Final Report for

GOTTFRIED CREEK BASIN MASTER PLAN

March 1996

Submitted to

SARASOTA COUNTY
FLORIDA

PARSONS ENGINEERING SCIENCE, INC.

FINAL REPORT

GOTTFRIED CREEK BASIN MASTER PLAN

Prepared for

SARASOTA COUNTY, FL

Prepared by

PARSONS ENGINEERING SCIENCE, INC.
SARASOTA, FLORIDA

March 1996

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Gottfried Creek basin is located in the southern portion of Sarasota County and extends into the northern portion of Charlotte County. The creek discharges into Lemon Bay, which in 1987 was designated Outstanding Florida Waters (OFW). As this basin, along with other basins in South Sarasota County, face substantial current and future development, the County decided to conduct a Basin Master Plan to be used as a tool that would guide future development and, at the same time, protect the area's natural resources. This study included the approximately 7,300 acres (11.3 square miles) located within the Sarasota County political boundaries.

Historically, the Gottfried Creek basin consisted of a series of contiguous wetlands and mesic hammocks that extended from the creek's headwaters to its outfall. In its original condition, the basin naturally collected water, nutrients, and sediments from upland areas to discharge into the wetlands and waterways. Over the years, extensive filling within the creeks' flood plain, including the wetlands, as well as substantial creek channelization and construction of man-made drainage structures have resulted in degradation of the natural system. However, due to the largely undeveloped state of the basin, valuable environmental habitat still exists. Environmental surveys within the basin identified several different habitat types. Aquatic and wetland habitats are predominantly influenced by differences in salinity and tidal amplitude. In terms of land uses, about 76 percent of the area is categorized as either open land or wetlands and about 27 percent of the undeveloped area is categorized as wetlands. Projections indicate that in the future most of the area will be developed as low and medium family residential.

One of the objectives of this study was to evaluate the extent at which the flood protection and water quality levels of service (LOS) are being met in the basin. The LOS for flood protection are delineated in the County's Land Development Regulations. LOS for water quality have not been established in Florida. A methodology to determine water quality LOS deficiencies and objectives was developed herein based on both data analysis and Best Management Practices (BMP) coverage. Hydrologic/hydraulic and water quality models were developed for assessing existing and expected conditions.

LOS analysis for flood protection indicated that no emergency shelters, essential services, or employment/service centers would experience flooding during a 100-year storm event. However, numerous buildings, all residences, would be flooded during this flood event. They are located along Van Gogh Road and Madder Lane, north of Artist Avenue, and along Olive Street area, south of Artist Avenue. Most of this area currently drain into the northern portion of the Englewood lateral. Another residence experiencing flooding in the Gottfried Creek basin is located on South River Road, north of the Pine Street Park entrance. Regarding road access, the Gottfried Creek basin shows LOS deficiencies exclusively at one location, McCall Road at the Gottfried Creek crossing. The evacuation routes of S.R. 776, Dearborn Street and River Road were found to meet LOS criteria. Similarly, neighborhood streets throughout the basin are meeting LOS criteria.

In terms of water quality, a recent FDEP study concluded that existing conditions in the basin are being threatened by current development. Erosion problems exist throughout the basin. Calculations of conditions based on the FDEP water quality index (WQI) indicated that water quality at the Dearborn Street bridge is in the fair category, bordering the poor water quality limit. Conditions improve downstream. WQI values correspond to the percentile distribution of stream water quality throughout Florida. Furthermore, the biological data indicated that pollution due to human or animal wastes is likely to be present. Causes of this problem could be septic tank effluents and/or runoff from grazing activities upstream. The biological conditions may have improved since the time when the water quality data were collected because, for example, a successful range management plan has been implemented in the Taylor Ranch area. Conditions will also improve within the next five years, as the Englewood wastewater collection system is constructed. Project construction will start this month.

The water quality LOS recommended for this basin is to initially achieve, throughout the stream, a minimum WQI value equal to the average for the fair-condition range. As conditions improve in the future, the WQI LOS could be improved. Furthermore, it is recommended that BMP coverage be provided for the existing developed areas in the basin, particularly in the Englewood area. This is consistent with the Sarasota Bay National Estuary Program goals.

Various individual projects were identified in this study to improve flood control and water quality conditions within each problem area. The identification of those projects was based on the evaluation of alternatives in terms of costs, environmental impacts, regulatory and permitting issues, and community acceptance. Project descriptions, recommended implementation time, and cost estimates were developed and are provided in this report. The cost associated with the construction of the short- and medium-term improvements amounts to about $3.2 million. County records indicate that there a total of 5740 Equivalent Stormwater Units (ESUs) in the Gottfried Creek Basin. Assuming a 10-year implementation period for this projects at an eight percent discount rate, the annual contribution per ESU would be approximately $60.

A regional stormwater management facility (RSMF) is being proposed for future implementation. It would be located north of the Englewood lateral confluence, in the Taylor Ranch area. The RSMF would be designed with flow-through culverts such that it would be inundated during large storms, while existing hydroperiods in the wetlands upstream would be maintained. Analysis indicated that it would be to the County's and the current land owner's benefit if this RSMF is developed. Its construction would require an initial investment to be paid later by those benefiting from the facility's operation. Initial expenses could be financed by dedicated ad valorem taxes. The investment would be recovered in the future by various finance alternatives described in this report. Mitigation banking could be an important source of revenue.

Finally, during the public meetings conducted during the development of this plan, it became apparent that the public perception is that many of the flooding problems in the Gottfried Creek basin are caused by lack of adequate maintenance. This report provides an evaluation of the current maintenance program in the County, makes operational recommendations, and proposes locations for easement acquisitions. Various maintenance considerations are analyzed including maintenance easement acquisition; mowing, clearing , and erosion control practices; mosquito and plant control activities; debris and litter removal; pond sediment removal; resetting of culverts; and data collection management. It should be noted that over the last two years the County has been in the process of implementing a more adequate countywide maintenance program based on the recognition that it is cost efficient to have a stormwater facility well-maintained and ready to convey the runoff from the next storm with minimal damage to surrounding property and the environment.

In an attempt to develop an objective program that provides a comprehensive approach to stormwater maintenance, and using the format developed by the County, Parsons Engineering-Science rated various conveyance systems within the study area and provided recommended maintenance schedules.

SECTION 1
INTRODUCTION

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INTRODUCTION

GENERAL

The Gottfried Creek basin is located in the southern portion of Sarasota County and extends into the northern portion of Charlotte County. Although the creek's discharge is located in Charlotte County, over 90 percent of the drainage area is within Sarasota County. This study included primarily the approximately 7,300 acres (11.4 square miles) located within Sarasota County political boundaries. A location map is included as Figure 1.1.

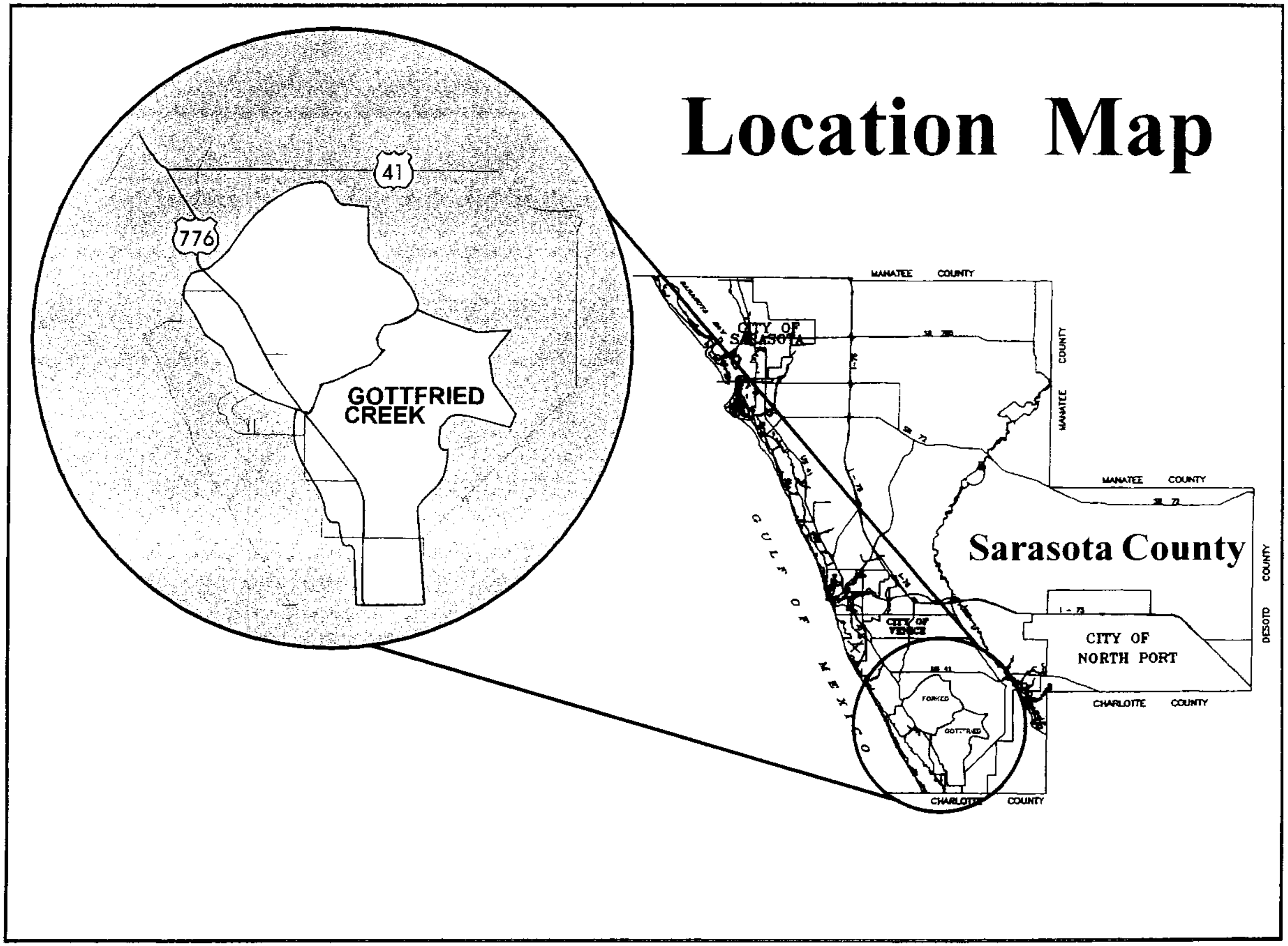
Gottfried Creek discharges into Lemon Bay, which in 1987 was designated Outstanding Florida Waters (OFW). The OFW designation provides additional protection to waters recognized for their ecological and recreational importance. According to Chapter 62-302.600 of the Florida Administrative Code (FAC) and County Ordinance 72-37, Lemon Bay is categorized as Class II surface waters, that is waters used for shellfish propagation and harvesting. Gottfried Creek is a Class III stream and its designated uses are the "recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife" (62-302.400 FAC).

As this basin, along with other basins in South Sarasota County, is facing rapid development conditions, the County decided to conduct a Basin Master Plan to be used as a tool that would guide future development and, at the same time, protect the area's natural resources. The Master Plan will be used as a tool to achieve the goals established in the Sarasota County Comprehensive Plan (APOXSEE) to protect and conserve surface and groundwater resources as well as to enhance the quality of the estuarine environment in Sarasota County.

PROJECT OBJECTIVES

The objectives of the Master Plan are:

- Evaluate the existing and future flood control levels of service (LOS) in the basin. This evaluation included application of the adopted LOS criteria to identify those areas where the existing system does not provide an acceptable LOS.
- Evaluate the existing and future water quality levels of service. This evaluation was based on calculations of expected pollutant loads for existing and build-out conditions



Location Map
41
776
GOTTFRIED
CREEK
MANATEE COUNTY
CITY OF
SARASOTA
MANATEE COUNTY
Sarasota County
DESOTO COUNTY
GULF OF MEXICO
CITY OF
VENICE
CITY OF
NORTH PORT
CHARLOTTE COUNTY
FORKED
CHARLOTTE COUNTY

FIGURE 1.1

- Identify the stormwater drainage improvements required to meet the existing and projected levels of service over the planning period. Alternative improvement plans were evaluated considering positive and negative impacts to developed areas and natural resources
- Identify the best management practices required to control stormwater pollution.

SCOPE

To achieve the objectives of this project, the scope of services included a series of tasks, the scope of which are discussed in the following paragraphs.

Project Management and Coordination. This task consisted of the preparation of a project management plan, quality assurance plan and project schedule.

Coordination with Federal, State, and Local Agencies. Local, state and federal agencies, having jurisdiction over the project were contacted to receive input, provide coordination, and establish project permitting criteria.

Define Basin and Subbasin Characteristics. Existing available data were reviewed and evaluated to identify deficiencies in the stormwater system. Field investigations were conducted to verify existing data, basins and subbasins were delineated and mapped, and existing and projected land uses were identified. In addition, various meetings were held to receive input from the public and keep the residents of Sarasota County abreast of the work being conducted.

Conduct Hydrologic, Hydraulic, and Water Quality Analysis. Computer models were developed and used as tools to assess existing and proposed conditions. The models were calibrated and verified to ensure that they replicated situations observed in the field. Model schematics and flood frequency profiles were developed and incorporated in an Hydrologic, Hydraulic and Water Quality Progress Report.

Evaluate Existing and Future LOS and Identify Problems and Solutions. The computer models were used to identify the areas were the LOS either were not currently being met or would not be met under future development conditions. In addition, stormwater management related problems were identified in the public meetings and field visits. Subsequently, a number of alternatives were screened to identify the more feasible solutions to the problems.

Detailed Evaluation of Alternatives. Preferred alternatives identified during the previous tasks were analyzed in more detail to identify specific projects recommended for implementation during the planning period.

Water Supply Supplement Analysis. One of the objectives of basin and watershed management is to evaluate the use of stormwater as a water supply supplement. Various options were evaluated in this study for that purpose.

Obtain Conceptual Approval of Basin Master Plan. Project implementation is guided to a large degree by permitting and regulatory issues. To ensure that the recommended projects would be permitted, a conceptual approval of the recommended basin improvements were obtained from the SWFWMD.

Develop Comprehensive Master Plan Report. This task included preparation of the final report document detailing the procedures and criteria used in identifying the recommended projects, as well as providing cost estimates of the recommended improvements.

AUTHORIZATION

Preparation of the Gottfried Creek Basin Master Plan was authorized by Contract (No. 93-110 dated February 16, 1993) between Sarasota County and Parsons Engineering Science, Inc.

SECTION 2
DESCRIPTION OF STUDY AREA

SECTION 2
DESCRIPTION OF STUDY AREA

BASIN DESCRIPTION

Typical of Southern Florida conditions, the Gottfried Creek drainage basin is characterized by a flat topography, high water tables, and many natural depressions and wetlands. The basin slopes from an elevation of about 15 ft msl in the upper reaches to sea level over a distance of about six miles. For this study, the basin was delineated using the Southwest Florida Water Management District (SWFWMD) topographic maps. In addition, field trips were conducted to further define basin boundaries.

The delineated boundaries were then compared with those shown in the county-wide basin delineation maps provided by the Sarasota County Planning Department. Those maps were developed based on the 1983 Delineation of Drainage Basins, Sarasota County report by Camp, Dresser, and McKee (CDM). As expected, some small differences were noted. Those differences resulted from the general nature of the CDM study. In addition, the flat configuration of the terrain required a substantial amount of judgment in the delineation process. The new delineation was accepted as the basis for this study.

From the delineated basin map, it was determined that the area encompassed by the Gottfried Creek basin within Sarasota County is about 7,300 acres (11.3 square miles). The portion of the basin within Charlotte County boundaries has been estimated to be about 250 acres.

EXISTING LAND USES

The extent of existing land uses in the basin was determined from the land use/land cover maps available from the Southwest Florida Water Management District (SWFWMD). The SWFWMD maps are based on the Florida Land Use and Cover Classification System (FLUCCS) and show 30 land use categories in the study area. The SWFWMD maps were obtained from Sarasota County in ArcCAD format and checked with the 1990 aerial photographs provided by the County.

Subsequently, the 30 land use categories shown in the SWFWMD maps were aggregated into six general categories which were considered to represent land use conditions in the study area. The six categories are as follows:

Low and Medium Density Residential
High Density Residential
Commercial and Industrial
Open land
Wetlands
Water

Calculations on the extent of the land uses indicated that most of the land in the Gottfried Creek basin is undeveloped. About 76 percent of the area is categorized as either open land or wetlands and about 27 percent of the undeveloped area is categorized as wetlands. Similarly to other areas of the County, development has occurred mainly along the coastal strip. Historically, it has occurred in the vicinity of S.R. 776. Developments consists mainly of low and medium density residential with pockets of commercial land uses. Figure 2.1 shows the existing land uses in the study area.

