Allen's Creek Watershed Rehabilitation

Terry J. Finch

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The Allen's Creek rehabilitation project, funded and developed cooperatively by the city of Clearwater, Pinellas County, and SWFWMD, and completed in June 1999, is on a 27-acre site within the Allen's Creek watershed at Clearwater, a highly urbanized area of Florida.

Historically, the site was a floodplain marsh and forest dominated by red maple (*Acer rubrum*) and bay (*Persea* spp.) trees. As late as 1957 aerial photographs show the area virtually intact, except for citrus groves that border the site and the start of construction of subdivision to the east and south of Oak Grove Middle School.

Over recent decades, portions of the site were dredged for borrow material, mined for peat, and filled with construction debris. The remnant floodplain where peat mining occurred had created open shrub dominated pits and shallow flooded depressions. These existing wetlands had been degraded by invasive nuisance and exotic vegetation such as castor bean (*Ricinus coomunis*), cattail (*Typha* spp.), primrose willow (*Ludwigia peruviana*), Cuban bulrush (*Scirpus cubensis*), Brazilian pepper (*Schinus terebinthifolius*), and air potato (*Discorea bulbifera*). Desirable species within these wetlands included duck potato (*Sagittaria latifolia*), red maple (*Acer rubrum*), coastal plain willow (*Salix caroliniana*), elderberry (*Sambucus canadensis*), pennywort (*Hydrocotyl ranunculoides*), and chain fern (*Woodwardia virginica*). The altered uplands consisted of mowed fields dominated by terrestrial grasses and weedy opportunistic species, shrubs such as castor bean (*Ricinus communis*), and trees such as chinaberry (*Melia azedarach*).

Remnant habitats included small areas of red maple floodplain bordering meanders of Allen's Creek and along old mine edges. In addition to red maple, small forest areas contained sweet bay (*Magnolia virginiana*) and loblolly bay (*Gordonia lasianthus*) trees. Other desirable swamp species included lizard's tail (*Saururus cernuss*), swamp fern (*Thelypteris interrupta*), and red root (*Lachnanthes caroliniana*).

Fish and wildlife resources at the project site were limited, primarily due to the highly altered condition of the site and the urban character of the surrounding land. Species seen at the site included river otter, raccoons, Florida cooter, blue jay, black racer, mockingbird, common grackle, red-winged blackbird, little blue heron, anhinga, and turkey vulture. The waters of the creek at the site did not support a wide variety of fish as the physical characteristics of the site would indicate (narrow stream width, steep side slopes, and shallow water). Mosquito fish and mollies were observed.

The purpose of the project is four-fold: management of surface water runoff to Allen's Creek, including attenuation of in-stream peak flow rates; biological treatment of surface runoff; restoration of the natural floodplain in such a manner as to maintain a balance among and improve wildlife utilization of uplands, open water and intermediate habitats; and provision for an educational opportunity for the public.

Watershed studies have identified flooding issues, water quality degradation, and natural habitat loss that can be relieved and reduced through a restoration and treatment project. The proximity to residential developments and neighborhood schools provides an excellent opportunity to educate the public on the value of ecological balance and the need for restoration and treatment through the combination of engineering and environmental science. Local flooding will be reduced through hydraulic modifications designed to maximize

stormwater treatment. Stormwater treatment features include quiet pools to slow velocities and reduce erosion, littoral shelf and marsh areas to provide biological assimilation of nutrients, and longer flow paths to increase residence time for maximum water quality treatment. Wetland and marsh construction was accomplished through removal of exotic and nuisance vegetation and replacement with desirable native species. Upland habitats have also been constructed to attract various species of native birds, mammals, and reptiles. The remnant forest is being restored to provide wildlife habitat. A passive park facility will provide schools an opportunity to enjoy and learn from the ecological features of the project. A nature trail with educational signs will highlight various aspects of the project and lead to a better understanding and appreciation of the ecosystem.

Total project costs included $200,000 for design and permitting and $1,670,000 for construction.

The Pinellas County Department of Environmental Management formed a partnership with Plumb Elementary School, west of the project site, and students from Grades 3, 4 and 5 are helping county staff monitor small animal and herpetological activity at several stations. The students are reading animal impressions at four track stations and are checking funnel traps at two stations. The Audubon Society has also performed bird surveys at the site.

An unusual area existed at the eastern side of the site, which was largely devoid of vegetation, where weathered peat is at the surface. Investigations revealed a heavy organic layer underlain by increasing amounts of fibrous organic matter down to a depth of 36 inches followed by increasing amounts of muck. The water table was encountered at six to eight inches below the surface. Further site investigations indicated that the water table on the site had been lowered, substantiated by the invasion of nuisance species within the remnant wetlands, soil subsidence, and urban development surrounding the site. Piezometers were installed to monitor groundwater levels in the surficial aquifer to determine the seasonal high water table and a number of hand augers, power borings and muck probes were performed to determine the value of any excavated material. The potential for soil subsidence in previously filled areas related to lowering the water table during construction and adverse impacts on the foundations of surrounding buildings that lowering some portions of the site might have were raised as concerns.

