to 2,325 pounds (~31%), TP from 531 to 374 pounds

TABLE 5.5
POLLUTANT LOADING COMPARISON
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA

EXISTING BMP CASE	TSS				TN				TP				FRESHWATER RUNOFF VOLUME			
BASIN	BMP % REMOVAL	LBS. REMOVED	LBS. BEGIN	LBS. REMAIN	BMP % REMOVAL	LBS. REMOVED	LBS. BEGIN	LBS. REMAIN	BMP % REMOVAL	LBS. REMOVED	LBS. BEGIN	LBS. REMAIN	BMP % REMOVAL	MGAL. REMOVED	MGAL BEGIN	MGAL REMAIN
A	72.3%	10,060	13,918	3,858	52.8%	251	476	225	57.7%	42	72	30	45.0%	2.5	25.0	22.4
B	61.9%	10,589	17,095	6,506	53.3%	362	680	318	50.8%	49	96	47	9.6%	3.2	33.1	30.0
C	65.6%	23,538	35,902	12,364	44.3%	493	1,114	621	37.8%	67	178	111	17.2%	8.8	51.1	42.3
D	64.9%	21,428	33,011	11,583	36.7%	365	994	629	41.4%	63	152	89	38.8%	18.8	48.4	29.6
E	92.1%	39,857	43,295	3,438	74.3%	1,115	1,499	385	77.3%	191	247	56	28.2%	22.4	73.9	51.5
F	88.7%	25,231	28,434	3,204	70.9%	673	949	277	69.6%	112	161	49	18.2%	9.1	50.1	41.0
G	84.5%	18,023	21,336	3,313	65.0%	507	779	272	67.5%	93	137	45	10.5%	4.3	40.8	36.5
H	49.5%	6,686	13,505	6,819	24.3%	137	563	426	28.4%	30	106	76	28.7%	8.9	31.0	22.1
I	34.1%	3,866	11,328	7,462	38.6%	147	381	234	32.6%	14	42	28	10.8%	3.7	34.0	30.4
TOTALS	73.1%	159,278	217,824	58,546	54.5%	4,049	7,435	3,386	55.4%	660	1,192	531	22.9%	81.6	387.3	305.8

FULL BMP CASE	TSS				TN				TP				RUNOFF VOLUME			
BASIN	BMP % REMOVAL	LBS. REMOVED	LBS. BEGIN	LBS. REMAIN	BMP % REMOVAL	LBS. REMOVED	LBS. BEGIN	LBS. REMAIN	BMP % REMOVAL	LBS. REMOVED	LBS. BEGIN	LBS. REMAIN	BMP % REMOVAL	MGAL. REMOVED	MGAL BEGIN	MGAL REMAIN
A	79.4%	11,053	13,918	2,865	67.8%	322	476	153	68.9%	50	72	22	58.4%	6.5	25.0	18.5
B	66.2%	11,315	17,095	5,780	60.5%	411	680	269	56.5%	54	96	42	44.8%	14.9	33.1	18.3
C	84.1%	30,192	35,902	5,710	66.6%	742	1,114	372	66.0%	118	178	61	50.8%	25.9	51.1	25.1
D	91.7%	30,262	33,011	2,749	72.9%	724	994	270	75.8%	115	152	37	60.7%	29.3	48.4	19.1
E	93.1%	40,323	43,295	2,972	77.6%	1,163	1,499	336	78.6%	194	247	53	47.4%	35.0	73.9	38.8
F	93.8%	26,673	28,434	1,761	80.6%	765	949	184	74.9%	121	161	40	40.5%	20.3	50.1	29.8
G	90.8%	19,363	21,336	1,973	75.0%	584	779	195	75.6%	104	137	33	46.9%	19.1	40.8	21.6
H	81.6%	11,014	13,505	2,492	44.1%	248	563	315	45.1%	48	106	58	69.5%	21.5	31.0	9.4
I	38.6%	4,373	11,328	6,956	39.5%	151	381	231	35.3%	15	42	27	16.7%	5.7	34.0	28.3
TOTALS	84.7%	184,567	217,824	33,257	68.7%	5,111	7,435	2,325	68.6%	818	1,192	374	48.1%	178.3	387.3	209.1