FUTURE LAND USES

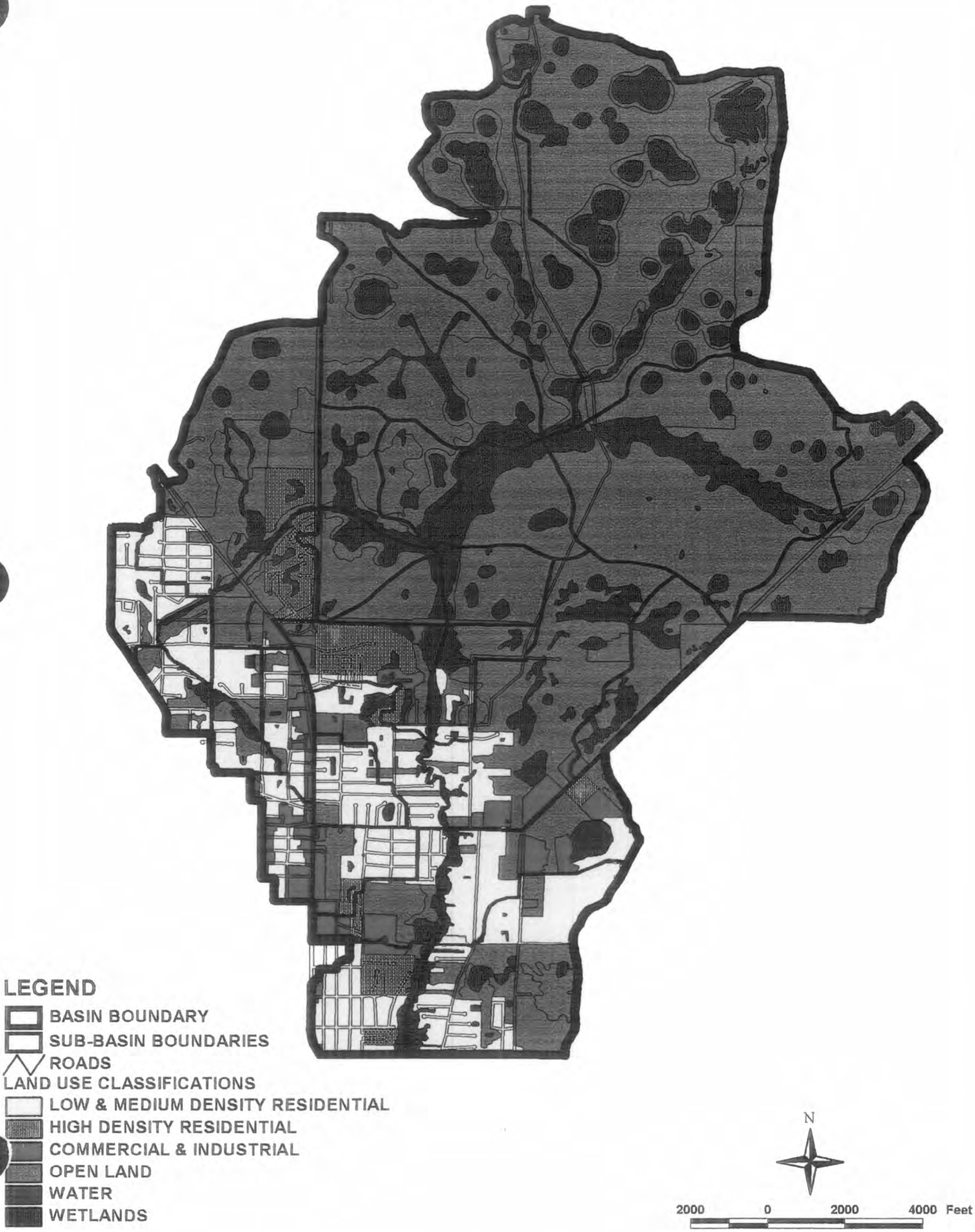
As one of the purposes of the current study is to evaluate the existing and future flood control and water quality conditions in the basin, it was necessary to compile a future land use map for the study area. This map, shown in Figure 2.2, was developed based on the Revised and Updated Sarasota County Comprehensive Plan APOXSEE; the Pine Street, Dearborn Street, and South River Road Sector Plan; contacts with the Sarasota County Planning Department; and investigations of approved re-zoning due to Development of Regional Impact (DRI) applications. No approved DRI applications were found in the study area.

It is important to note that the future land use map represents build-out conditions. At that stage, over 70 percent of the area in the basin is expected to be developed. According to APOXSEE, low and medium density residential development is likely to become the dominant land use in the study area in the future.

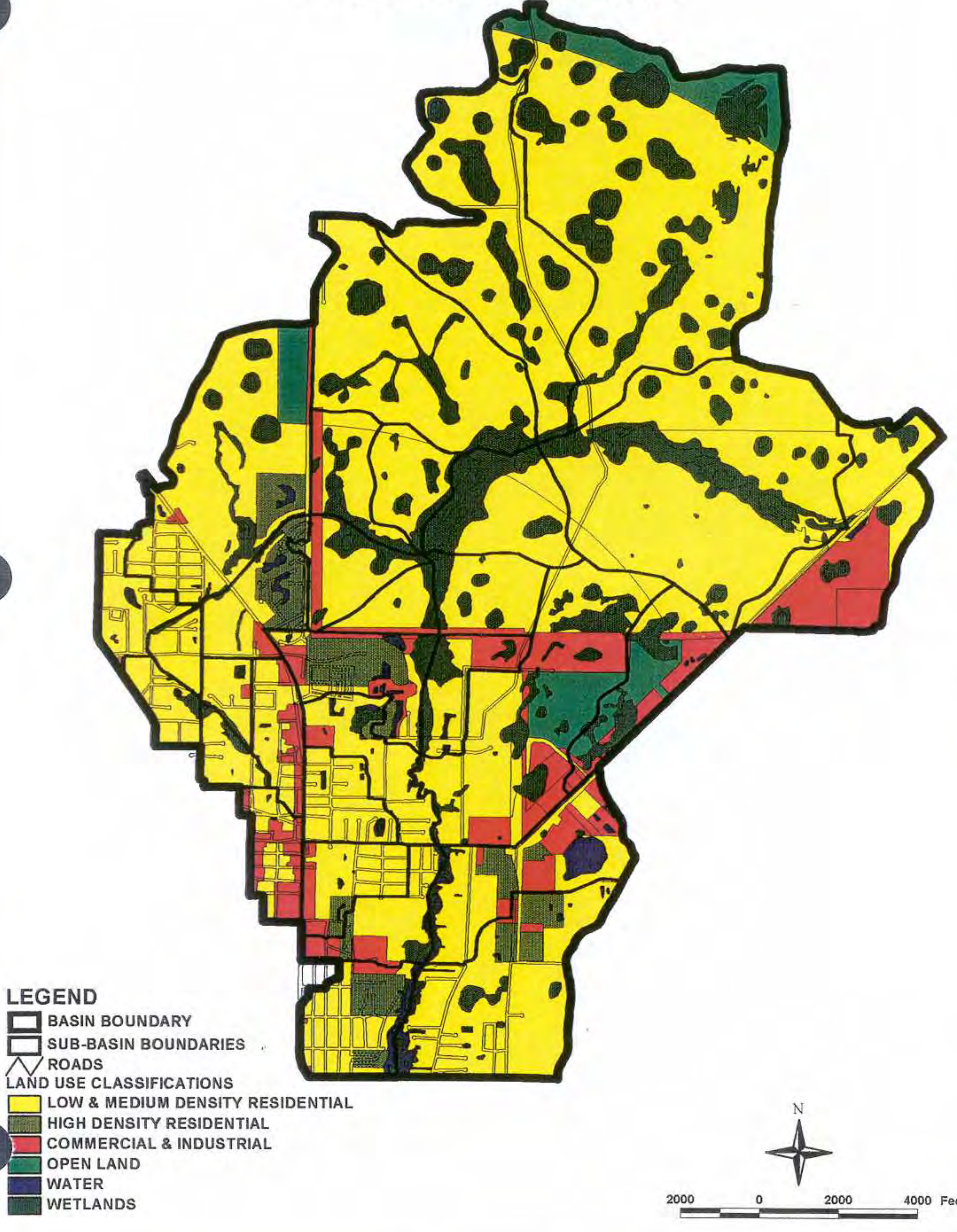
Future development is expected to occur primarily along the proposed Pine Street extension, the proposed extension of Keyway Road, the area north and northwest of River Road, and in the proposed "Village Centers" such as those planned around the Pine Street-Dearborn Street-River Road intersection.

The future land use map developed for this project does not include the water features that are likely to be developed in the area as stormwater management facilities. Those facilities will be designed and constructed as needed to comply with current state surface water management regulations and the County's land development standards. However, calculations of future stormwater conditions considered the attenuating effects of these facilities.

EXISTING LAND USE
GOTTFRIED CREEK BASIN



FUTURE LAND USE
GOTTFRIED CREEK BASIN



SOILS

A soil classifications map for the Gottfried Creek basin is shown in Figure 2.3. Soils in the basin are mainly of sandy, siliceous type, belonging to the Myakka and EauGallie series. According to the Natural Resources Conservation Service (NRCS), typically the surface layer of the EauGallie soil is black fine sand. The subsurface layer is gray fine sand. The Myakka soil is dark grayish brown fine sand and the subsurface layer is light gray fine sand. These poorly drained soils, formed in beds of sandy and loamy marine sediments, are categorized by the (NRCS) in the hydrologic groups B and D for drained and undrained areas, respectively. These soils have low available water capacity and low organic content. Water is removed slowly such that they saturate periodically during the rainy season, or remain wet for long time periods. These conditions are evident by the long recession periods shown by the measured hydrographs available for this area.

Under natural conditions, the EauGallie and Maykka soils are poorly suited to cultivated crops because of the wetness and the sandy texture of the root zone. However, their suitability for improved pasture and hay crops is good. Their condition for shallow excavations is considered severe because of cutbanks caving. In addition, the recommended erosion factors for soil erosion calculations, considered as measures of susceptibility to sheet and rill erosion by water, indicate high erosion potential. This condition is evident in the existing drainage system where unprotected ditch banks have collapsed in many areas, resulting in significant erosion deposits downstream.

NATURAL ENVIRONMENT

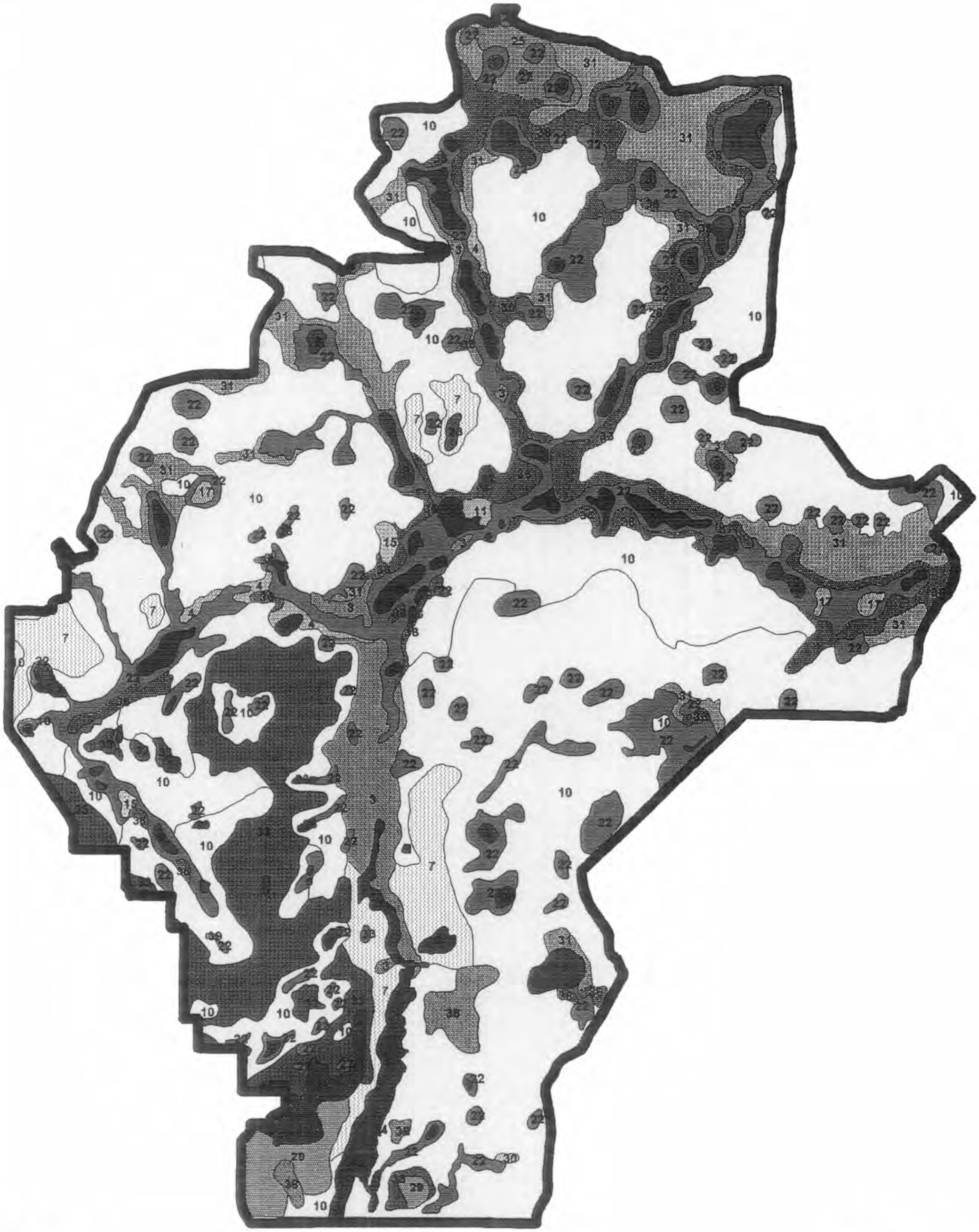
Historically, the basin consisted of series of contiguous wetlands and mesic hammocks that extended from the creek's headwaters to its outfall in Lemon Bay. In its original condition, the basin naturally collected water, nutrients, and sediments from upland areas to discharge into the wetlands and waterways. Over the years, extensive filling within the creeks' flood plain, including the wetlands, as well as substantial creek channelization and construction of man-made drainage structures have resulted in degradation of the natural system. Channelization has reduced the capacity of the basin for natural water storage, thus increasing the potential for downstream flooding. Several sites had documented historical flooding problems.

Existing environmental characteristics of the Gottfried Creek Basin were identified during field reconnaissance of specific sites within the basin. Furthermore, the existing environmental conditions were reviewed using the U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps. Driving surveys utilizing existing roads and trails were also conducted in the basin. General community types and dominant vegetation were documented in field books.

Natural Communities and Wetlands

Environmental surveys within the basin identified several different habitat types. This study identified aquatic and wetland habitats that are predominantly influenced by differences in salinity and tidal amplitude. The closer the waterbody is to Lemon Bay

SOIL CLASSIFICATIONS
GOTTFRIED CREEK BASIN



LEGEND

10 **Soil group per attached table**

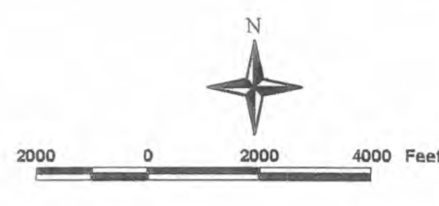


FIGURE 2.3 (Continued)
SOIL LEGEND

SYMBOL	NAME
3	Boca and Hallandale soils
4	Bradenton fine sand
7	Cassia fine sand
8	Delray fine sand, depressional
10	EauGalle and Myakka fine sands
11	Felda fine sand
12	Felda fine sand, depressional
15	Floridana and Gator soils, depressional
17	Gator muck
21	Ft. Green fine sand
22	Holopaw fine sand, depressional
24	Kesson and Wulfert mucks, frequently flooded
25	Malabar fine sand
26	Manatee loamy fine sand, depressional
29	Orsino fine sand
30	Ono fine sand
31	Pineda fine sand
32	Pits and Dumps
33	Pomello fine sand
36	Pople fine sand
38	Smyrna fine sand
39	St. Augustine fine sand
40	Tavares fine sand

the greater the dominance by estuarine species. In upland locations, vegetative community compositions were dependent on the elevation in the landscape, hydrology, and substrate.

In Charlotte County, at the creek's discharge point, the area supports an estuarine habitat that is dominated by tidal swamp vegetation. Natural communities and urban development share the creek banks at this location. The Sarasota County Natural Resources Department is conducting a study to identify environmentally sensitive areas throughout the County. A parcel has been identified in the Gottfried Creek basin, which is located adjacent to the creek at the east end of Selma Avenue and about 1,800 feet south of Dearborn Street in Englewood. The parcel is within the vegetated portions of the Englewood wellfield and, according to the Natural Resources Department report, it is unique in being the only substantial stand of scrub that contains both sand pine and rosemary in the County.

Further upstream in Sarasota County near the Dearborn Street crossing, estuarine habitats persist. Tidal marsh habitat is present along the shallow flats of the creek. Residential housing is adjacent to the creek at this location. Upland canopy vegetation adjacent to the creek is dominated by the exotic species Australian pine. In urbanized areas of the basin that are outside of the creek drainage, slash pine, live oak, cabbage palm and various landscape vegetation are also present.

Continuing further upstream, the Park Forest Bridge crosses the main channel of Gottfried Creek. Along the creek sideslopes, vegetation is characteristic of an oligohaline marsh. Pine flatwoods vegetation is present along the creek top of bank. The water course is narrow at this location with steep banks. Vegetation along the creek sideslopes include leather fern , wax myrtle, and Brazilian pepper. Spoil mounds have been historically piled adjacent to the creek, creating berms that parallel the creek's banks. Brazilian pepper is the dominant vegetation. Higher elevations near the Park Forest Bridge that are adjacent to the creek banks support xeric hammock habitat. Live oak, cabbage palm, slash pine and saw palmetto are present in this community.

An isolated wetland is located on the east side of Gottfried Creek northeast of the Park Forest Bridge. This system was reviewed for wetland enhancement or restoration opportunities. Coastal-plain willow was the dominant shrub cover with pickerel weed dominating the fringing herb layer. Several transitional wetland species, Groundsel bush, broomsedge and wax myrtle were also present in the isolated system. Based on the observation of transitional species, the hydroperiod of the wetland appears to have been altered from its historical condition. A homeowner living adjacent to the isolated wetland stated that this area was deeded as a conservation easement per a residential development condition. Wading birds reportedly use the area.