Existing Drainage

Approximately 1,158 acres drained through the site from the upper reaches of the basin. The majority of the flow entered the site from the west under a residential road via a double 10- by 6-foot box culvert. The creek flowed east around several bends and meandered along the northern boundary of the site before flowing south through a deeply incised 90-degree bend showing evidence of erosion typical of high channel velocities. At the center of the site the creek flows to the eastern boundary where the channel slope is flatter and creek depth shallower. The channel then turned south through another 90-degree bend that is encroaching on and bisecting private property. Flow also entered the site through ditches from the west and north and two man made lakes north and northeast of the site that serve as neighborhood detention systems. A retention/borrow pit south of the creek at the site serves as the drainage for an apartment complex and subdivision to the south, and it drains into Allen's Creek through a culvert at the pond's southeast corner. None of the existing lakes was proposed to be changed. Contours of the site showed that elevations across the site range from approximately 30 feet down to 12 feet. Although the 25- and 100-year 24-hour storm events overtop the creek banks, there was no reported home flooding in the immediate vicinity.

Improvements

The existing site conditions and past activities on the site posed a challenge in the development of a design that would meet project objectives within the available budget. The costs associated with the removal and disposal of construction debris dictated that a significant portion of the open grassed area continue as upland. That area immediately adjacent to road was used for a small parking area and future playground and education/interpretive area. Project design was constrained by construction difficulties and concerns regarding soil subsidence associated with dewatering and the removal of sufficient quantities of wet highly organic material to eliminate nuisance species seed source and to create open water areas.

The project included the modification of the structure at the inflow to the site, realignment and widening of the channel with gentler side slopes, and elimination of the ninety-degree bends, thereby reducing erosion. Because of the alignment and velocities being greater than 3.5 feet per second, open-cell interlocking block mats were installed along the slopes for approximately 350 feet. The channel was extended to drain directly to the center cell area. A pipe connection was installed between the main channel and the first ninety-degree bend to the south to maintain low flows in the channel and the central cell, and to eliminate the significant erosion in this section. The existing flow from the west was redirected in the central cell to improve water quality treatment.

The nuisance and exotic plants in the western and central areas of the site were removed, and new trees and shrubs were planted to restore the area. The central cell was enlarged and deepened to provide additional storage capacity and water quality treatment via shallow littoral zone plantings and increased residence time with an extended meandering flow path. A second shallow pond was constructed in the southern cell and planted with emergent vegetation to provide additional treatment of runoff. The central and southern cells are connected with a 20-foot wide channel. Discharge is accomplished through the installation of limestone rubble weirs. A 15-foot wide overflow channel connects the central cell to Allen's Creek. Pedestrian access through the site is maintained by crossing the channels with single span steel bridges and a ten-foot wide sidewalk.

The air potato (*Discorea bulbifera*), which infested the eastern cell, was eradicated through a program which included the use of track drawn bushhogs to clear the area, chemical treatment, and manual removal of tubers. This program is still ongoing because of the tenacity of the air potato. Understory and canopy species have been planted to restore the site.

Overall, the project reduces the 25-year, 24-hour peak discharge rate from 1610 cfs to 1416 cfs by increasing the flood storage by 21 acre-feet. The project has enhanced approximately five acres of degraded wetlands and uplands and created approximately 3.2 acres of wetlands. Interpretive signs will be designed to highlight the various ecosystems within the park. Biological assimilation of nutrients and longer flow paths to increase residence time will improve water quality by reducing TSS and TN in the basin. While water quality monitoring was originally proposed to determine the actual reductions in pollutant loading that are realized as a result of the project, this has not yet been initiated. Maintenance of the project for the first several years is expected to be intense to ensure establishment of a native community that can preclude the growth of nuisance and exotic vegetation. ■

Glossary of Common Terms Used in this Publication

ASR	aquifer storage and recovery
AWT	advanced water treatment
AWWT	advanced wastewater treatment
AWWA	American Water Works Association
BOD	5-day biochemical oxygen demand
BOD_x	BOD test based on other than 5 days
CBOD	5-day carbonaeous BOD
COD	chemical oxygen demand
cfm	cubic feet per minute
cfs	cubic feet per second
CWA	Clean Water Act
DEP	Florida Dept. of Environmental Protection
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FAC	Florida Administrative Code
fps	feet per second
FSAWWA	Florida Section of AWWA
FWEA	Florida Water Environment Association
FWPCOA	Fla. Water & Pollution Control Operators Assoc.
GIS	Geographic Information System
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
hp	horsepower
MGD	million gallons per day
mg/L	milligrams per liter
MLSS	mixed liquer suspended solids
MLTSS	mixed liquer total suspended solids
NPDES	Nat. Pollutant Discharge Elimination System
NTU	nephelometric turbidity units
ORP	oxidation reduction potential
POTW	public-owned treatment works
ppm	parts per million
ppb	parts per billion
psi	pounds per square inch
PVC	polyvinyl chloride
RO	reverse osmosis
SCADA	supervisory control and data acquisition
SJRWMD	St. Johns River Water Mangement District
SFWMD	South Florida Water Management District
SRWMD	Suwannee River Water Management District
SWFWMD	Southwest Florida Water Management District
TDS	total dissolved solids
TMDL	total maximum daily load
TOC	total organic carbon
TSS	total suspended solids
USGS	United States Geological Survey
WEF	Water Environment Federation
WRF	water reclamation facility
WTP	water treatment plant
WWTP	wastewater treatment plant

Grease… Has It Slipped through the Cracks?