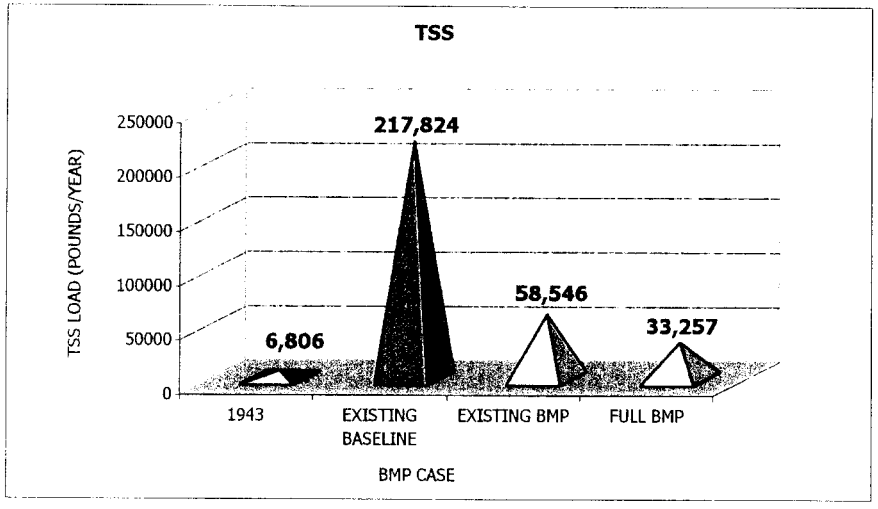
DIFFERENCE FULL BMP TO EXISTING BMP CASE	11.6%	25,289		43%	14.3%	1,061		31%	13.2%	157		30%	25.2%	97		32%

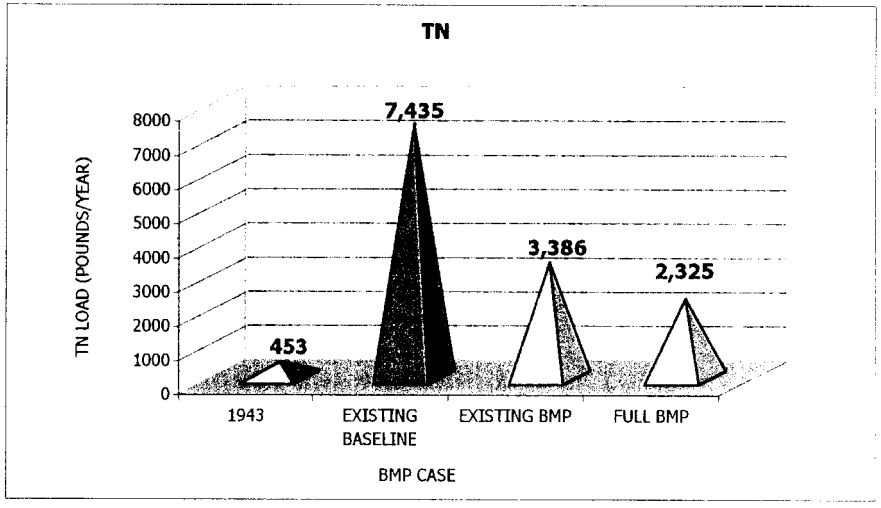
REFERENCE DATA FROM WATER QUALITY ASSESSMENT SECTION

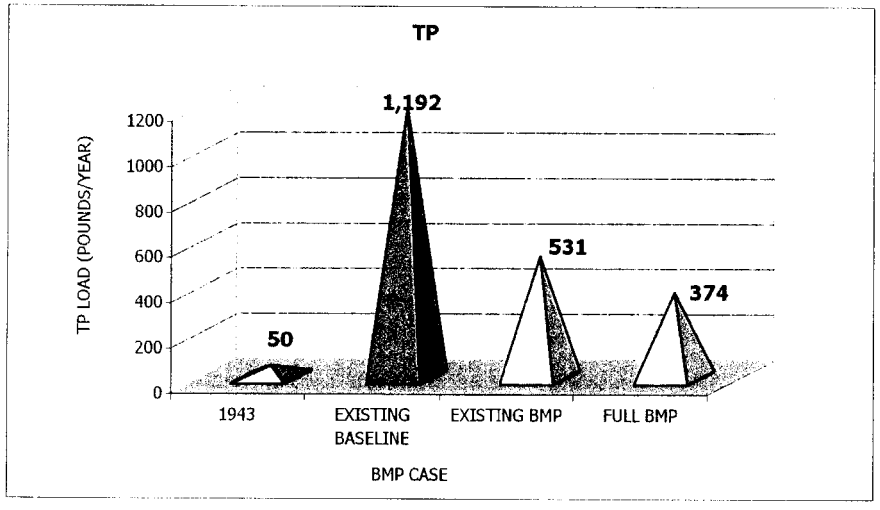
1943 CASE TOTALS:	**6,806**	**453**	**50**	**54**
% DIFFERENCE FROM EXISTING BMP CASE:	88.4%	86.6%	90.6%	82.3%
% DIFFERENCE FROM FULL BMP CASE:	79.5%	80.5%	86.6%	74.1%