Further upstream, Gottfried Creek flows through the area known as Taylor Ranch. Within the ranch, the creek banks have been maintained cleared of vegetation, especially on the western side. A jeep trail is located adjacent to the creek area. Creek sideslopes are approximately 1:1. On the eastern bank, Brazilian pepper is the dominant vegetation. Pine flatwoods are the dominant community outside of the disturbed Brazilian pepper habitat. Live oak, cabbage palm, and saw palmetto are also present adjacent to the creek. In its upstream reaches, Gottfried Creek flows through channelized shrub-scrub and emergent wetlands. Pine flatwoods comprise much of the upland areas adjacent to the creek along with scattered areas of mesic hammocks that are dominated by cabbage palm and oak.

The east branch of the creek terminates near South River Road. At this location the creek has been altered to create a wide channel and cattails dominate the waterway. Natural pine flatwoods communities dominates the surrounding land cover.

Gottfried Creek also drains a portion of Urban Englewood. This area has been severely disturbed by development. At the SR 776 creek crossing, near the Tangerine Woods Subdivision, the creek has been extensively dredged and channelized. Coastal-plain willow, wax myrtle, saw palmetto, and Brazilian pepper are present along the banks. Adjacent undeveloped habitats include mesic hammocks dominated by oak and cabbage palm. West of SR 776, Gottfried Creek has been piped under several street crossings and channelized through residential developments. Few areas of natural creek meandering still exist in this area.

Threatened and Endangered Species

As shown in the existing land use map (Figure 2.1), development in the basin has occurred mainly in its southern and western portions. As a result, significant undeveloped lands are still available for wildlife utilization. The Florida Natural Areas Inventory provided a list of element occurrence records for a one mile radius of the Gottfried Creek basin. An element occurrence represents the locational record of an ecological component including plant, animal, community type, or natural feature. This list, included as Table 2.1, does not represent all of the species and community types that may be found in the area. Site specific surveys would need to be conducted to determine the current presence or absence of listed species, special community types, and/or unique natural features.

According to staff from the Englewood Water District, scrub jays have also been observed in the environmentally sensitive area identified by the County's Natural Resources Department, but are not known to be currently nesting there. In addition gopher tortoises sightings have been reported to occur on that property.

EXISTING FLOODING CONDITIONS

Research was conducted in this study to assess existing flooding conditions in the basin. This research included review of existing information, interviews with local residents, interviews with the County's stormwater maintenance personnel, review of citizen's complaints, and review of the information collected during the June 1992 storm, as well as recent significant storm events in the area. Research results showed that flooding in the basin has, for the most part, been confined to street flooding.

TABLE 2.1
LIST OF ELEMENT OCCURRENCE RECORDS

Scientific Name	Common Name	Status Fed/State(1)	Preferred Habitat
Amphibians			
Rana capito	Gopher Frog	C2/LS	Xeric sandhill, or scrub community, containing ephemeral wetlands.
Reptiles			
Alligator mississippiensis	American alligator	LT-SA/LS	Various palustrine habitats.
Drymarchon corais couperi	Eastern Indigo snake (2)	LT/LT	Mesic flatwoods, upland forests.
Gopherus polyphemus	Gopher tortoise	C2/LS	Sandhill, scrub habitats.
Birds			
Aphelocoma coerulescens coerulescens	Florida scrub jay (2)	LT/LT	Scrub, Scrubby flatwoods.
Charadrius alexandrinus	Snowy plover	C2/LT	Beach Dune, Exposed Estuarine substrates.
Egretta caerulea	Little blue heron	N/LS	Various palustrine habitats.
Egretta thula	Snowy egret	N/LS	Various palustrine habitats.
Egretta tricolor	Tricolored heron	N/LS	Various palustrine habitats.
Eudocimus albus	White ibis	N/N	Various palustrine habitats.
Falco sparverius paulus	Southeastern American kestrel	C2/LT	Various terrestrial habitats, ruderal.
Grus canadensis pratensis	Florida sandhill crane	N/LT	Dry prairie, Ruderal habitats.
Haliaeetus leucocephalus	Bald eagle (2)	LE/LT	Various palustrine habitats.
Mycteria americana	Wood stork	LE/LE	Various palustrine habitats.
Polyborus plancus	Crested caracara	LT/LT	Dry prairie, ruderal habitats.
Mammals			
Felis concolor coryi	Florida panther	LE/LE	Various terrestrial/palustrine habitats.
Trichechus manatus	Manatee (2)	LE/LE	Various marine habitats.
Plants			
Cereus gracilis var. aboriginum	Aboriginal prickly-apple (2)	LE/LT	Rockland hammock, maritime hammock
Eragrostis tracyi	Sanibel lovegrass	C2/LT	Maritime Hammock, disturbed sites
Glandularia tampensis	Tampa vervain (2)	C2/LE	Mesic flatwoods, hydric hammock
Helianthus debilis spp. vestitus	Hairy beach sunflower	C2/N	Marine tidal swamp, disturbed areas
Lechea cernua	Nodding pinweed	3C/LE	Scrub habitats.

TABLE 2.1 (Continued)
LIST OF ELEMENT OCCURRENCE RECORDS

LEGEND:

(1) Status Codes:

- LE = Endangered;
- LT = Threatened;
- LS = Species of Special Concern;
- C2 = Candidate Species;
- 3C = Taxa that are more abundant that originally thought, and not subject to any identifiable threat.
- LTSA = Threatened due to similarity of appearance.
- N = Not currently listed or being considered for listing.

(2) Documented element occurrence information mapped within a 1 mile radius of the Gottfried Creek and Forked Creek Study area.

Sources:
Florida Natural Areas Inventory;
US Fish and Wildlife Service;
Florida Game and Freshwater Fish Commission;
Florida Department of Agriculture and Consumer Services.

However, there has been various cases of house flooding, many of them occurring during the July 1995 storms. Both the June 1992 and the July 1995 storms are some of the largest storms on record in Sarasota County.

The causes of flooding have been development within the flood plain, the presence of inadequate drainage structures, and the lack of adequate stormwater system maintenance. In several areas the structures have been placed at, or below, the street grade elevation. In addition, as indicated previously, the historic floodplain, including wetlands, has been filled resulting in a substantial reduction in the creek's storage capacity. The various structures that have been placed in the creeks to provide for road crossings, access for residences, and for agricultural purposes are often undersized. In some cases, existing culverts have been poorly constructed, sometimes with their invert elevations pointing in a direction opposite to the flow.

Drainage problems in the Gottfried Creek basin have occurred primarily in the urban portion of Englewood west of Indiana Avenue and east of Old Englewood Road. More specifically, the areas west of Indiana Avenue included those along Elm Street, between Wentworth Avenue and Artist Avenue, and the areas along Olive street and Van Gogh Road. That area was also identified as the critical flooding area during the Lower Gottfried Basin Study conducted for the County in 1965 by Smally, Wellford, and Nalven. The highly urbanized Englewood area was developed prior to the establishment of the new, more stringent, stormwater regulations. It should be mentioned that the 1965 study was used to delineate the current riverine floodplain for the study area.

The Sector Plan for Pine Street, Dearborn Street, and South River Road conducted by the County's Planning Department in 1993 identified various other areas of drainage concern including South River Road and Dearborn Street. Recent house flooding has been reported in the vicinity of South River Road, north of the WENG Radio Station. Various neighborhood streets feeding into Dearborn Street between Indiana Avenue and the Gottfried Creek bridge have also experienced flooding in the past, particularly during the June 1992 storm. In all these cases, flooding was limited to street inundation.

EXISTING WATER QUALITY CONDITIONS

Existing water quality conditions in the Gottfried Creek basin was analyzed by determining potential sources of pollution from the field visits, as well as by analyzing historical water quality data available from Sarasota County and the Florida Department of Environmental Protection (FDEP). The field visits revealed that an important water quality-related element to be controlled is erosion. Dredging activities conducted in the past to facilitate drainage have resulted in the creation of unprotected creek banks that easily erode. Solids carried in the runoff are subsequently deposited in culverts and other drainage facilities, thus reducing their conveyance capabilities.

Other water quality conditions were investigated by analyzing data available from FDEP and the Sarasota County Natural Resources Department. FDEP data indicated that, at this time, Gottfried Creek is meeting the established water quality standards. However, existing conditions are being threatened by development pressures. County data showed that critical water quality parameters are biological and dissolved oxygen concentration. The data analyzed included those from two sampling stations located about 0.25 miles north and about one mile south of the Dearborn Street bridge, respectively. Calculations of conditions based on the FDEP water quality index (WQI) indicated that water quality at the Dearborn Street bridge is in the fair category, bordering the poor water quality limit. Conditions improve substantially downstream. More detail discussions of these conditions are presented later in this report when discussing the estimated levels of service deficiencies for water quality in the basin.

SECTION 3
SUBDRAINAGE BASINS AND EXISTING CONVEYANCE SYSTEM

SECTION 3
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SUBDRAINAGE BASINS

To better define its hydrologic characteristics, the Gottfried Creek basin was subdivided in three major subbasins and 31 modeled subbasins. Modeled subbasins are smaller hydrologic units which resulted from subdividing the major subbasins. In this report, the modeled subbasins are referred to simply as subbasins. Major subbasins and subbasins were delineated using the SWFWMD topographic maps and, in most cases, were field verified. The location of the major subbasins and modeled subbasins is depicted in Figure 3.1.

As shown in Table 3.1 the size of the subbasins varies from 48 to about 2100 acres. The median size is 115 acres. The subbasins in developed areas are generally smaller than those in undeveloped areas to account for hydrologic and water quality considerations resulting from the heterogeneity of land use types. The larger subbasins are those located in the watershed's headwaters because land in those areas is generally undeveloped.

In many cases, the subbasins in the Gottfried Creek basin consist of an aggregation of closed catchment areas discharging to wetland systems. This results in a large basin retention capacity, which has been lost in many of the developed areas where wetlands have been filled and the runoff has been conveyed to man-made ditches that transport runoff to the main creek channel.

To be consistent with previous work conducted by the County, a subbasin numbering scheme for this project was developed based on the 1983 CDM report. The nomenclature is based on a five-digit code that represents the following:

The first two digits identify the basin in which the subbasin is located. The Gottfried Creek basin was assigned the numbers 15. The next digit represents the major subbasin number in the drainage basin. The final pair of digits identifies each modeled subbasin. An example of this scheme is 15301, which indicates the first subbasin in the third major subbasin in the basin.

The delineated basins and subbasins were digitized in ArcCAD format and superimposed over the County's base map. In this manner it was possible to combine the subbasin data with base map information as well as with the land use and soil data provided by the County and discussed later in this report. Tables 3.1 and 3.2 show the extent per subbasin of the existing and future land uses.

SUB-BASINS & STORMWATER SYSTEM STRUCTURES

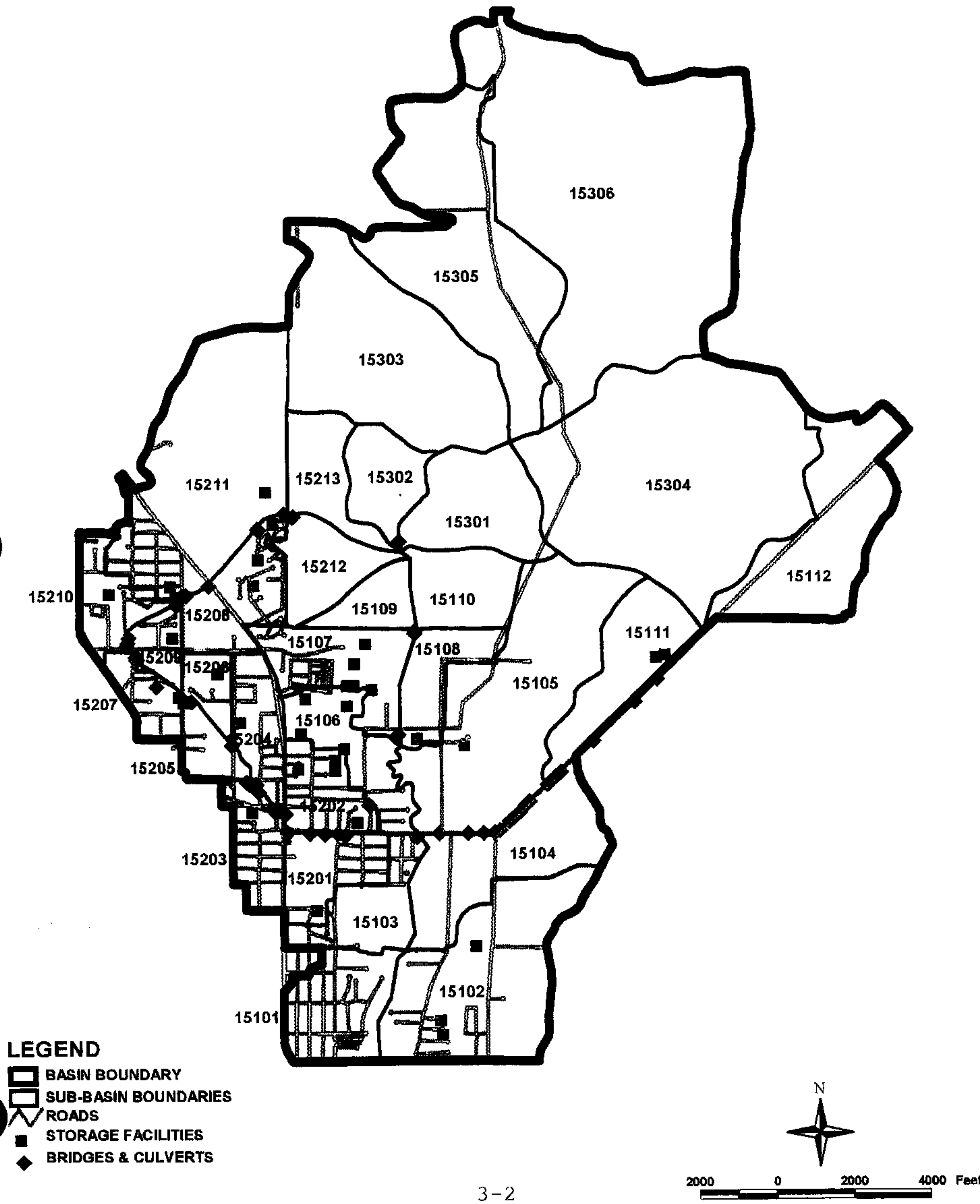

TABLE 3.1
SUBBASINS AND EXISTING LAND USES

SUBBASIN	Low & Medium Residential (acres)	High Density Residential (acres)	Commercial & Industrial (acres)	Open Land (acres)	Water (acres)	Wetlands (acres)	Total (acres)
15101	89.7	39.3	9.7	5.5	11.9	4.0	160.1
15102	174.2	0.0	3.1	167.7	17.0	19.1	381.1
15103	26.2	6.8	26.9	46.5	5.1	8.9	120.3
15104	103.7	8.4	39.1	60.2	33.3	2.6	247.2
15105	61.8	0.0	31.1	311.7	5.8	78.1	488.5
15106	78.5	3.5	9.7	24.8	7.9	7.4	131.8
15107	14.3	74.8	29.0	19.8	10.5	16.0	164.4
15108	16.8	0.0	0.7	56.1	2.9	27.1	103.5
15109	0.0	0.0	9.1	48.5	0.0	10.7	68.2
15110	0.9	0.0	5.4	93.1	0.0	25.4	124.8
15111	0.0	0.0	4.0	126.1	1.0	42.1	173.3
15112	0.0	0.0	1.9	266.0	2.1	30.0	300.0
15201	53.0	10.0	21.1	24.3	1.8	0.0	110.2
15202	79.2	0.0	2.0	14.9	4.4	0.0	100.5
15203	44.7	0.0	48.9	0.0	0.3	0.3	94.2
15204	39.7	0.0	31.0	25.0	0.9	0.3	96.8
15205	30.5	0.0	0.0	15.0	0.4	8.6	54.5
15206	31.8	0.0	2.2	9.4	2.4	3.2	49.1
15207	35.7	0.0	0.4	22.5	1.1	4.8	64.7
15208	4.0	51.9	14.6	59.5	6.6	5.6	142.1
15209	30.2	0.0	0.0	14.1	0.4	3.2	47.9
15210	80.5	0.0	0.7	9.0	3.0	1.1	94.4
15211	70.4	30.5	16.4	325.6	5.0	57.6	505.5
15212	0.0	2.9	7.5	76.0	0.0	29.0	115.4
15213	0.0	0.0	1.7	77.0	0.0	34.1	112.8
15301	2.2	0.0	0.0	108.6	0.0	80.6	191.4
15302	0.6	0.0	0.0	82.7	0.0	24.6	107.8
15303	0.0	0.0	0.5	390.0	0.0	93.5	484.0
15304	0.0	0.0	0.0	647.3	0.0	157.5	804.8
15305	0.0	0.0	0.0	390.1	0.0	117.4	507.5
15306	0.0	0.0	0.0	829.8	0.0	278.5	1108.3
TOTAL	1068	228	317	4347	124	1171	7255

TABLE 3.2
SUBBASINS AND FUTURE LAND USES

SUBBASIN	Low & Medium Residential (acres)	High Density Residential (acres)	Commercial & Industrial (acres)	Open Land (acres)	Water (acres)	Wetlands (acres)	Total (acres)
15101	95.2	39.3	9.7	0.0	11.9	4.0	160.1
15102	295.2	41.1	6.9	0.0	18.8	19.1	381.2
15103	72.6	6.8	26.9	0.0	5.1	8.9	120.3
15104	122.3	25.6	60.0	0.0	35.2	4.0	247.2
15105	231.7	0.0	107.3	66.2	5.8	77.4	488.5
15106	103.3	3.5	9.7	0.0	7.9	7.4	131.8
15107	34.6	71.3	32.0	0.0	10.5	16.0	164.3
15108	47.2	0.0	26.4	0.0	2.9	27.1	103.5
15109	47.3	0.0	10.3	0.0	0.0	10.7	68.3
15110	89.4	0.0	9.0	0.0	0.0	26.3	124.8
15111	30.0	0.0	52.6	47.1	1.0	42.1	172.9
15112	158.7	0.0	118.4	0.0	2.1	21.0	300.2
15201	77.3	10.0	21.1	0.0	1.8	0.0	110.2
15202	94.1	0.0	2.0	0.0	4.4	0.0	100.5
15203	44.7	0.0	48.9	0.0	0.3	0.3	94.2
15204	64.7	0.0	31.0	0.0	0.9	0.3	96.8
15205	45.4	0.0	0.0	0.0	0.4	8.6	54.5
15206	41.3	0.0	2.2	0.0	2.4	3.2	49.1
15207	58.3	0.0	0.4	0.0	1.1	4.8	64.7
15208	68.9	51.9	9.1	0.0	6.6	5.6	142.1
15209	44.3	0.0	0.0	0.0	0.4	3.2	47.9
15210	89.5	0.0	0.7	0.0	3.0	1.1	94.4
15211	358.7	30.5	10.0	43.7	5.0	57.6	505.5
15212	66.7	2.9	16.8	0.0	0.0	29.0	115.4
15213	63.5	0.0	15.2	0.0	0.0	34.1	112.8
15301	108.6	0.0	0.0	0.0	0.0	82.8	191.4
15302	82.7	0.0	0.0	0.0	0.0	25.2	107.8
15303	389.6	0.0	0.9	0.0	0.0	93.5	484.0
15304	646.6	0.0	0.7	0.0	0.0	157.5	804.8
15305	390.1	0.0	0.0	0.0	0.0	117.4	507.5
15306	713.4	0.0	0.0	115.8	0.0	278.5	1107.7
TOTAL	4776	283	628	273	128	1167	7254

EXISTING CONVEYANCE SYSTEM

As indicated previously, Gottfried Creek discharges into Lemon Bay. The lower portion of the creek, approximately up to the Dearborn Street Bridge, is influenced by tidal fluctuations. In the past, prior to the development of current stormwater policies and regulations, the emphasis was to control surface water by quickly moving it away from developments. In an effort to control flooding, the creek was extensively dredged and channelized. Maintenance activities have resulted in dredged material accumulating as spoil berms on the creek's banks. Over the years, these spoil berms have become steep and in many instances are currently sources of erosion problems. In many of the urbanized areas, the creek has become simply a system of side road ditches.