Robert E. Heilman

Grease from restaurants and other food processing facilities has been a problem for wastewater utilities for many years. As grease coagulates and congeals in collection systems and lift stations, the effectiveness of the collection system is reduced. To control the discharge of grease from various establishments, either grease traps or interceptors have been installed on sewer laterals leaving the facilities. Unfortunately, many of the grease collection devices have been severely undersized or inadequately maintained, resulting in direct discharge of grease into the municipal collections system. Sewers with minimal slope or small lift stations are often the first to experience problems due to grease blockages or clogs. Blockages in the sewers or pump failures in lift stations, due to grease accumulation, often result in sanitary sewer overflows that can have adverse effects on human health, aquatic life, or the environment.

Agency Response

Auditing of collection systems has shown that varying levels of controls are implemented across the nation to deal with grease. One obvious solution is to properly size and maintain grease traps and interceptors. However, historically these devices have not been regulated by any specific entity. There are several sources of design criteria for the sizing of grease traps, so the specifications are left up to the local utilities and vary from municipality to municipality. However, the Florida Department of Health does have specific requirements for the sizing of grease traps and interceptors connected to on-site sewage disposal systems. State regulatory agencies do not have authority to enforce the proper maintenance of these units. The high profile of the grease problem has caused many groups to begin looking at what can be done to control the situation.

Wastewater Utility Response

Utilities control the grease discharges to their collection systems through various methods. Grease control can be either reactive or proactive. Reactive programs respond to instances of pump station clogs, sewer blockages, or sewage backup. Grease may accumulate until it backs up into the generator's facility, or the utility may identify the facility as the cause of a problem in the collection system. Many times these are the only reasons the trap or interceptor is pumped. The facility causing the problem can be billed for the services to clean and repair the lift station or sewer to recoup the utilities' cost.

The proactive approach, as practiced by several utilities, requires regular maintenance of grease removal appurtenances. Some utilities specify a frequency for cleaning. Some have regular inspection programs and require pumping based on the trap's condition. Some leave it up to the owner to determine the frequency but require that pumping logs or records be kept at the facility. Still others issue permits and require regular sampling and monitoring of the discharge from the trap to determine compliance with local discharge limitations. The essence of a proactive approach is developing an enforceable sewer use or grease trap ordinance that is strong enough to ensure compliance.

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Many utilities have also instituted a surcharge program for the treatment of high-strength wastewater. When a grease trap is not properly maintained, its discharge usually contains high BOD and TSS, and both are typical surcharge parameters. Therefore, the facility with a trap in need of maintenance, located in an area with a surcharge program, may be billed for its wastewater strength above the normal domestic levels. The surcharge program can be an effective incentive for facilities to adequately maintain their traps to reduce their monthly sewer billing.

Federal Response

EPA Region IV, in conjunction with WEF, has developed a grease control training program tailored for each municipality depending on the extent of the grease problem. It emphasizes several options to control oil and grease, including enforcement of local limits and proper interceptor sizing, development of maintenance programs for industrial users, and public education programs, or a combination. Any grease control strategy should be implemented under the umbrella of the pretreatment program. The training program stresses good communication among the municipality's pretreatment, wastewater operation, and collection system staffs to determine the magnitude and options to address the grease problem.

EPA's new sanitary sewer overflow rule will accelerate the grease control program by requiring capacity, management, operation and maintenance plans for proper collection, system management, and maintenance. The plans require public utilities with surface water discharges to have adequate staff and legal authority, sufficient monitoring programs, proper maintenance programs, emergency response plans, and capacity evaluation and assurance plans to reduce or eliminate any sanitary sewer overflows.

State Response

The DEP Pretreatment Program has also been concerned with the regulation of grease. A "Grease Survey" was developed and sent to all of Florida's approved pretreatment programs via the January 2000 issue of the *Pretreatment Communicator*. The survey included several questions about what the control authorities were doing to control the grease discharges into their collection systems. The results of the survey have been tabulated and are shown in the accompanying table. Although many pretreatment programs have O&G local limits, very few programs enforce them consistently.

DEP has also selected the grease issue as one of its environmental problem-solving candidates. A committee is being formed to consider the options of controlling the grease discharge problem in an effort to reduce the sewer overflow problem. However, this may prove to be redundant, due to the activities already discussed as well as the activities outlined below.

The Florida Building Commission is currently rewriting the Florida Building Code. A specific section of the building code is dedicated to the sizing of grease traps and interceptors. Additionally, a Plumbing/Gas Technical Advisory Committee (TAC) is considering requiring a statewide maintenance program for grease traps and interceptors, though it is not clear who would enforce those requirements.