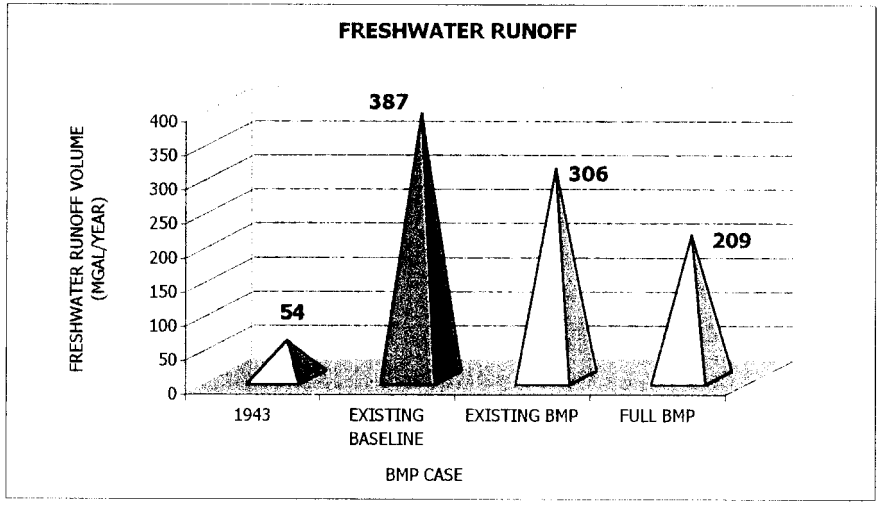
EXISTING BASELINE CASE TOTALS:	**217,824**	**7,435**	**1,192**	**387**
% DIFFERENCE TO 1943:	96.9%	93.9%	95.8%	86.0%
% DIFFERENCE TO EXISTING BMP:	73.1%	54.5%	55.4%	21.1%
% DIFFERENCE TO FULL BMP:	84.7%	68.7%	68.6%	46.0%

FIGURE 5-8
POLLUTANT LOADING RESULTS COMPARISON
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA









5.7 CONCLUSION

This section provides an engineering basis for the recommendation of solutions to the problems identified in the Water Quality Assessment and Flooding Assessment sections of this Master Plan. This section provides a list of conceptualized projects that could be implemented with respect to technical constraints and land availability.

The analysis of existing and proposed BMPs in this section provides a key component in the development of the PLRG-based LOS criteria developed in Section 4. The analysis of the existing BMPs effect on annual pollutant loadings was used in defining the PPRLG. The analysis of the potential application of BMPs in the future provided the basis for the development of the TAPLRG. In defining these pollutant reduction goals, the City's current LOS with respect to water quality can be evaluated along with future improvements in LOS under the CIP.

The flooding problems identified in Section 3 were primarily borderline conditions or LOS exceedances. The implementation of a water quality focused BMP program will likely improve these problems through the reliance on BMPs that promote overall runoff volume reduction. **As such, the general recommendation is to defer these flooding issues until after the CIP implementation with the expectation that they will not persist. If they are shown to persist, then they can be addressed on a site-specific basis.**

The results of the BMP evaluation will be utilized in the CIP development (Section 6) of the Master Plan. To develop the CIP, the identified BMP projects will be evaluated further given the constraints of cost and implementation time to prioritize the projects that will provide the best benefit. From this prioritization, the best combination of BMP projects and BMP project groupings will be identified to establish the CIP that will guide the City's Stormwater Utility over the next decade.