As shown in the enclosed Plate 1, the creek has four conveyance systems, a main branch and three secondary branches. The main branch originates at a location about three miles east of the Myakka River and one mile south of U.S. Highway 41 and extends for about six miles to the mouth of the creek. The area considered as the creek's headwaters is a wetland system that flows toward both the Myakka River and the Gottfried Creek basin. Topographic maps showed that, at low flows, drainage from that wetland system is mainly toward the Myakka River. However, at high flows, a portion of the runoff drains towards Gottfried Creek.

The first secondary branch (east branch) of Gottfried Creek originates on the north side of River Road, at a location approximately 2.5 miles northeast from the Dearborn Street bridge, and flows westward until it meets the main branch about 1.4 miles downstream. A weir structure exists about 4,000 ft from this confluence to control the creek's base flows. That structure was built as part of a master development plan for the Berry Ranch Citrus Grove.

The second creek branch collects drainage flows from the urban Englewood area west of S.R. 776 and east of the Old Englewood Road. This branch, known as the Englewood lateral, is "C-shaped" with the north and south points connecting to the creek's main branch. The drainage area is heavily developed and the conveyance system consists primarily of roadside ditches and driveway culverts. The northern portion of the lateral runs north/northeast and confluences with the main branch about 3,500 feet north of the Park Forest bridge. The southern portion drains toward Dearborn Street and discharges just north of the Dearborn Street bridge. A weir structure located at the Elm Street crossing separates the drainage flow. The construction of this weir possibly resulted from a 1965 study recommendation to increase flow towards the north subbranch of the lateral.

Finally, the third branch of Gottfried Creek is comprised of the South River Road drainage system itself. Drainage towards the creek originates at the Pine Street Park entrance and flows southwest through a system composed of a number of open ditches and driveway culverts. The downstream portion of this lateral is currently being redesigned by way of the Dearborn Street Improvement project. The upstream portion of South River road currently flows toward Ainger Creek through a combination of 24 and 36-inch culverts.

STORMWATER SYSTEM STRUCTURES

Important components of a stormwater system are the drainage, storage, and control structures such as ponds and culverts. As part of this study, field surveys were conducted to identify the location and geometric characteristics of culverts, bridges, and on-line detention facilities. In addition, other facilities, such as off-line detention ponds, were identified from field visits and aerial photographs. The information on these structures was stored as Geographical Information System (GIS) files that combine graphical output and database capabilities. Figure 3.1 shows the location of these structures. A list of the existing structures is included in Appendix A.

SECTION 4
LEGAL AND REGULATORY FRAMEWORK

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LEGAL AND REGULATORY FRAMEWORK

PERTINENT LAWS AND REGULATIONS

The legal framework guiding the development of Master Plans directed toward flood and water quality control encompasses local, state, and federal policies and regulations. However, in general, flood control is a local government function. Local governments are responsible for regulating land uses in the floodplains and providing the necessary drainage facilities needed to satisfy established regulations. Water quality control, because of the need to be addressed on a more regional basis, includes responsibilities at all levels of government. In addition, surface water management for water quality includes both point and non-point sources of pollution. Point sources are regulated by FDEP, whereas non-point sources are regulated by a combination of local, state, and federal programs. Following is a brief description of the most important pieces of legislation related to basin master planning in Sarasota County.

Local Legislation

The most important local policy component is the Sarasota County Comprehensive Plan (APOXSEE). Goal Five of the Environment Section is to "conserve, protect, maintain, and, where necessary, restore the natural resources of Sarasota County to ensure their continued high quality and critical value to the quality of life in the County". Specific management principles are established to protect biological and other natural resources. At the same time, in the Public Facilities/Drainage section, the Plan states that the County's stormwater Levels of Service (LOS) should be designed to reduce flooding potential caused by future development and provide performance standards to minimize impacts on existing surface water quality. Correspondingly, Policy 4.1.2 defines drainage LOS for stormwater quantity and quality. The concept of LOS will be further discussed later in this Section.

The regulations governing land development to ensure conformity with APOXSEE are defined in the County's Land Development Regulations, Ordinance 94-004. This set of regulations addresses the requirements for stormwater management improvements; protection of preservation, conservation, and buffer areas; permits of stormwater facilities; and others. This set of regulations also defines in detail the County's LOS requirements for flood protection.

Ordinance 89-117, establishing the Stormwater Environmental Utility (SEU), allows the County to develop and implement stormwater management plans, as well as to construct regional stormwater management facilities. The objective of the SEU is to manage stormwater runoff as a resource in developing solutions to stormwater problems.

State Legislation

Relevant Florida legislation includes the Florida State Comprehensive Plan Chapter 187 F.S.; the Florida Water Resources Act, Chapter 373 F.S.; the Florida Air and Water Pollution Control Act, Chapter 403 F.S.; the State Water Policy 62.40 FAC; the Surface Water Quality Standards, Chapter 62-302 FAC; and the State Water Quality Standards, Chapters 62-3, 62-4, and 62-25 FAC.

Through the State Comprehensive Plan, Chapter 187 F.S., Florida adopted specific goals and policies to protect water resources and the natural systems in the State. The goal established in the plan is to maintain the function of the natural systems and the overall present level of surface and groundwater quality. Adopted policies encourage the development of a strict floodplain management program, as well as the protection and use of natural systems in lieu of structural alternatives. One of the goals of the implementation plan is to integrate planning capabilities into all levels of government in the State.

The Florida Water Resources Act, Chapter 373 F.S., establishes the state's policies for the waters of the State, directs the development of the Florida Water Plan, and establishes criteria for the management and storage of surface waters. The Florida Air and Water Pollution Control Act, Chapter 403 F.S., establishes the power of the State to control and prohibit pollution of air and water resources; establish air and water quality standards; and adopt comprehensive programs for the prevention, control, and abatement of pollution.

General water policy regulations, including resource protection and management as well as water program development are established in 62-40 FAC. These regulations state that local governments must establish stormwater management programs, which are in accordance with the State's and the Water Management Districts' stormwater quality and quantity goals. The rule describes the permit requirements for surface water management projects and directs the Districts to determine flood levels for priority floodplains, including at the minimum the 100-year flood level. Districts are encouraged to determine the 100-year flood elevation to regulate septic tanks in floodplains.

Pursuant to Chapter 373 F.S. and Chapter 62-40 FAC, SWFWMD developed the Management and Storage of Surface Waters (MSSW) regulations, which state that off-site discharges for existing and developed conditions shall be computed using the District's 24-hour, 25-year rainfall maps. For closed drainage basins, post-development runoff volume should not exceed pre-development runoff conditions.

The criteria establishing minimum water quality standards for Florida streams are established in 62-302 FAC. These regulations also list the bodies of water that have been designated Outstanding Florida Waters, which afford special protection in terms of water quality degradation. Water quality standards for groundwater are established in 62-3 FAC. Regulation 62-4 FAC sets forth the procedures on how to obtain discharge permits from the state regulatory agencies. Specific stormwater discharge regulations, including design and performance standards for stormwater facilities and permit requirements for wetland stormwater discharge facilities, is set forth in 62-25 FAC

Federal Legislation

The Clean Water Act, through the National Pollutant Discharge Elimination System (NPDES), administered by the U.S. Environmental Protection Agency (EPA), requires a federal permit for discharging of pollutants into Water of the United States. In 1990, regulations to control non-point source discharges from industrial facilities and municipal stormwater systems were adopted. As part of the discharge permit, municipalities are required to develop and implement comprehensive stormwater management programs. Sarasota County, in cooperation with the incorporated municipalities in the County, has submitted to EPA the corresponding permit application. This basin master plan is part of the County's efforts to meet the NPDES permit requirements. It should be mentioned that the State of Florida is in the process of achieving delegation for administering the NPDES stormwater program.

LEVELS OF SERVICE OBJECTIVES

A system that performs well under certain stormwater conditions is one that meets the levels of service (LOS) intended for it. The LOS applicable to stormwater management planning include flood protection and water quality. A stormwater system that does not perform well is one that causes unacceptable flooding that result in personal inconvenience, actual property loss or harm, or degradation of the quality of water in the receiving waterbodies. This section describes the basis for determining LOS deficiencies and objectives in the Gottfried Creek Basin. Actual deficiencies and objectives are discussed later in Sections 5 and 6 of this report.

Levels of Service for Flood Protection

As indicated previously, the levels of service for flood protection are delineated in the County's Land Development Regulations, as adopted by the Board of County Commissioners. Table 4.1 and Figure 4.1 show those adopted LOS. The objective of the Master Plan is to ensure that improvements are identified to meet those LOS under existing and future conditions.

Levels of Service for Water Quality

LOS for water quality have not been established in Sarasota County. However, for this study, recommended LOS were developed to help establish both baseline conditions and master plan objectives. The methodology used to determine water quality LOS deficiencies was based on existing data analysis as well as Best Management Practices (BMP) coverage.

TABLE 4.1
STORMWATER QUANTITY LEVELS OF SERVICE CRITERIA

FLOODING REFERENCE (Buildings, roads, and sites)	LEVELS OF SERVICE (Flood Interval in Years)
I BUILDINGS: Pre-FIRM (*) or Post-FIRM structures are at or above the flood water elevation.	
A. Emergency shelters and essential services	>100
B. Habitable	100
C. Employment/Service Centers	100
II. ROAD ACCESS: Roads shall be passable during flooding. Roadway flooding less than or equal to 6 inches depth at the outside edge of pavement is considered passable.	
A. Evacuation	> 100
B. Arterials	100
C. Collectors	25
D. Neighborhood	10

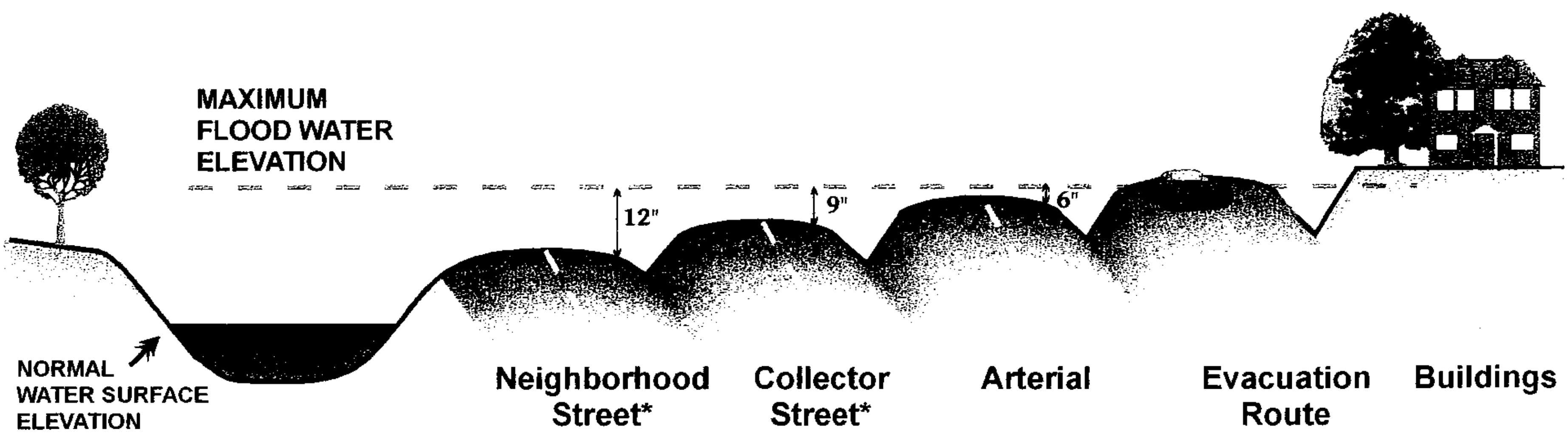
III. The water quantity levels of service can be adjusted to allow for greater amounts of flooding of roads and sites if the flooding does not adversely impact public health and safety, natural resources or property. The level of service for improvements to existing roadways may be adjusted based on existing conditions such as adjacent topography and economic impacts.

ACCEPTABLE FLOODING CRITERIA

ROADWAYS	10-YR	25-YR	100-YR
A. Evacuation	NONE	NONE	NONE
B. Arterials	**NONE**	**NONE**	**6 inches**
C. Collectors	NONE	6 inches	9 inches
D. Neighborhood	6 inches	9 inches	12 inches

* FIRM = Flood Insurance Rating Maps

LEVELS OF SERVICE
ACCEPTABLE FLOODING CRITERIA FOR THE 100-YEAR STORM



*Depth shown is for illustration purposes only. Neighborhood and collector streets should be passable for the 10 and 25-year storm flood, respectively.

FIGURE 4.1

The data analysis encompassed the evaluation of a non-point source assessment study conducted by FDEP in 1994 as well as the calculation of the stream's water quality index (WQI) using FDEP guidelines. The 1994 non-point source assessment study was a qualitative study by which 40 percent of the basins in Florida were ranked based on four "impairment rating" categories based on the degree at which the designated uses of the waterbodies are being met. The categories were good, threatened, fair, and poor. The Gottfried Creek basin was categorized as threatened, which means that "all surface waters in the basin are attaining their use classification, but in the absence of any future management activities, it is suspected that within five years at least some of the surface waters in the watershed will not support their designated use".

The non-point source assessment categorization was further tested in this study by calculating the stream's WQI. According to FDEP, the WQI is based on the quality of water as measured by six water quality categories: water clarity, dissolved oxygen, oxygen demand, bacteria, nutrients, and biological diversity. Index values correspond to the percentile distribution of stream water quality throughout Florida. In general, the overall WQI is the arithmetic average of the six water quality categories. The cutoff values for the WQI are as follows: 0 to less than 45 represents good quality, 45 to less than 60 represents fair quality, and 60 to 99 represents poor quality. Values of the WQI for Gottfried Creek were calculated based on data provided by Sarasota County. Calculations and data analysis, further discussed in Section 6 of this report. The water quality LOS recommended for this basin is to achieve a minimum WQI of 53, which represents the average for the fair-condition range.

BMPs refer to those practices, structural or non-structural, which are used to achieve desired water quality conditions. Mechanisms, such as the SWFWMD's MSSW permitting process aims to control runoff pollution as land is developed. Permitted facilities, for which design criteria have been pre-established, capture and treat runoff from the first inch of rainfall. The MSSW permit is basically a construction permit that applies to developments designed and constructed after the regulations came into effect. In terms of existing conditions, it is estimated that about 14 percent of the existing land developed in the Gottfried Creek basin have stormwater quality control facilities. However, since the basin is undeveloped to a large extent, it is estimated that the MSSW process will be effective in controlling pollution as growth continues.

BMP coverage refers to the extent of stormwater treatment in the basin. It also addresses the attainment of Pollution Load Reduction Goals (PLRGs). Chapter 62-40.432 FAC establishes that each Water Management District must develop specific PLRGs for all waterbodies in Florida on a priority basis. At this time, SWFWMD has not established PLRGs for Lemon Bay. However, as a reference for this study, we have considered the environmental quality objectives of the Sarasota Bay National Estuary Program by which 27 percent of the contaminant load and seven percent of the nitrogen load could be reduced if stormwater treatment technologies are applied to 50 percent of the contributing watersheds. The recommended LOS for this basin is to provide BMP coverage for 50 percent of the existing developed area in the basin.