DEP does not have direct authority to regulate the discharge of grease, other than through the prohibited discharge standards in Chapters 62-604 and 62-625, FAC. The prohibitions essentially state that no solid or viscous substances that would cause a blockage in any component of the wastewater system may be discharged. DEP's authority is limited to permitting collection systems within the public right-of-way. There appears to be no statutory authority for DEP to regulate grease traps on private property.

The Department of Health has authority to regulate grease traps and interceptors associated with on-site sewage disposal systems only. The Department of Business and Professional Regulation checks to see if restaurants have grease traps or interceptors, but does not check the condition. If there is an obvious backup into the facility or a complaint, it can order the facility closed until the problem is corrected, but cannot require the trap or interceptor to be pumped out. Health concerns are referred to the Department of Health. The Department of Agriculture and Consumer Services has no authority over grease traps or interceptors. It investigates complaints from consumers about facilities to protect the public but typically forwards such complaints to other state agencies.

An ad hoc committee of the Plumbing/Gas TAC has been formed of the above state agencies and chaired by a TAC member. The committee's purpose is to further evaluate the various agency legal authorities and to develop optional grease control strategies.

Summary

Clearly, the discharge of oil and grease to a public utility collection system is a problem in some service areas. Many agencies are concerned about the problem and are evaluating options to deal with it. Some immediate issues that have already been discussed include incorporation of uniform sizing criteria for grease traps and interceptors as part of the Florida Building Code to ensure proper design, and development of model grease trap ordinance language to ensure proper operation and maintenance. The federal government is proposing regulations to protect collection systems from excess flows and to ensure proper maintenance.

Nevertheless, several issues have not been fully evaluated and will need to be addressed. One major concern is whether the legal authority to require proper maintenance of grease traps should reside at the state or the local level. Another issue yet to be adequately addressed is the final disposal of grease trap waste. Currently, few public utilities allow disposal of grease trap waste into components of its wastewater treatment plants. There are even fewer private/commercial grease treatment facilities in Florida. Land disposal is prohibited, unless the grease is mixed and treated in adequate proportions with domestic septage. Again, there are not enough septage treatment facilities to handle the volume of grease as more traps are being mandated to be properly maintained. These issues will also have to be considered before any final decisions are made on how to prevent the grease from slipping through the cracks. ■

Grease Control Program Survey Results

Pretreatment Program Name	Year Established	Number of Sources	Location of Requierments	Mandatory/ Voluntary?
Altamonte Springs	Before 1985	95	SUO or Pretreatment Ordinance	Mandatory
Apopka	1997	65	Being revised in I.W. Ordinance	Mandatory
Auburndale	No program, case by case basis			
Bay County	No program, case by case basis			
Boca Raton	1988	550+	Sewer use or pretreatment ordinance	Mandatory
Casselberry	1999	5	SUO or Pretreatment ordinance proposed	Mandatory
Charlotte County	Under development	100	Revising Sewer Use Ordinance	Undecided
Davie			SFBC – Broward Edition– Section 4612	Mandatory
Ft Lauderdale			City code	Voluntary
Ft. Myers	Has "always" been in place	All facilities that discharge grease.	SUO or pretreatment ord.	Mandatory
Ft Pierce			Util. Auth. Policy & Procedures	Mandatory
Fort Walton Beach	1990	68	SUO or Pretreatment Ordinance.	Mandatory
Hillsborough County	Under development		Under development	Mandatory
Jacksonville Elect. Auth.	1998, being revamped		SUO or pretreatment ord.	
Kissimmee	1990	430+	SUO or pretreatment ord.	Mandatory
Lake City	No program, case by case.			
Lakeland	1995, no problems with O&G	250	SUO or pretreatment ord.	Mandatory
Marion County	Under development	13		Mandatory
Melbourne	No program, case by case			
Ocala	1991	220	SUO or pretreatment ord.	Voluntary
Oldsmar	1997	~50	Ordinance	Mandatory
Orlando	1974	141	SUO or pretreatment ord.	Mandatory
Ormond Beach	No program, case by case			
Palm Beach County	1997	~700	Uniform Policies and Procedures	Mandatory
Plantation	1990	153	SUO or pretreatment ord. also specified by permit.	Mandatory
Plant City	No program, case by case			
Rockledge	1985	25	No detailed program	Voluntary
St. Petersburg	1999	450		Voluntary
Seminole County	Under developement	300-400	Draft ord..	Mandatory
Stuart	1990	216	City manual	Mandatory
Tampa	Before 1980	1000's	SUO or pretreatment ord.	N/A
Titusville	1999	25	SUO or pretreatment ord.	Mandatory
West Palm Beach	1986	>300	SUO or pretreatment ord.	Mandatory