SECTION 5
STORMWATER SYSTEM MODELING AND ANALYSIS OF FLOOD CONTROL LEVELS OF SERVICE

SECTION 5
STORMWATER SYSTEM MODELING AND ANALYSIS OF FLOOD CONTROL LEVELS OF SERVICE

GENERAL

The hydrologic/hydraulic models developed for this project were the main tools used for assessing existing and expected levels of service (LOS) conditions in the study area. The development of these models included conducting field surveying work, developing the preliminary hydrologic/hydraulic model networks, calibrating and verifying the models, and conducting the model simulations for various conditions. These steps will be described in the following subsections.

FIELD SURVEYING

As indicated previously, field surveying work was conducted as part of this project to obtain the geometric characteristics of the existing drainage structures in the stormwater system. In addition, the field survey was used to collect the data associated with the conveyance system. These data were used as input for the hydraulic analysis. The work consisted of:

a) Conducting a vertical-controlled survey to determine typical channel cross-sections at identified channel reaches

b) Obtaining lengths and diameters of existing culverts

c) Obtaining the geometry of existing on-line detention ponds

d) Obtaining the geometry of existing bridges

A copy of the survey field notes was provided to the County. In those notes, the location of channel cross-sections was identified using the basin identifier "G" for Gottfried Creek. Also, a consecutive numbering system was used to represent each cross-section, e.g. G-1 indicates the first cross-section in the Gottfried Creek basin. In some cases, several cross-sections were obtained around the same location and a second identifier was added, i.e. A or B. When developing the hydraulic model input files, a system was develop to correlate the information in those files with the survey notes. This system will be described in more detail later in this report.

DEVELOPMENT OF THE HYDROLOGIC MODEL

The purpose of this task was to create the basin hydrologic model input files that could be used for model calibration purposes. Modeling data were also obtained from the land uses and soils data developed for each subbasin using the ArcCAD intersection routine.

The hydrologic parameters determined in this study included subbasin area, amount of impervious area, initial rainfall abstraction, hydrologic loss rate, and the basin's time of concentration (tc). The subbasin area was read directly from the ArcCAD database files. The other parameters were calculated as the weighted average for each subbasin based on the extent of each land use category within that subbasin. The values of the parameters assigned to each land use category are described in the following paragraphs.

Amount of Impervious Areas

From the hydrologic standpoint, the amount of impervious areas within a catchment considers two parameters, total impervious area (IA) and directly connected impervious area (DCIA). Both the IA and the DCIA values for each of the six land use categories considered herein were obtained from previous studies recently conducted by Sarasota County on neighboring basins. In those studies, the values of the variables were obtained by selecting representative parcels within a basin. For each parcel, the IA and DCIA were outlined in aerial photographs and planimetered. The results provided an average value for each land use category. It was estimated that values obtained from those previous studies were applicable to the Gottfried Creek basin, as land use configurations are similar throughout the County. The value of the DCIA was used in the hydrologic analysis as input for the Soil Conservation Service (SCS) loss rate methodology applied herein. The IA was used as a reference in the calculation of the time of concentration (tc) for overland flow.

The percent of IA and DCIA per land use category is shown below. Table 5.1 shows the IA and DCIA values calculated for and existing and future conditions in the basin.

Land Use	IA (%)	DCIA (%)
Low and Medium Density Residential	28.7	19.7
High Density Residential	75.0	44.3
Commercial and Industrial	76.7	59.3
Open land	0.8	0.8
Wetlands	100.0	100.0
Water	100.0	100.0

Initial Rainfall Abstraction.

Initial rainfall abstraction was defined in this application as the volume of precipitation that will not appear as pervious area runoff until that volume is satisfied. It was further assumed that no rainfall abstraction occurs in the impervious areas. Using these two assumptions, it was possible to account for the processes associated

TABLE 5.1
HYDROLOGIC MODEL PARAMETERS
EXISTING CONDITIONS

SUBBASIN	Width (ft)	Length (ft)	Initial Storage (inch)	Basin Slope (ft/ft)	Weighted CN	Weighted DCIA	Weighted IA	Weighted Manning's n	t_c (Hours)
15101	2600	2683	0.41	0.00500	89	35	49	0.05	1.31
15102	3100	5354	1.02	0.00143	86	19	24	0.12	11.89
15103	1800	2912	0.8	0.00429	88	32	40	0.10	3.34
15104	2400	4487	0.3	0.00207	89	34	41	0.08	5.61
15105	5681	3745	2.07	0.00102	86	24	26	0.15	12.80
15106	1700	3376	1.16	0.00414	88	29	36	0.08	2.91
15107	2100	3410	0.6	0.00138	92	49	66	0.06	3.85
15108	1900	2373	2.42	0.00192	87	33	35	0.14	5.57
15109	1100	2701	2.12	0.00294	86	24	26	0.16	5.78
15110	1900	2861	3.35	0.00112	86	24	24	0.17	10.51
15111	3600	2097	2.06	0.00047	86	27	27	0.17	11.85
15112	1900	3475	1.14	0.00091	84	12	12	0.19	15.52
15201	2000	2400	1.89	0.00094	88	27	37	0.08	4.32
15202	2000	2189	2.38	0.00115	86	21	29	0.07	3.27
15203	1800	2280	1.81	0.00029	90	41	54	0.04	3.82
15204	2300	1833	0.8	0.00130	88	28	38	0.08	3.00
15205	1400	1695	1.5	0.00286	87	28	33	0.10	2.25
15206	1400	1526	2.14	0.00143	87	27	34	0.08	2.31
15207	2100	1341	2.52	0.00013	86	21	26	0.09	6.12
15208	3100	1996	2.5	0.00012	89	32	45	0.08	8.39
15209	1600	1304	4.22	0.00013	86	20	26	0.09	5.74
15210	2100	1958	4.12	0.00010	86	22	30	0.08	8.40
15211	4400	5005	4.76	0.00078	86	20	24	0.15	19.31
15212	1700	2957	2.41	0.00350	87	31	33	0.16	5.73
15213	1800	2730	1.76	0.00096	87	32	32	0.17	10.57
15301	3300	2526	1.74	0.00262	88	43	43	0.16	5.53
15302	2200	2135	1.96	0.00266	86	24	24	0.18	5.24
15303	3000	7028	1.99	0.00400	85	20	20	0.18	14.40
15304	4700	7459	0.88	0.00117	85	20	20	0.18	28.24
15305	4231	5225	3.05	0.00059	86	24	24	0.18	27.31
15306	8324	5800	2.04	0.00019	86	26	26	0.17	52.81

CN = Curve number

DCIA = Directly connected inpervious area

IA = Impervious area

t_c = Time of concentration

TABLE 5.1 (Continued)
HYDROLOGIC MODEL PARAMETERS
FUTURE CONDITIONS

SUBBASIN	Width (ft)	Length (ft)	Initial Storage (inch)	Basin Slope (ft/ft)	Weighted CN	Weighted DCIA	Weighted IA	Weighted Manning's n	t_c (Hours)
15101	2600	2683	0.41	0.00500	89	36	50	0.04	1.17
15102	3100	5356	1.02	0.00143	88	31	42	0.05	4.93
15103	1800	2912	0.8	0.00429	89	39	50	0.05	1.49
15104	2400	4487	0.3	0.00207	91	45	56	0.04	2.80
15105	5681	3745	2.07	0.00102	89	40	48	0.07	6.19
15106	1700	3376	1.16	0.00414	88	33	42	0.05	1.85
15107	2100	3409	0.6	0.00138	92	51	70	0.04	2.66
15108	1900	2373	2.42	0.00192	91	53	62	0.06	2.22
15109	1100	2704	2.12	0.00294	89	38	47	0.05	1.96
15110	1900	2861	3.35	0.00112	88	39	47	0.06	3.62
15111	3600	2092	2.06	0.00047	90	47	53	0.10	6.71
15112	1900	3475	1.14	0.00091	90	41	53	0.05	3.75
15201	2000	2400	1.89	0.00094	88	31	43	0.04	2.46
15202	2000	2189	2.38	0.00115	87	24	33	0.05	2.24
15203	1800	2280	1.81	0.00029	90	41	54	0.04	3.82
15204	2300	1833	0.8	0.00130	89	33	45	0.04	1.59
15205	1400	1695	1.5	0.00286	88	33	41	0.06	1.31
15206	1400	1526	2.14	0.00143	88	31	39	0.05	1.47
15207	2100	1342	2.52	0.00013	87	27	36	0.05	4.48
15208	3100	1996	2.5	0.00012	90	38	55	0.04	5.49
15209	1600	1304	4.22	0.00013	87	26	34	0.05	4.36
15210	2100	1958	4.12	0.00010	87	24	32	0.05	6.85
15211	4400	5005	4.76	0.00078	87	30	39	0.07	8.58
15212	1700	2957	2.41	0.00350	90	46	55	0.06	2.12
15213	1800	2730	1.76	0.00096	90	49	57	0.06	3.95
15301	3300	2526	1.74	0.00262	90	54	60	0.07	2.54
15302	2200	2135	1.96	0.00266	88	38	45	0.06	1.83
15303	3000	7028	1.99	0.00400	88	35	43	0.06	4.75
15304	4700	7459	0.88	0.00117	88	35	43	0.06	9.35
15305	4231	5225	3.05	0.00059	88	38	45	0.06	9.50
15306	8324	5800	2.04	0.00019	88	38	44	0.08	23.63

CN = Curve number

DCIA = Directly connected inpervious area

IA = Impervious area

t_c = Time of concentration

with relatively large retention storage available in the numerous closed catchments that exist within the subbasins, particularly in the undeveloped areas, while at the same time be able to simulate creek flow even during small precipitation events.

The initial rainfall abstraction was determined by first calculating a preliminary estimate of interception and depression storage in a subbasin based on its land use composition. Consistent with other County projects, initial values were estimated at 0.08 and 0.15 inches for impervious and pervious areas, respectively. Subsequently, those values were modified to account for actual retention and detention capabilities within the subbasins due to the presence of storage ponds and/or wetlands not included as storage nodes in the hydraulic model. Individual storage volume estimates due to the presence of these hydrologic features were made using the topographic maps. The storage estimates were then converted to water depth over the subbasin and added to the preliminary estimates. Table 5.1 also shows the computed initial rainfall abstraction estimate by subbasin.

It should be noted that future, more detailed, hydrologic/hydraulic studies conducted within the basin will likely consider and incorporate the storage capabilities of existing wetlands as storage nodes for channel routing purposes. In that case, the values of rainfall abstraction would have to be recalculated.

Hydrologic Loss Rate

The hydrologic loss rate procedure used in this study was that of the Soil Conservation Service (SCS) runoff curve number (CN). The CN is an index that represents the combined hydrologic effect of soil, land use, hydrologic condition, and antecedent soil moisture. According to the SCS Soil Survey of Sarasota County, the prevalent soil group classification is D. Dual classification B/D soils were also assumed to be D soils. The antecedent soil condition was assumed to be average. The assumed CN by land use category is indicated below. Some variations from typical values were made as a result of the calibration process. Table 5.1 shows the composite CN by subbasin. A constant CN equal to that for open land combined with the DCIA value for each subbasin were used to avoid double counting imperviousness.

Land Use	CN
Low and Medium Density Residential	86
High Density Residential	92
Commercial and Industrial	94
Open land	83
Wetlands	95
Water	100

Time of Concentration.

The time of concentration (tc) for hydrologic modeling was calculated based on the subbasin length, slope and surface roughness. A method recommended by the South

Florida Water Management District (SFWMD) was used for calculating tc. According to SFWMD, that method more nearly matches observed conditions in South Florida where flat slopes and high retardance values prevail. The calculated values were then compared with those obtained by application of the kinematic wave equation for overland flow conditions and the velocity method for channelized flow conditions. Both methods showed comparable results. The tc using the SFWMD method is calculated using the formula:

$$tc = \frac{333\ L\ n}{(Qp)^{0.6}\ (H)^{0.5}}$$

Where:

L= Length of overland flow (miles)
n = Manning's coefficient
H= Basin Slope (feet/mile)
Qp= Peak rainfall excess (inches)
333= Conversion factor

The subbasin length was obtained from the digitized ArcCAD drawings. Subbasin slope was calculated using the topographic maps. Surface roughness for overland flow, represented by the Manning's coefficient (n), was determined from the literature as a function of land uses. The assumed n value by land use category is indicated below. Tables 5.1 shows the subbasin slope and the calculated value of tc for existing and future conditions in the basin.

Land Use	Manning's n (%)
Low and Medium Density Residential	0.05
High Density Residential	0.03
Commercial and Industrial	0.03
Open land	0.20
Wetlands	0.10
Water	0.02

DEVELOPMENT OF THE HYDRAULIC/ROUTING MODEL

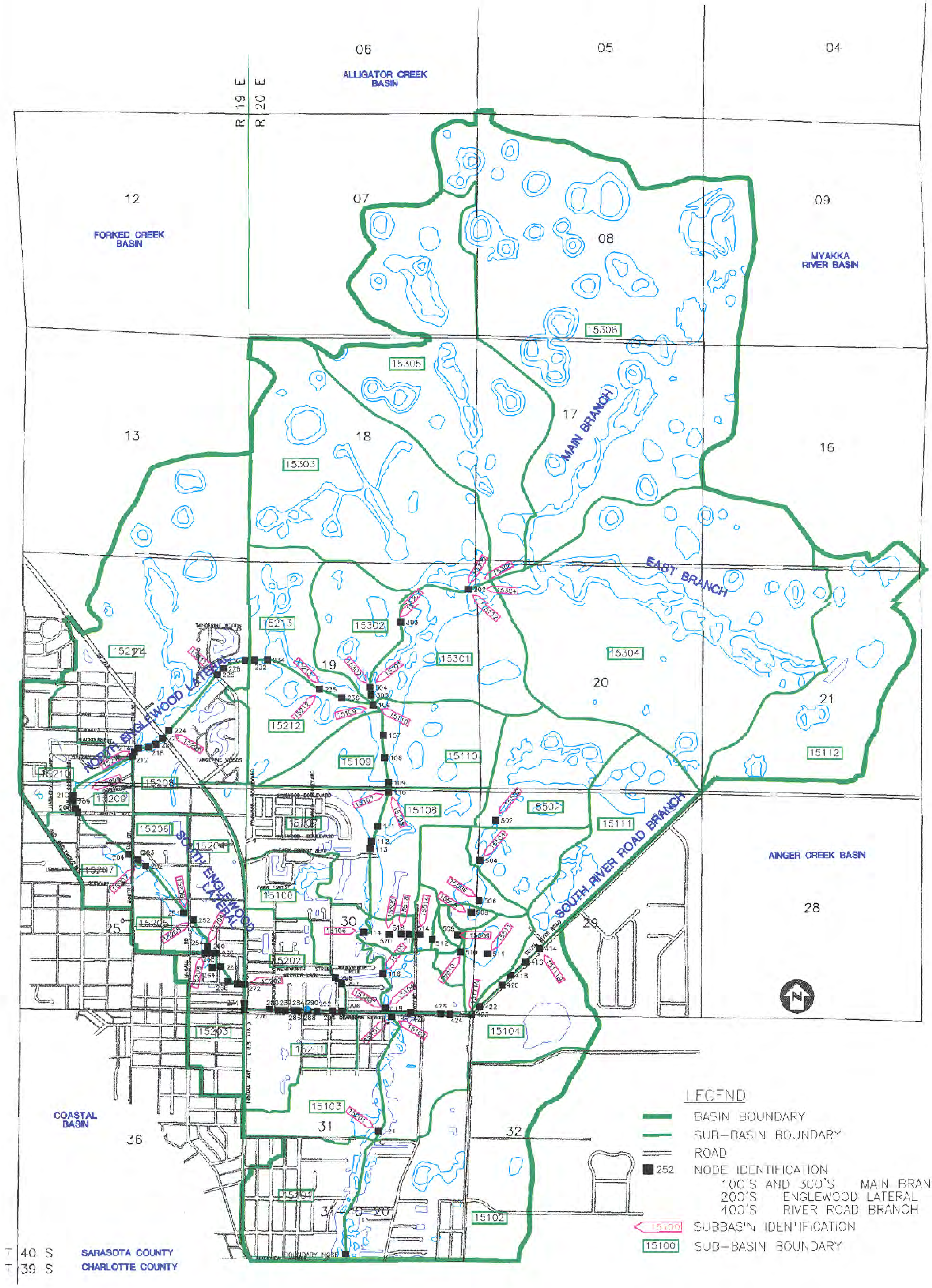
During the development of the preliminary model network, emphasis was placed on reflecting the results of the field surveys when defining the parameters that describe the stormwater conveyance system. Figure 5.1 and the attached Plate 1 show the model network developed for the Gottfried Creek basin.

As the hydraulic analysis was conducted using the Extended Transport (EXTRAN) block of the U.S. Environmental Protection Agency (EPA) Stormwater Management Model (SWMM), version 4.31, the input files were developed to conform to the input requirements for that model. It should be mentioned that the EXTRAN mathematical

FIGURE 5.1

COMPUTER MODEL SCHEMATIC

GOTTFRIED CREEK BASIN



approach is to solve the dynamic equations for gradually varied flow using a finite difference solution technique.

The nomenclature used in the EXTRAN input files was as follows: the system nodes to be modeled were numbered using a three-digit code based on their major subbasin location. Same notation was used for storage nodes. For these nodes, stage versus surface area relationships were provided to the model.

Conduits, or channel reaches, included in the model were numbered using a four-digit identifier as follows: the first three digits represented the upstream node whereas the fourth digit was used to differentiate between conduits that joined the same nodes. For example, one of the conduits of a double box culvert between nodes 110 and 120 would be 1100 whereas the other would be 1101.

Another input parameter needed for the hydraulic model was the cross-section geometry for natural channels. To facilitate correlating the model input and the surveying notes, cross-sections for natural channels were labeled using the basin number and the survey field notes notation. For example, cross-section 15130 indicates surveying cross-section G-13A. Cross-section 15131 would be G-13B. Printouts of the model input files are shown in Appendix B.

CALIBRATION AND FIELD VERIFICATION OF THE HYDROLOGIC HYDRAULIC MODEL

General

The model calibration and verification activities are the process needed to ensure that the computer models are able to replicate natural conditions. Site-specific parameters and constants appropriate for model prediction are identified during the calibration process. During verification, those parameters are checked with an independent data set to test for the robustness. Calibration and verification provide a degree of certainty for the predicted conditions.

Model calibration and verification were conducted using measured hydrologic data provided by the United States Geological Survey (USGS), which in cooperation with Sarasota County, in the summer of 1991 initiated rainfall runoff monitoring stations in seven (7) coastal watersheds in the County, including Gottfried Creek. The stations consisted of a continuous water level gauge and a rainfall gauge.

Model calibration was conducted using rainfall and streamflow data collected between June 24 and June 29, 1992. Data collected between August 9 and 17, 1992 were used for model verification. In addition, the County surveyed high water marks elevations for the June 1992 storm at various locations throughout the study area. Those data were compared to the modeling results and the model was fine-tuned to further ensure the model's reliability.

Model Calibration

The June 1992, storm resulted in one of the most extreme flooding events on record in Sarasota County. A statistical analysis of 41 years of rainfall collected at the National Oceanic and Atmospheric Administration (NOAA) station in Venice showed that the rainfall volume of 11 inches accumulated during this storm at that station is in the 99.9 percentile bracket. A graph showing a probability distribution of rainfall volume is shown in Figure 5.2. The USGS Gottfried Creek station recorded about 11 inches of accumulated rainfall. The storm hyetograph is shown in Figure 5.3. The consistency in the accumulated rainfall volume is another indication of the region-wide characteristics of this storm event.

Figure 5.4 shows the measured hydrograph obtained during the June 1992 storm event and used for calibration. This type of hydrograph appears to be typical of the area as they show similar characteristics of other hydrographs reviewed during this study. The runoff to rainfall ratio is about 70 percent. The initial storage stage is relatively large and results from retention in the existing wetlands as well as in the soil layer above the water table. As indicated previously, during model calibration the value of initial storage coupled with the amount of impervious area was used as a method to account for the existence of closed catchments within the subbasins.

The hydrograph shows an initial period of small flow within its rising limb, which is a consequence of the high retardance effects. Subsequently, the hydrograph rising stage is characterized by a rapid and substantial increase of the flowrate until the peak is reached. During the June storm, the volume under the hydrograph's rising limb amounted to about 36 percent of the total storm runoff. Finally, the hydrograph recession period is sustained during several days as runoff is released from storage. It should be pointed out that at the gauge station location, the base flow is minimum.

The calibration procedure consisted of identifying an appropriate hydrologic method for modeling purposes as well as conducting the corresponding hydraulic routing calibration runs using EXTRAN. Although the hydrologic model initially selected and specified in the scope of work was the EPA SWMM/RUNOFF computer software, difficulty in calibrating the SWMM/RUNOFF module to recorded data with reasonable parameters prompted consideration of other methods.

A variety of hydrologic modeling methods are available. Investigating the most adequate hydrologic method for this project became necessary. The use of a computer program that is widely used and is in the public domain was another basic criterion for selecting the method to be used herein. All methods investigated were based on the unit hydrograph concept. Simulations were conducted using the U.S Army Corps of Engineers HEC-1 Flood Hydrograph Package.

The unit-hydrograph methods investigated during this study included the SCS, Snyder's, and Clark's methods. The SCS method was analyzed for various shape factors ranging from 100 to 484. For all simulations, the hydrologic loss rate calculations were as discussed previously. Results were also fined-tuned by modifying

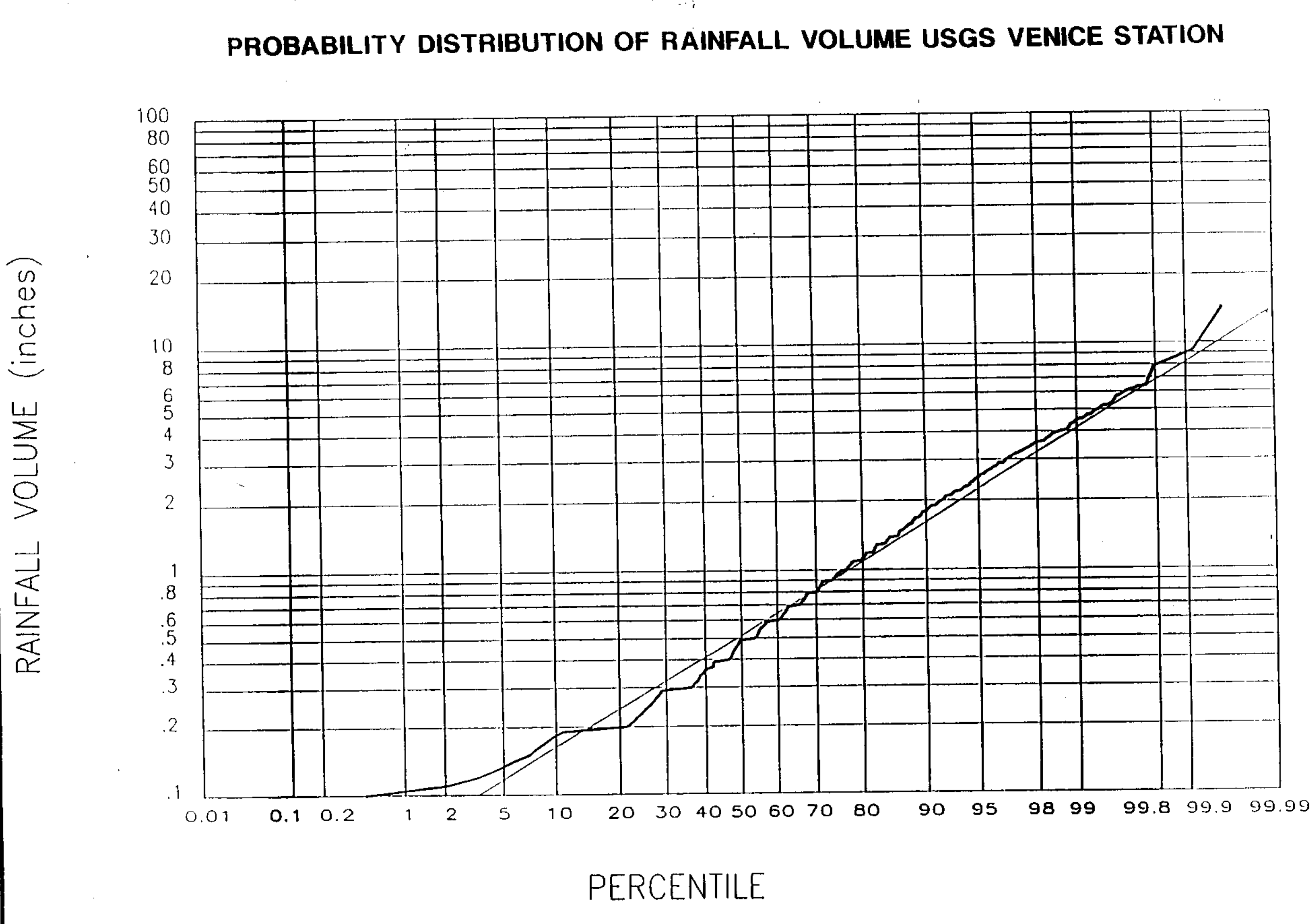


FIGURE 5.2

C:\UTIL\AUTOGRAF\RAIN.DWG

FIGURE 5.3

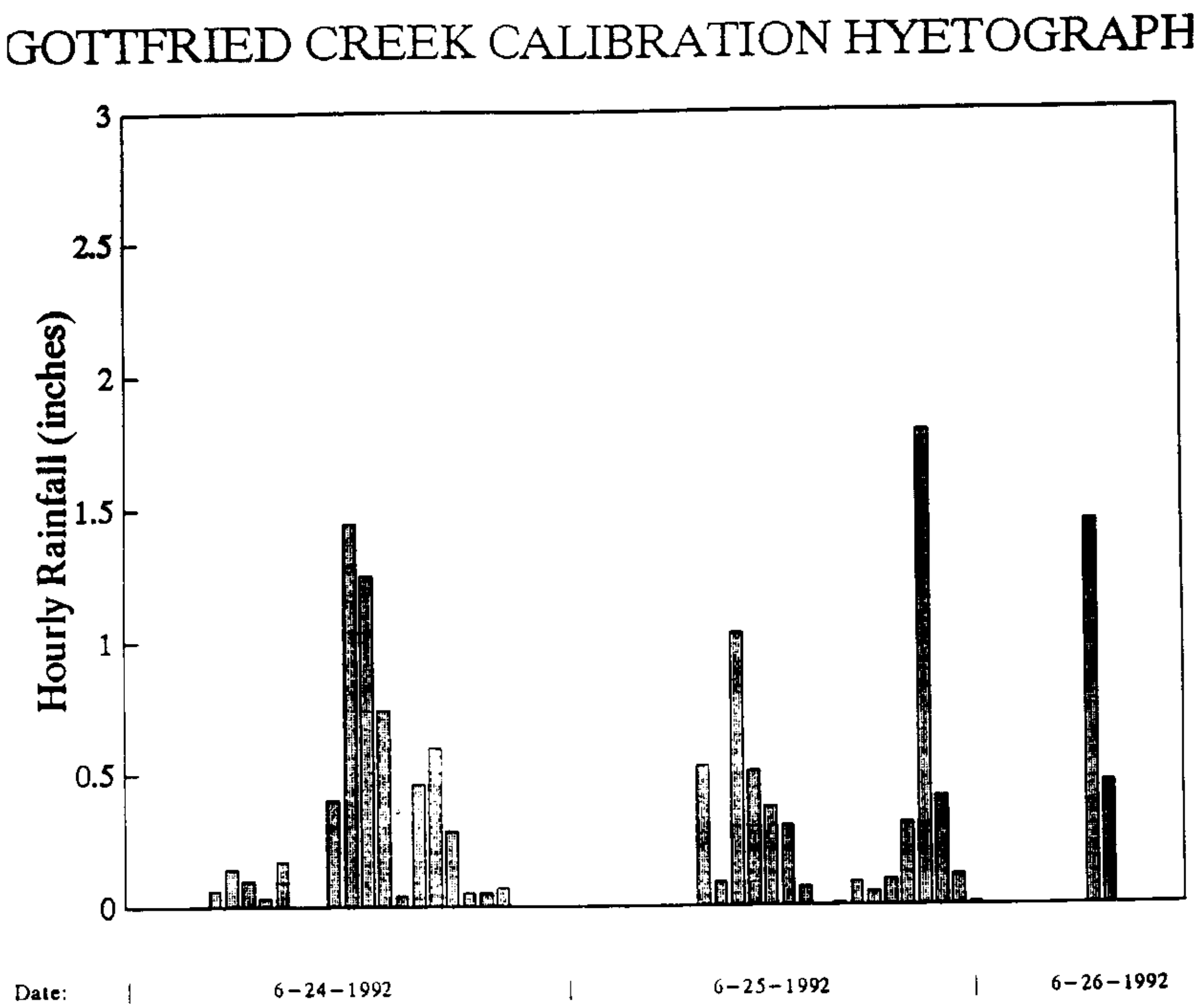
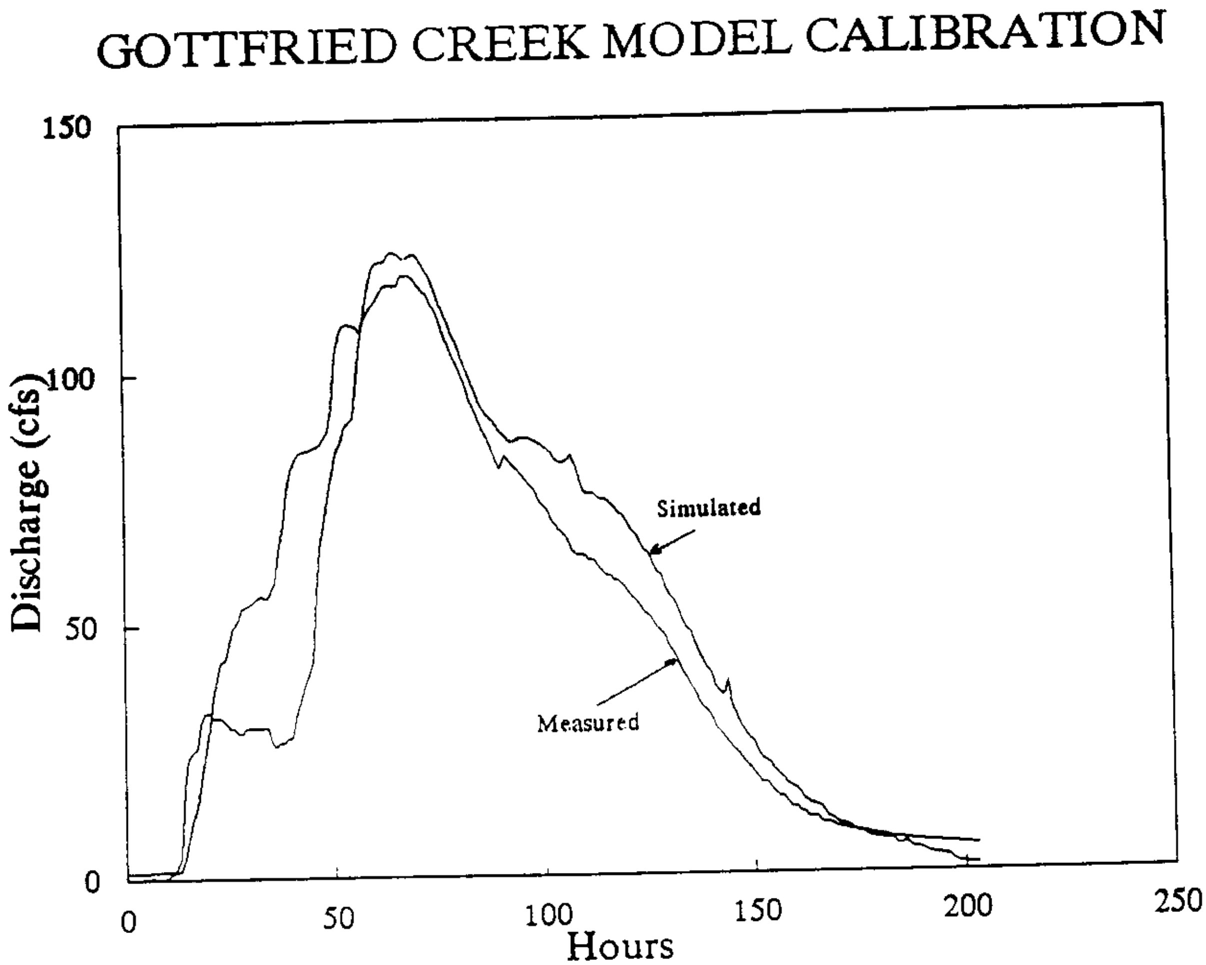

GOTTFRIED CREEK CALIBRATION HYETOGRAPH
Hourly Rainfall (inches)
3
2.5
2
1.5
1
0.5
0
Date:
6-24-1992
6-25-1992
6-26-1992

FIGURE 5.4



Date (1992): | 6-24 | 6-25 | 6-26 | 6-27 | 6-28 | 6-29 | 6-30 | 7-1 | 7-2 |

Hydrograph	Peak (cfs)	Volume (million cf)
Measured	119	32.83
Simulated	124	38.86

the conveyance parameters in the hydraulic model. Those results indicated that the SCS method with a shape factor equal to 150 and the Clark's unit hydrograph method seem to be the most appropriate for calibrating the hydrologic models as they provide reasonably accurate results. Sarasota County elected to use the SCS method for this project because of its wide use in central and south Florida. Table 5.2 shows the unit hydrograph ordinates used in this study.

Model Verification

Model verification data were obtained for the storm occurring between August 9 and 17, 1992. The procedure consisted of conducting the hydrologic analysis using the SCS method with a shape factor of 150 and routing through the system the input hydrographs developed for the new conditions. Figure 5.5 shows the rainfall hyetographs obtained from the USGS for the modeled storm event. As shown in Figure 5.6, results showed an adequate fit between the measured and simulated hydrographs.

High Water Marks Calibration and Field Verification

Once the hydrologic/hydraulic parameters were determined through the calibration process, model simulations were conducted using the June 1992 storm conditions. Table 5.3 shows the calculated maximum water surface elevations at selected nodes and the corresponding high water marks surveying data provided by the County. The results indicate a very reasonable agreement between the simulated and surveyed data. Field verifications also revealed that the computer model was providing accurate results.

MODELING OF STANDARD STORMS FOR EXISTING CONDITIONS

Once the hydrologic/hydraulic model was calibrated and verified, existing conditions in the basin were analyzed for the 24-hour 2, 5, 10, 25, and 100-year return period rainfalls, per the SWFWMD rainfall maps, assuming average antecedent rainfall conditions. This type of analysis is necessary to analyze compliance with the County's levels of service for flood control. The total rainfall values per return period are listed below. The rainfall distribution ratios are shown in Table 5.4.