Permits issued to grease discharging facilities?	Permits issued to grease haulers?	Grease traps required at all facilities?	Frequency of trap pumping	Frequency of trap inspection	Manifests of other tracking required of grease haulers?	Recordkeeping requirements for dischargers	Limits mg/L	Additional comments
No	No	Yes	As needed,	Monthly	No	Receipts / Documentation of cleaning and maintenance		
Yes	No	Yes	Generally done in conjunction with sampling events for BOD/TSS.		No — will change in new ordinance		100	Currently writing new ordinance for grease traps, oil & grease, etc.
						100		
No	No	Yes	Depends on volume		Yes	Invoices. records	100	Have reduced foaming & nocardia at plant
Yes	No	Yes	Min. quarterly			Manifest, 3 yrs records & logs		
Undecided	Yes	Yes				Septic/Grease haulers required by DOH to submit monthly log sheets which indicate all waste (septic/grease) hauled and the point of origin.		
No	No	All per S. FL Building Code	As Needed		No	Pump records recommended		
No	Yes	Yes		Inspections controlled by grease quantity observed by pumping station crews	Yes	Pumping records available upon request.	500	Problems, which are minimal, referred to. Env. Services.
No	No	Yes	When needed		No	Must maintain a "service return card" and receipts on premises for inspection	100	
			As necessary to maintain at least 50% of the grease retention capacity	Grease traps must be inspected quarterly.				
No	No	Yes	Every 6 months		No	To furnish a copy of certificate of pump out upon request by city.		Aggressive grease trap and preventative maintenance programs
No	Yes	Yes			No	Invoices of grease trap pump outs and/or copy of contract with hauler		Interested in starting a grease control program. Anticipate that it would be mandatory for nonresidential customers.
Yes, depending on facility type	Yes, one facility since it is contracted to sewer.		Every 90 days with total clean yearly	Current case by case response assoc. w/line cleaning	N/A	Copies of manifests/tickets required to document cleaning.		
No	Yes	Yes	As often as 4 weeks		No	Monthly reports.		City does not have many industrial users, mostly restaurants.
No	City no, DOH yes.	Yes	Variable	Grease interceptor policy: city personnel inspects grease interceptors on regular basis.	No	Pump receipts.	450	
No	No	Yes	1-2 months depending on buildup		No			
								No O&G problems.
No	Yes	Yes	Monthly, primary and last trap		No	Pump receipts		
Yes	Yes	Yes	Monthly or as necessary		Yes		50	
No	No	Yes	As needed		No	Copy of last pump out		Revising program.
No	Yes	Yes	Minimum once/year		Yes	fax copies of receipts	100	
Yes	Yes	Yes	Quarterly		Yes	Retain original on site 24 months; copy to city quarterly.		
No	Yes (County)	Yes	Every 30 days		Regulated by county	Hauler records, records of interceptor cleaning and facility inspection.		
No	No				Regulated by co.	Receipts of pumpting		Plan to revise program.
No	No	Yes	Not specified		Yes	Plan to require pump-out sheets	100	
Yes	Yes	Yes	Intervals that ensure 50% retention capacity	Inspect when complaints or violations.	Yes	Require maint. schedule		
No	Health Dept.	Yes	No freq. set		N/A	Manifest file	100	Private rendering treats most grease traps
Yes		Yes	Grease trap pumping required		Yes	Control log	100	
Yes	Yes	Yes	Min. 3/year		Yes	Tracking form	100	Restaurants must have interceptors or sample point. Violations incur monthly surcharge.

Implementation of a Master Stormwater Management Plan in Jacksonville

Patrick R. Victor, John Pappas, and Michael F. Schmidt

The city of Jacksonville initiated the Master Stormwater Management Plan (MSMP) with SJRWMD in 1987. A series of sub-basin plans, development criteria, and facility needs were identified to control flooding and retrofit for water quality improvement of the 980 square miles of tributary areas to the lower St. Johns River, a Florida Surface Water Improvement and Management (SWIM) priority water body, in Duval County.

The city commenced implementation in 1989 and has worked with SJRWMD, the Florida Department of Transportation, and DEP to jointly plan, permit, and fund over $30 million of capital projects. In 1998 the city issued a bond for $67.2 million that will provide funding to further implement the master plan. Twelve projects were identified and will provide both water quality (non-point source pollutant load reduction) and quantity benefits (flood and erosion control). These projects were selected to be engineered so as to optimize the available funds.

This article discusses the third phase of the multi-year, phased stormwater management program. The first phase addressed much of the general data collection and project directions including facility investigations, non-point source pollution load estimates, problem identification and prioritization, defining levels of detail for subsequent studies, and defining data needs and screening areas for early-out retrofit projects.

The second phase addressed the detailed master planning for the Lower St. Johns River Basin in Duval County and a portion of St. Johns County. It included studies and reports on nine of the 12 major river basins in Duval County. The watercourses were evaluated in terms of both water quantity and water quality. Alternative evaluations were developed for individual sub-basins, and recommendations were made to address serious flooding, erosion, and non-point source pollution problems.

CDM applied its modified versions of the EPA Storm Water Management Model (SWMM) EXTRAN and RUNOFF modules for the following basins as shown in Figure 1:

1. Lower St. Johns River Upstream of Trout River
2. Intracoastal Waterway
3. Trout River
4. Ortega River
5. Broward River
6. Dunn Creek
7. Arlington River
8. Lower St. Johns River Downstream of Trout River, and
9. Julington Creek

In Phase III, CDM is assisting Jacksonville in implementing the recommendations of Phase II. CDM performed program implementation assistance to guide various city and consultant design teams in the retrofit of the existing stormwater system to improve water quality and water quantity levels of service. This assistance included preliminary design, alternative refinement and phasing, quality assurance and quantity control, value engineering of designs, additional verification of models developed in Phase II, and permitting. The major projects selected in Phase III as part of the 1998 bond issue are discussed in this article.