Return Period (years)	Accumulated Volume (inches)
2	4.25
5	6.00
10	7.00
25	8.00
100	10.00

Results indicated that the flood elevations for the June 1992 storm were similar to those obtained for the 100-year storm analysis. Maximum junction elevations for the existing conditions scenario are shown in Table 5.5. Figure 5.7 shows the corresponding hydraulic grade line plots. Table 5.6 shows results for the future land

TABLE 5.2
MENSIONLESS UNIT HYDROGRAPH RATIOS

scharge Ratios (Q/Qp)	Mass Curve Ratios (Qa/Q)	Time Ratios (T/Tp)	Discharge Ratios (Q/Qp)	Mass Curve Ratios (Qa/Q)
0.0000	0.000	2.4286	0.5391	0.732
0.1376	0.002	2.4980	0.5143	0.746
0.2805	0.008	2.5674	0.4902	0.760
0.4116	0.017	2.6368	0.4669	0.773
0.5281	0.030	2.7062	0.4443	0.786
0.6294	0.046	2.7756	0.4225	0.798
0.7161	0.065	2.8450	0.4015	0.809
0.7888	0.085	2.9144	0.3813	0.820
0.8487	0.108	2.9837	0.3618	0.830
0.8969	0.132	3.0531	0.3432	0.840
0.9345	0.157	3.1225	0.3253	0.849
0.9626	0.183	3.1919	0.3081	0.858
0.9821	0.210	3.2613	0.2917	0.866
0.9942	0.237	3.3307	0.2761	0.874
0.9995	0.265	3.4001	0.2611	0.881
0.9991	0.292	3.4695	0.2469	0.888
0.9936	0.320	3.5389	0.2333	0.895
0.[illegible]	0.347	3.6082	0.2204	0.901
0.9[illegible]	0.374	3.6776	0.2080	0.907
0.9532	0.400	3.7470	0.1964	0.913
0.9337	0.426	3.8164	0.1852	0.918
0.9120	0.452	3.8858	0.1747	0.923
0.8885	0.477	3.9552	0.1647	0.928
0.8636	0.501	4.0246	0.1552	0.932
0.8375	0.524	4.0940	0.1462	0.936
0.8107	0.547	4.1634	0.1377	0.940
0.7832	0.569	4.2328	0.1296	0.944
0.7554	0.590	4.3021	0.1220	0.947
0.7275	0.610	4.3715	0.1148	0.950
0.6996	0.630	4.4409	0.1080	0.953
0.6718	0.649	4.5103	0.1015	0.956
0.6443	0.667	4.5797	0.0954	0.959
0.6172	0.684	4.6491	0.0897	0.962
0.5906	0.701	4.7185	0.0843	0.964
0.5645	0.717			

FIGURE 5.5

GOTTFRIED CREEK VERIFICATION HYETOGRAPH

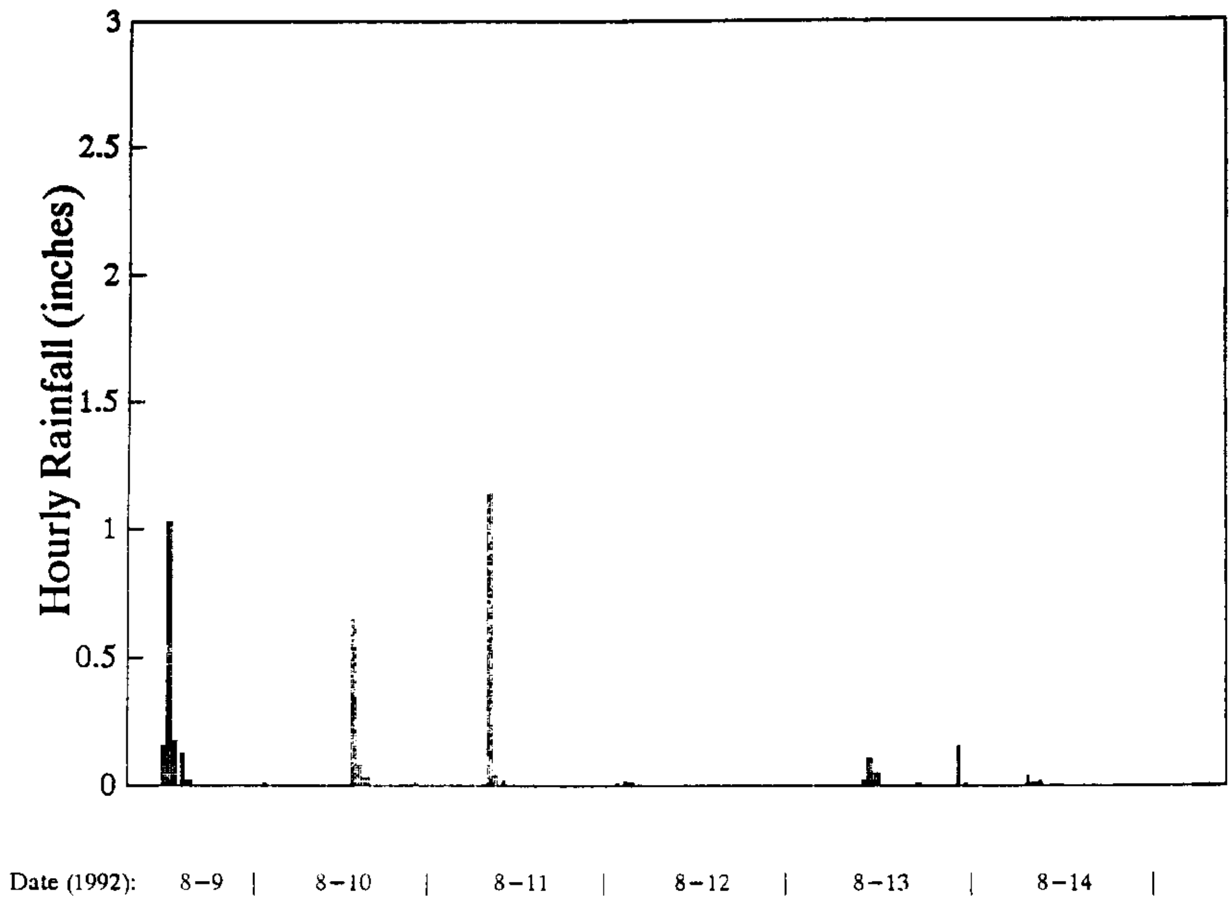
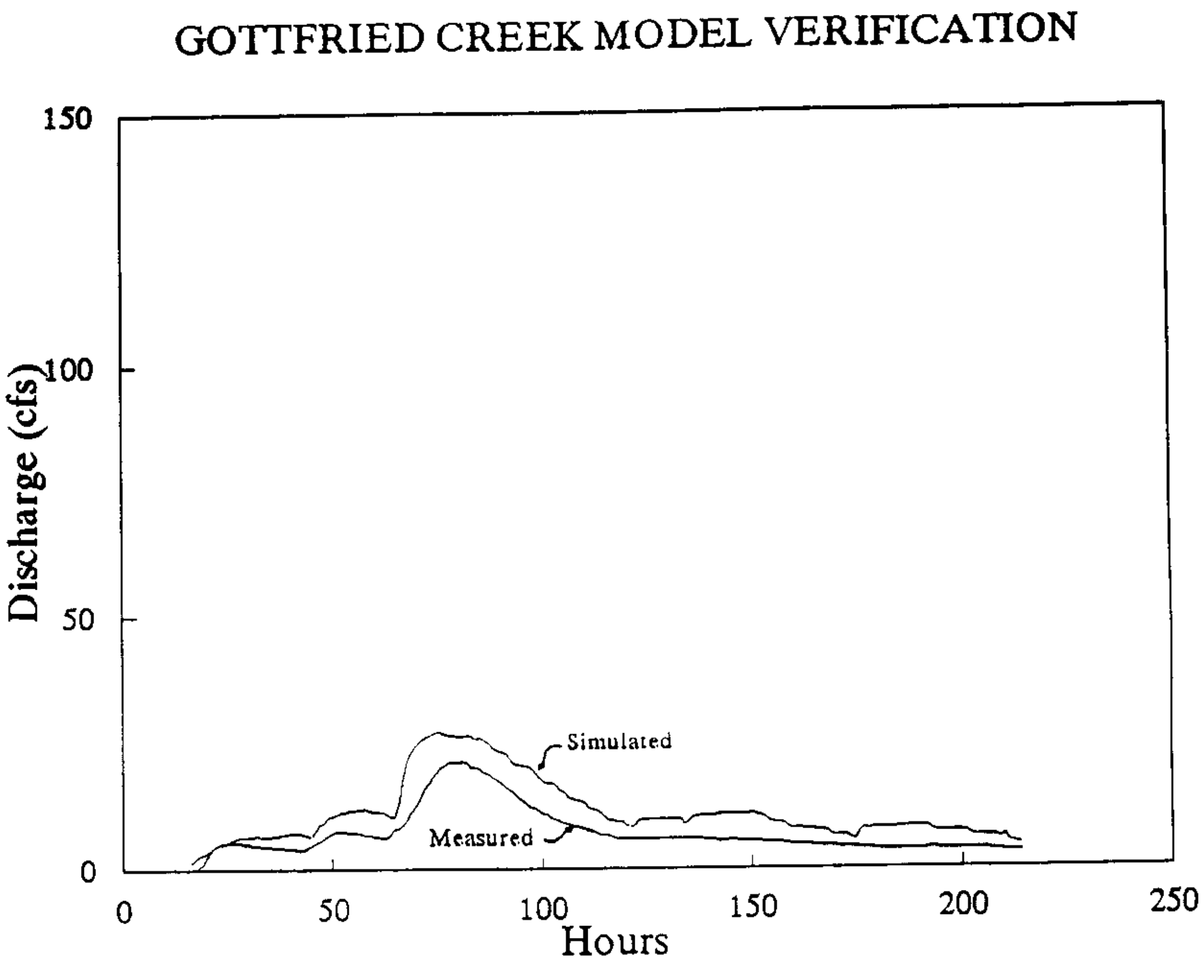


FIGURE 5.6



Date (1992): | 8-9 | 8-10 | 8-11 | 8-12 | 8-13 | 8-14 | 8-15 | 8-16 | 8-17 | 8-18 |

Hydrograph	Peak (cfs)	Volume (million cf)
Measured	21	5.1
Simulated	27	8

TABLE 5.3
HIGH WATER MARKS CALIBRATION

High Water Marks		Location	Branch series	Junction Node		Explanation of Discrepancies
Survey Pt. #	Elevation (ft)			#	Elevation 92 storm (ft)	
S-5	10.2	Stake west of SR776	200's	222	9.90	
S-6	11.2	Stake south of Viridian St. & west of Elm St.	200's	212	10.11	
S-7	9.56	Tangarine Woods Blvd. bridge	200's	226	9.56	
S-8	11.8	Wentworth St. & New York Ave.	200's	266	11.48	
S-9	11.71	Cross on McCall Rd.	200's	251	11.70	
S-10	11.5	Elm St. and ditch	200's	202	11.67	
S-11	10.4	South of Artist Ave.	200's	206	11.00	
S-12	6.9	Park Forest Blvd. bridge	100's	112	5.78	
S-14	7.7	West of Stratford Dr.	200's	296	6.60	
S-15	3.4	Northwest of Dearborn St. at Gottfried Creek	400's	118	3.59	
S-16	8.6	East of Lee Cir. at Dearborn St.	200's	292	9.08	
S-17	9.35	West of Broadway St. at Dearborn St.	200's	278	11.70	Not sensitive to changes of n

TABLE 5.4
RAINFALL DISTRIBUTION

Time (Hours)	Cumulative Unit Volume (inches)	100-Year Storm, Total Rainfall Volume = 10 inches: Cumulative Volume (inches)	Incremental Volume (inches)	Intensity (inch/hr)
0.00	0.000	0.000	0.000	0.000
0.50	0.006	0.060	0.060	0.119
1.00	0.012	0.120	0.060	0.119
1.50	0.019	0.190	0.070	0.139
2.00	0.025	0.250	0.060	0.125
2.50	0.032	0.320	0.070	0.139
3.00	0.039	0.390	0.070	0.139
3.50	0.047	0.470	0.080	0.159
4.00	0.054	0.540	0.070	0.139
4.50	0.062	0.620	0.080	0.159
5.00	0.071	0.710	0.090	0.187
5.50	0.080	0.800	0.090	0.179
6.00	0.089	0.890	0.090	0.179
6.50	0.099	0.990	0.100	0.198
7.00	0.110	1.100	0.110	0.218
7.50	0.122	1.220	0.120	0.238
8.00	0.134	1.340	0.120	0.250
8.50	0.148	1.480	0.140	0.278
9.00	0.164	1.640	0.160	0.317
9.50	0.181	1.810	0.170	0.337
10.00	0.201	2.010	0.200	0.397
10.50	0.226	2.260	0.250	0.496
11.00	0.258	2.580	0.320	0.667
11.50	0.308	3.080	0.500	0.992
12.00	0.607	6.070	2.990	5.933
12.50	0.719	7.190	1.120	2.222
13.00	0.757	7.570	0.380	0.754
13.50	0.785	7.850	0.280	0.556
14.00	0.807	8.070	0.220	0.458
14.50	0.826	8.260	0.190	0.377
15.00	0.842	8.420	0.160	0.317
15.50	0.857	8.570	0.150	0.298
16.00	0.870	8.700	0.130	0.258
16.50	0.882	8.820	0.120	0.238
17.00	0.893	8.930	0.110	0.229
17.50	0.904	9.040	0.110	0.218
18.00	0.913	9.130	0.090	0.179
18.50	0.923	9.230	0.100	0.198
19.00	0.931	9.310	0.080	0.159
19.50	0.940	9.400	0.090	0.179
20.00	0.948	9.480	0.080	0.167
20.50	0.955	9.550	0.070	0.139
21.00	0.962	9.620	0.070	0.139
21.50	0.969	9.690	0.070	0.139
22.00	0.976	9.760	0.070	0.139
22.50	0.983	9.830	0.070	0.139
23.00	0.989	9.890	0.060	0.125
23.50	0.995	9.950	0.060	0.119
24.00	1.000	10.000	0.050	0.099

Table 5.5
Gottfried Creek Existing Conditions
Peak Flood Stage Summary

Junction Number	Node Location	Existing Conditions Peak Flood Stage Summary 2-Year Storm Peak Elev. (ft NGVD)	5-Year Storm Peak Elev. (ft NGVD)	10-Year Storm Peak Elev. (ft NGVD)	25-Year Storm Peak Elev. (ft NGVD)	100-Year Storm Peak Elev. (ft NGVD)
106	Confluence of Branches	7.39	7.99	8.30	8.61	9.06
107	Station 41+00	7.19	7.79	8.09	8.40	8.86
108	Station 36+00	7.08	7.66	7.93	8.23	8.69
109	FP&L Access Road (U/S)	6.99	7.55	7.80	8.09	8.54
110	FP&L Access Road (D/S)	6.49	7.52	7.76	8.05	8.49
111	Station 16+00	4.23	5.17	5.64	6.06	6.66
112	Park Forest Blvd. Bridge (U/S)	3.95	4.88	5.35	5.74	6.21
113	Park Forest Blvd. Bridge (D/S)	3.92	4.84	5.31	5.69	6.15
114	Channel Expansion Point	2.61	2.71	2.79	2.92	3.13
116	Confluence w/ G-4 Branch	2.59	2.67	2.73	2.84	3.07
118	Dearborn St. Bridge (U/S)	2.62	2.71	2.77	2.89	3.10
120	Dearborn St. Bridge (D/S)	2.54	2.58	2.62	2.71	2.90
121	MAIN BRANCH	2.51	2.53	2.55	2.58	2.66
122	SR. 776 (U/S)	2.50	2.50	2.50	2.50	2.50
202	Elm St. (D/S)	11.71	11.85	11.90	12.10	12.44
203	Elm St. Weir	12.55	12.72	12.74	12.75	12.78
204	Elm St. (U/S)	11.28	11.76	11.88	12.10	12.44
206	Artist Ave. (D/S)	11.17	11.36	11.60	11.78	12.29
208	Artist (U/S)	9.79	11.23	11.60	11.78	12.29
209	Madder Lane Rd. (U/S)	9.76	11.24	11.60	11.78	12.29
210	Madder Lane Rd. (U/S)	9.76	11.21	11.58	11.81	12.31
212	Viridian Street (U/S)	9.39	11.17	11.55	11.71	12.21
213	Blackburn St. Pond	9.25	11.17	11.55	11.69	12.20
214	Viridian Street (D/S)-Elm Street (U/S)	9.25	11.17	11.55	11.70	12.20
216	Elm Street (D/S)	9.11	10.53	10.77	11.44	12.20
218	Shell Rd (U/S)	9.07	10.51	10.75	11.43	12.19
220	Shell Rd. (D/S)	8.57	10.24	10.75	11.43	12.19
222	SR 776 (U/S)	8.48	10.20	10.71	11.41	12.18
224	SR 776 (D/S)	8.40	9.85	10.04	10.24	10.48
226	Tangerine Woods Blvd. (U/S)	8.37	9.84	10.02	10.21	10.45
228	Tangerine Woods Blvd. (D/S)	8.33	9.76	9.88	9.97	10.05
230	Access Rd. (U/S)	8.31	9.75	9.84	9.91	9.96
232	Access Rd. (D/S)	7.59	8.04	8.43	9.21	9.22
234	USGS Gage	7.43	8.03	8.41	8.75	9.18
235	Station 59+00	7.41	8.01	8.36	8.68	9.12
236	Station 54+00	7.40	8.01	8.34	8.66	9.10
251	McCall Rd. (U/S)	11.72	11.87	11.93	12.13	12.46
252	McCall Rd. (D/S)	11.84	11.92	11.97	12.13	12.46
254	Wentworth St. (U/S)	11.90	12.08	12.22	12.35	12.61
256	Wentworth St. (D/S)-Driveway Culvert (U/S)	11.90	12.14	12.23	12.35	12.61
258	Driveway Culvert (D/S)	11.90	12.16	12.23	12.35	12.61
260	Driveway Culvert (U/S)	11.90	12.16	12.23	12.35	12.61
262	Driveway Culvert (D/S)	11.90	12.18	12.24	12.35	12.61
264	New York Ave. (U/S)	11.90	12.18	12.24	12.35	12.61
266	New York Ave. (D/S)	11.26	12.18	12.23	12.35	12.61
268	Perry Ave. (U/S)	11.26	12.18	12.23	12.35	12.61
270	Perry Ave. (D/S)-SR 776(U/S)	11.04	11.89	11.98	12.07	12.21
272	SR 776 (D/S)	10.99	11.82	11.92	12.00	12.11
274	Dearborn St. /SR 776 Intersection (U/S)	10.97	11.81	11.91	11.99	12.10
276	Dearborn St. /SR 776 Intersection (D/S)	9.83	11.75	11.86	11.94	12.04
278	Broadway Street (U/S)	9.83	11.75	11.86	11.94	12.04
280	Broadway Street (D/S)	9.06	10.34	10.42	10.48	10.56