Common to all the projects discussed is the fact that stormwater models (RUNOFF and EXTRAN) developed as part of Phase II were modified to evaluate the discussed alternatives.

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Little Pottsburg Creek

Little Pottsburg Creek, which is within the Arlington River Basin, has a tributary area of about 4.5 square miles. The subbasin is nearly at build-out (overall DCIA of the basin is 45%) with medium density residential and commercial development, a somewhat flat topography, and overall soils with infiltration characteristics typically ranging from type B to type D soils. The basin is served by extensive and efficient secondary storm sewer facilities. The primary surface water management system (PSWMS) is a main stem and two smaller branches with a total of 10 roadway crossings.

The effect of urbanization (high impervious area and quick delivery of runoff via storm sewer), and the high runoff potential of soils have contributed to the strain on the capacity of the creek. However, two factors are the dominant cause of the flooding and erosion: the floodplain is being steadily filled with construction debris, soil, and house waste; and houses are being built in the floodplain.

In Phase II, an area south of Emerson Street was identified as a critical water quantity problem area. Velocities greater than erosive velocities for bare channels were also detected in that reach in our EXTRAN model runs and verified during field visits. Since the basin is mostly developed and because discharges and stages from this system are controlled by tailwater, CDM recommended that the city implement volume control criteria for new construction. This will prevent the aggravation of the existing water quantity problem.

In Phase III, additional problem areas were identified. Houses downstream of the project area were identified as flood prone, and additional serious erosion problem areas were also identified.

The predominant causes of house flooding are houses built in the floodplain and the reduction of conveyance capacity due to placement of fill materials into the floodplain. The cross-sectional area of the creek floodplain has been progressively reduced, and this reduction has caused an increase in stages upstream of the filled area. The reduction in cross-sectional area of the floodplain has also increased the frequency and severity (higher stages) of house flooding. Therefore, restoring the floodplain will provide relief of flooding experienced upstream of the filled areas while reducing velocities and sediment scour which is degrading downstream wetlands.

Because the basin is mostly developed, finding land that could be used for the construction of a lake that would provide for the needed peak attenuation and water quality benefits was very difficult. Therefore, restoration of the floodplain and stabilization of the side banks was the recommended alternative. A calibrated model was used to document that the homes that were flooded upstream of the filled area by the 5-year 24-hour storm will be protected for the 25-year, 24-hour storm. In addition to a reduction in peak velocities, the side banks will be graded to at a minimum of 4 horizontal to 1 vertical and synthetic revetment and vegetation will be used to stabilize the

side banks and minimize erosion. SJRWMD has been very supportive of the project since it will restore an impacted floodplain and reduce erosion.

In areas downstream of the filled areas where houses were built in wetlands, it was determined that purchase of the houses would be the most cost effective approach. The recommendation was to offer each homeowner with finish floor elevation below the 100-year flood plain an option for the property to be acquired by the city. Eleven homes between Emerson Street and Bedford Road were affected, and ten have opted to sell.

Upper Deer Creek

Upper Deer Creek is in the Deer Creek sub-basin which in turn is in the Lower St. Johns River Upstream of Trout River (LSJRU) basin. The tributary area of the sub-basin is 722 acres, of which 200 acres is from Upper Deer Creek. It is nearly built out (overall DCIA 52% with Upper Deer Creek at 62%) with commercial and medium density residential land use, a flat topography, and poorly drained soils. The PSWMS consists of a main stem that discharges directly into the St. Johns River with two roadway crossings. Undersized and clogged secondary storm sewers cause the streets within the Upper Deer Creek sub-basin to flood frequently.

The secondary system was re-designed to provide for a 5-year, 24-hour storm level of service for roadways and protection of house flooding for the 100-year storm to the maximum extent practicable. The capacity increase of the secondary system also increased the discharge to Deer Creek. That, in turn, caused an increase in flood stages downstream (i.e., Talleyrand Avenue flood stage increased from 6.5 to 6.9 feet-NGVD). Therefore, a detention system had to be provided for peak attenuation.

Two other projects are underway in the basin that provided opportunity for a joint solution. A wet detention facility had been permitted for the city's lower Eastside Bond Project, and CDM is evaluating alternatives to control industrial related groundwater/surface water contamination of lower Deer Creek. The proposed joint solution for the three projects includes:

1. Increase the size of the permitted wet detention pond to incorporate the needed treatment volume and residence time to make all three projects permittable. Proposed increase of the wet detention pond from 6.5 to 7.3 acres, steepen the side slopes from 4:1 to 2:1 (fenced access), and eliminate short circuiting by maximizing treatment pool length.
2. Implement a stormwater best management Practice (BMP) Treatment Train (Figure 2).
3. Size a smart box was sized to direct 90% of the average annual volume to treatment, and
4. Solve the contamination problem by enclosing lower Deer Creek to reduce sediment transport and groundwater flow.

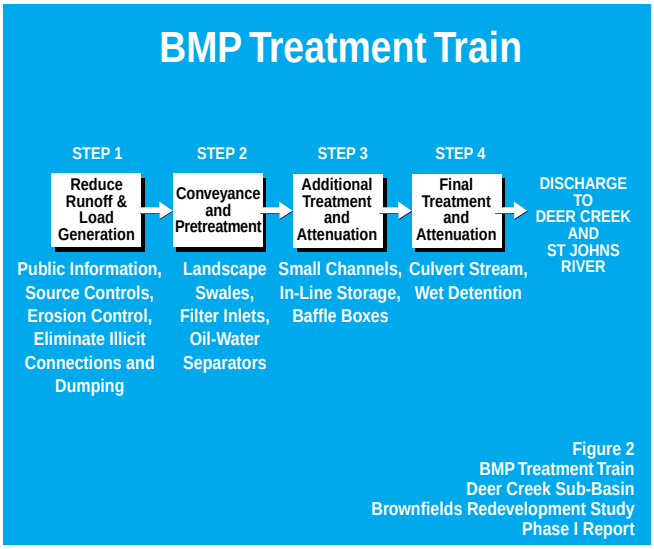

Figure 2
BMP Treatment Train
Deer Creek Sub-Basin
Brownfields Redevelopment Study
Phase I Report

Working in close contact with the two regulating agencies, SJRWMD and DEP, CDM will apply for a conceptual permit for the Brownfields project and for an individual permit for the Upper Deer Creek project. This project should move to implementation within the next two years.

Murray Hill

Murray Hill is in the Big Fishweir Creek Sub-basin which in turn is in the Lower St. Johns River Upstream of Trout River basin. The tributary area of the Big Fishweir Creek Sub-basin is 2.5 square miles (1600 acres) of which 134 acres are from Murray Hill. This sub-basin is nearly built out (overall DCIA 36% with Murray Hill at 51%) with mostly medium density residential land use, a flat topography, and poorly drained soils. The PSWMS consists of two main stems that discharge directly into the St. Johns River with many roadway crossings.

Undersized and badly clogged secondary storm sewers causes the streets within the Murray Hill area to flood frequently.

The secondary system was designed to provide for a 5-year, 24-hour storm level of service for roadways and protection of house flooding for the 100-year storm to the maximum extent practicable. As with the other projects, finding real estate for a retention/detention facility proved very challenging since the basin is built out. However, a baffle box was designed to provide for the water quality benefit required for a retrofit project.

The baffle box was sized using the Storage, Treatment, Overflow, Runoff Model (STORM) which is a hydrologic model designed for flowrate characterization in combined sewer systems and stormwater detention. Its methodology is based upon the original STORM developed by CDM for the United States Army Corps of Engineers (USACOE) in the 1970s. STORM employs the basic assumptions that rainfall runoff is modeled using the rational method, a constant one-hour time step is employed, and no hydraulic routing is performed (hydrologic storage routing is performed).

As used, the program generates runoff using long term rainfall record (49 years of hourly data) and the rational formula (Q=CiA). The program then routes the runoff through the storage facilities (approximately 4,700 feet of pipe including the baffle box). At each time step, the program calculates the runoff and routes it through the storage at the given treatment rate. If the runoff rate exceeds the treatment rate and the storage provided is full, the excess runoff is shunted around the system and is considered untreated. When all events in the rainfall file have been processed, the program calculates the percentage of runoff that was routed and treated through the system. CDM analyzed 49 years of rainfall data with STORM. Various treatment rates were evaluated. The optimum treatment rate that would allow for the capture of 94% of runoff from the Murray Hill area was found to be 27 cfs. Using the residence time of the proposed baffle box and assuming that each particle is removed from the water column when it drops below one of the three weirs, the baffle box was sized to remove 50 µm or coarser particles.

CDM recommends that during the first year the baffle box be monitored to establish the proper maintenance schedule that will maintain the accumulation of sediment at no more than 50% of the box capacity (one half of the weir depth). Research has shown that above the 50% capacity, sediments in the box may be re-suspended. This is expected to be approximately 4 cleanings per year.

As before, the Phase II MSMP SWMM RUNOFF and EXTRAN models were used to evaluate the impact (if any) on stage caused

by the potential increase in discharge rate from the Murray Hill Sub-basin. Model results indicated that the proposed system was efficient and treatment was achieved and that a slight decrease (0.1 ft) in flood stages occurred due to the slight increase in system storage at peak condition.

A permit has already been issued for this project by SJRWMD.

Grand Park and Moncrief Creek

Grand Park is in the Moncrief Creek Sub-basin that in turn is in the Trout River basin. The tributary area of the sub-basin is 4,146 acres, of which 161 acres are from Grand Park. The sub-basin is developed (overall DCIA 34% with Grand Park 33%) with mostly medium density residential land use, a flat topography, and poorly drained soils. The PSWMS consists of one main stem that discharges directly into the Trout River with many roadway crossings. Undersized secondary storm sewers cause the streets, some low lying homes within the Grand Park, and at least one house off 33rd Street to flood frequently.

To reduce the frequency and duration of flooding events the secondary system was designed to provide for the 5-year 24-hour storm level of service for roadways and for the 100-year storm level of service for houses to the maximum extent practicable. However, by increasing the conveyance capacity to the McMillan Canal, thus to Moncrief Creek, stages will also increase in the canal/creek, making the improvement an unacceptable solution unless attenuation or the conveyance capacity of the channel is improved. Furthermore, since the peak discharge is increased, water quality treatment will also be required by the SJRWMD.

By improving the conveyance capacity of the upstream system to solve flooding, stages were increased downstream. Since the canal is lined and is located within a fully developed area, a pond or widening of the channel in that reach were not the best alternatives. Close examination of the canal showed that within a span of 2,000 feet of canal there were seven crossings, mostly 300 feet apart. The recommended solution was to remove some of the crossings to reduce the overall head loss through the canal, thus reducing stage to at least the pre-development level.

A combination of channel widening and online wet detention will provide for the water quality benefit required for the Grand Park project and will reduce house flooding. A v-notch weir will be constructed to control flows in the creek. In addition, two lakes that were proposed for other city projects will be re-dedicated for this project

The permitting agency, SJRWMD, has been kept abreast of this project and has endorsed the project approach.

Sandalwood Canal

Sandalwood Canal is in the Hogpen Creek Sub-basin that in turn is in the Intracoastal Waterway. The tributary area of the canal is 6.7 square miles. The sub-basin is mostly undeveloped (overall DCIA 13%). However, it is located in an area of active growth. The predominant land use is medium density residential. It has a flat topography and poorly drained soils.

The canal was constructed in the 1970s to provide mosquito control and flood relief for the most upstream subdivision. As the basin has continued to be developed, the discharge rate and the velocity within the canal have increased. The side banks of the canal are steep (>2:1 in some reaches). The canal has been experiencing severe erosion problems that may eventually threaten the structural integrity of several of the bridge crossings. Scouring, eroding side-banks, and island formation at various locations in the canal is common. CDM has updated the Hogpen Creek RUNOFF and EXTRAN models that were developed in 1992 to evaluate the extent of the problem and to identify solutions.

Although land is available for the construction of stormwater facilities within the sub-basin, its cost and the size of the detention facility needed to have an impact on the velocity would make this project cost prohibitive. However, CDM was aware of an area within the sub-basin that was being considered by the SJRWMD and Florida Department of Transportation (FDOT) as wetland mitigation alternative for SR 9A. On behalf of the city of Jacksonville, CDM approached the SJRWMD to provide a solution to bother parties: create a wetland with approximately 170 acres of land under a conservation easement that will also provide for the peak attenuation required to solve the stage and velocity problem of the canal. The area where the wetland will be created/enhanced is a remnant of Cedar Swamp Creek headwater that has been ditched and impacted over the years. This project would restore the hydrology and add storage to reduce flooding and erosion while re-establishing the hydro period consistent with the offline wetland system. The invert of the wetland would be designed so that frequently occurring storms will be routed through the wetland to establish a healthy hydroperiod and provide for peak attenuation.

The permitting agency (SJRWMD) is participating in the project via the wetland creation/restoration.

West 1st Street and Melson Avenue

West 1st Street and Melson Avenue are in the Little Sixmile and McCoy Creek sub-basins that in turn are in the Trout River and the LSJRU. The tributary area of the project that discharges into Little Sixmile Creek is 472 acres and 42 acres to McCoy Creek. This sub-basin is mostly developed (overall DCIA 45%). As with most of our project, the soils are poorly drained and the topography is very flat.

The most serious flooding problems within the basin (mostly roadway overtopping) were found to be caused by poorly functioning (silted storm sewers and swales) secondary storm sewer systems.

To alleviate flooding, the secondary system was designed to provide for a 5-year, 24-hour storm level of service for roadways and protection of house flooding for the 100-year storm to the maximal extent practicable. Also, a wet detention facility will be constructed along the tributary to Little Sixmile Creek to provide for the peak attenuation and water quality required. For the McCoy Creek Sub-basin a series of wet detention facilities that were previously designed and permitted will be used for that portion of the sub-basin that is being upgraded.

A permit has already been issued for the McCoy Creek Sub-basin, and the wet detention for the Little Sixmile Creek Sub-basin exceeds the requirement for a new development.

San Marco and Nira Avenues

These sub-basins are mostly medium density residential development and light commercial land use. Storm sewer networks discharge directly into the St. Johns River, and the flooding problems of that basin are mostly created by high water level in the river. To mitigate for the high tailwater, pump stations will be installed. To provide for the required water quality treatment, a CDS and a Vortechnics centrifugal unit will be used as the wet well for pump station. Steps are also being taken to develop a monitoring plan to evaluate the efficiency of the sediment in removing pollution from storm water.

The remaining four projects are mostly small roadway stormwater improvement (Morse Avenue and Parete Circle, and Bradley Road) and program implementation assistance for Wills Branch and Lincoln Villas. ■