Table 5.5
Gottfried Creek Existing Conditions
Peak Flood Stage Summary

Junction Number	Node Location	Existing Conditions Peak Flood Stage Summary 2-Year Storm Peak Elev. (ft NGVD)	5-Year Storm Peak Elev. (ft NGVD)	10-Year Storm Peak Elev. (ft NGVD)	25-Year Storm Peak Elev. (ft NGVD)	100-Year Storm Peak Elev. (ft NGVD)
282	Beverly Circle (U/S)	9.02	10.33	10.41	10.47	10.54
284	Beverly Circle (D/S)	8.58	9.59	9.65	9.70	9.77
286	Harwich Circle (U/S)	8.51	9.56	9.63	9.68	9.74
288	Harwich Circle (D/S)	8.07	9.06	9.11	9.14	9.19
290	Lee Circle (U/S)	8.02	9.04	9.09	9.13	9.17
292	Lee Circle (D/S)	7.37	8.07	8.10	8.12	8.15
294	Sandy Island Circle (U/S)	7.16	7.95	7.98	8.01	8.04
296	Sandy Island Circle (D/S)	5.67	5.88	5.89	5.90	5.90
297	Stratford Dr. (U/S)	2.67	2.80	2.85	2.96	3.23
298	Stratford Dr. (D/S)	2.60	2.68	2.74	2.87	3.15
302	North of G-17	7.71	8.16	8.41	8.71	9.15
303	G-17	7.55	8.08	8.36	8.67	9.11
304	G-16A	7.46	8.01	8.31	8.62	9.07
306	Weir at G-16A	7.39	7.99	8.30	8.61	9.06
414	Post Office Entrance Rd. (U/S)	9.75	10.11	11.65	10.48	11.06
416	Post Office Entrance Rd. (D/S)	10.53	11.49	11.52	11.59	11.73
418	William Ln. (U/S)	10.51	11.47	11.50	11.56	11.68
420	William Ln. (D/S)-Pine St.	10.39	11.29	11.32	11.39	11.59
422	Stiver Ln.	8.89	9.17	9.30	9.42	10.58
423	River Rd. (U/S)	8.14	8.58	8.78	8.97	10.50
424	River Rd. (D/S)	7.33	7.65	7.78	7.88	8.21
426	Dearborn St. (U/S)	5.67	5.97	6.10	6.19	6.52
428	Dearborn St. (D/S)	2.85	3.03	3.14	3.26	3.54
502	Secondary Branch (U/S)	8.84	9.36	9.59	9.78	10.06
504	Secondary Branch (U/S)	8.82	9.34	9.57	9.76	10.05
506	Access Rd. (U/S)	8.81	9.33	9.57	9.76	10.05
508	Access Rd. (D/S)	8.81	9.33	9.57	9.76	10.05
509	Secondary Branch	8.77	9.31	9.54	9.74	10.03
510	Access Rd. (U/S)	8.60	9.19	9.44	9.66	9.97
511	Access Rd. (D/S)	8.60	9.19	9.44	9.66	9.97
512	Secondary Branch	7.83	8.41	8.79	9.02	9.41
514	Oxford St. (U/S)	5.07	6.07	6.85	7.87	8.86
516	Oxford St. (D/S)	4.90	5.63	6.19	6.85	7.59
518	Shell Rd. (D/S)	4.66	5.11	5.39	5.64	6.07
520	Secondary Branch at Confluence	3.73	4.10	4.33	4.56	5.02

FIGURE 5.7a
EXISTING CONDITIONS: HYDRAULIC GRADE LINE PLOTS
GOTTFRIED CREEK

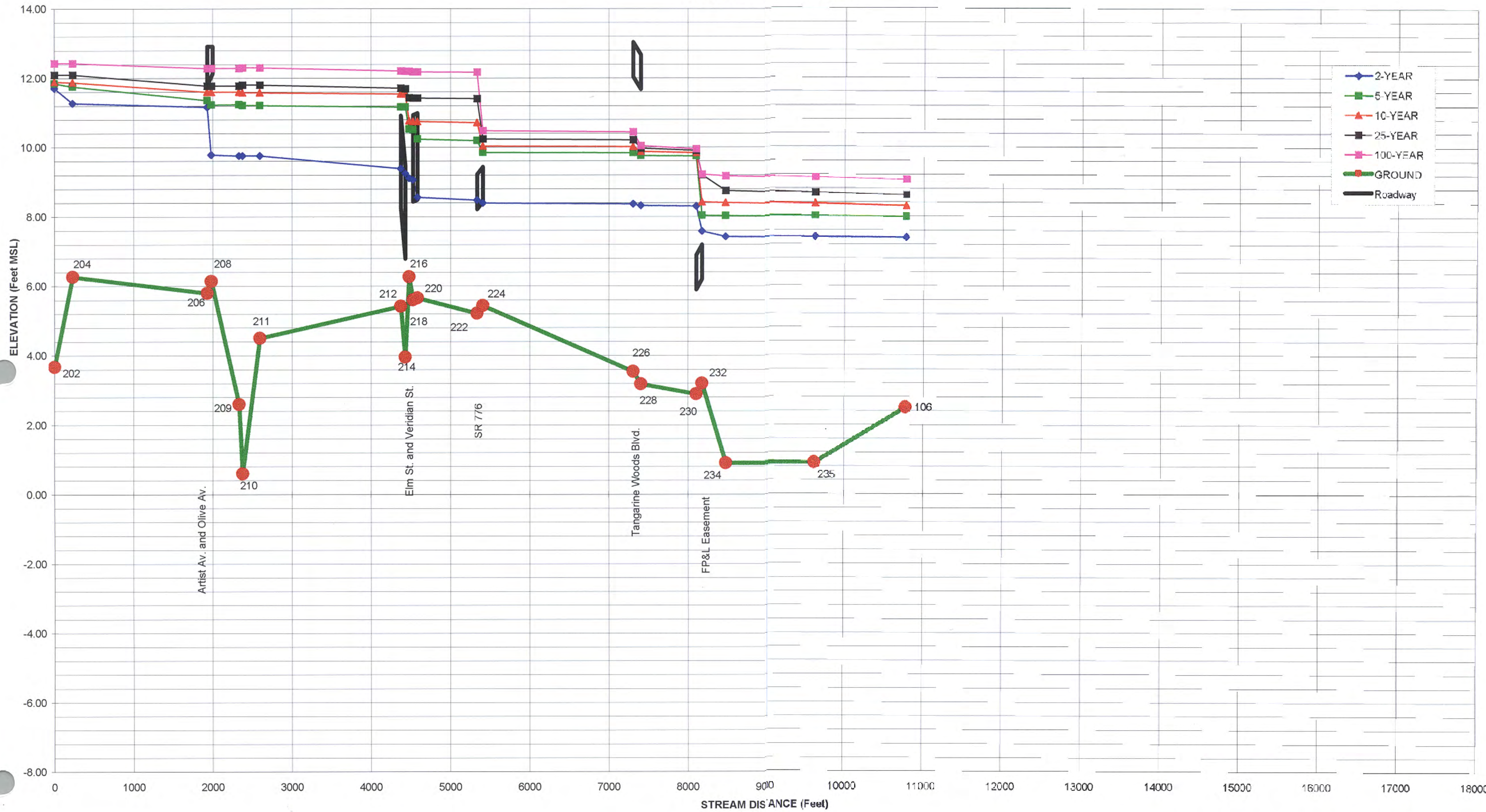


FIG. 5.7b
EXISTING CONDITIONS: HYDRAULIC GRADE LINE PLOTS
GOTTFRIED CREEK

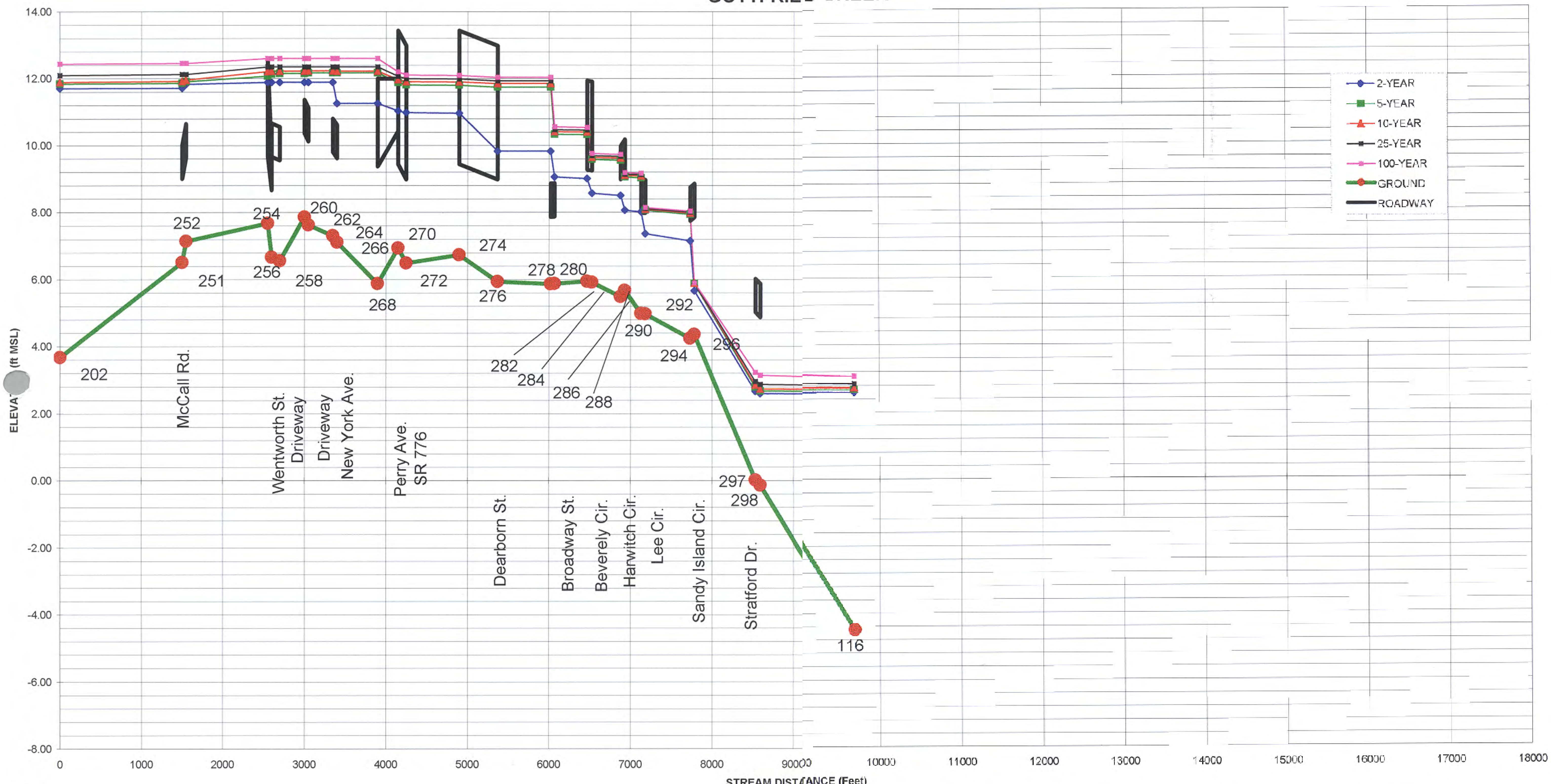


FIGURE 5.7c
EXISTING CONDITIONS: HYDRAULIC GRADE LINE PLOTS
GOTTFRIED CREEK

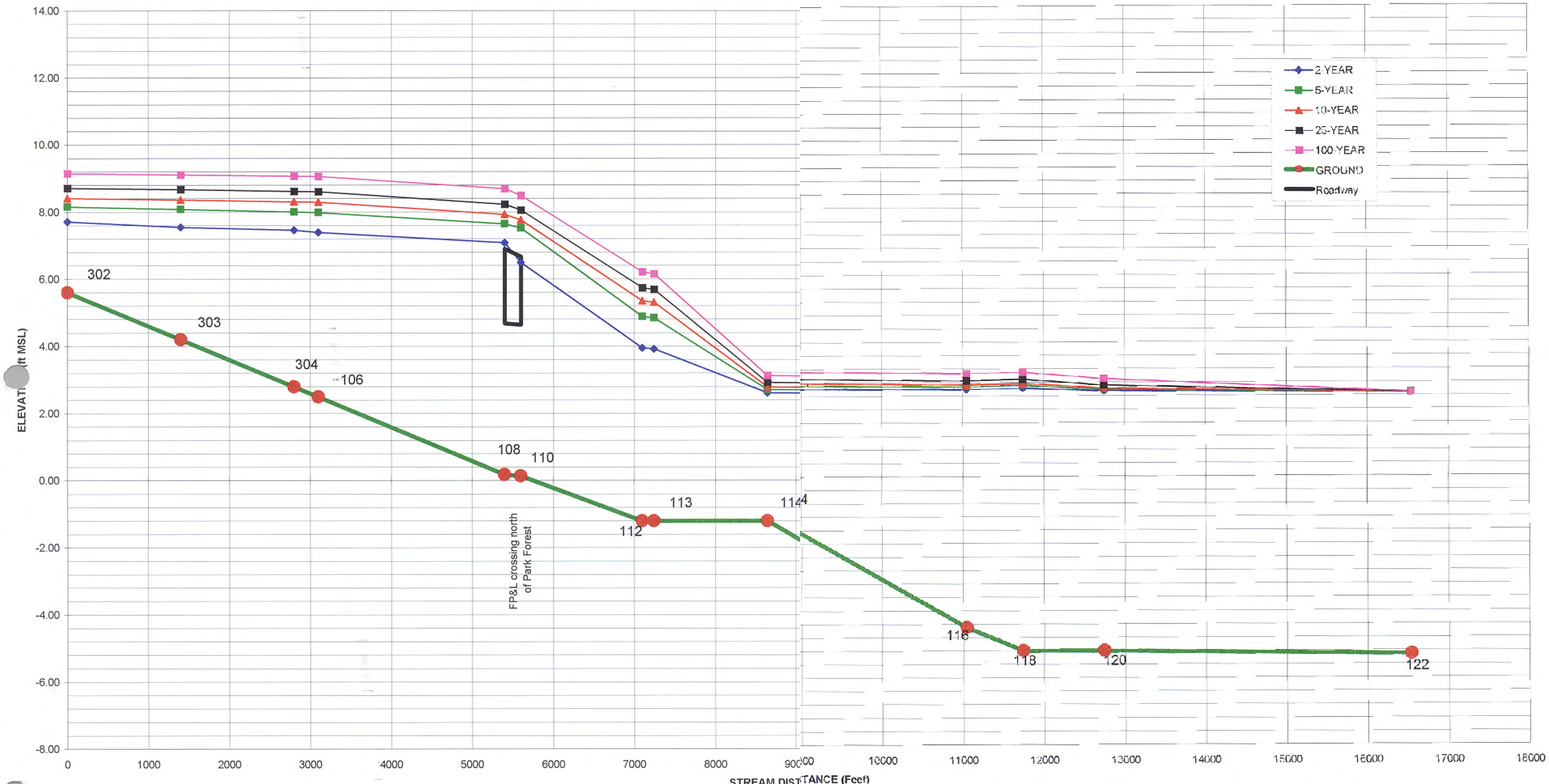


FIGURE 5.7d
EXISTING CONDITIONS: HYDRAULIC GRADE LINE PLOTS
FORKED CREEK

Table 5.6
Gottfried Creek Future Landuse/ Existing Conditions
Peak Flood Stage Summary

Junction Number	Node Location	Future Landuse/ Existing Conditions Peak Flood Stage Summary				
		2-Year Storm Peak Elev. (ft NGVD)	5-Year Storm Peak Elev. (ft NGVD)	10-Year Storm Peak Elev. (ft NGVD)	25-Year Storm Peak Elev. (ft NGVD)	100-Year Storm Peak Elev. (ft NGVD)
106	Confluence of Branches	7.57	7.92	8.43	8.58	9.14
107	Station 41+00	7.36	7.72	8.22	8.37	8.95
108	Station 35+00	7.22	7.57	8.05	8.2	8.79
109	FP&L Access Road (U/S)	7.11	7.47	7.91	8.06	8.64
110	FP&L Access Road (D/S)	6.92	7.43	7.87	8.02	8.58
111	Station 16+00	4.54	5.09	5.8	6.01	6.66
112	Park Forest Blvd. Bridge (U/S)	4.25	4.81	5.5	5.7	6.28
113	Park Forest Blvd. Bridge (D/S)	4.22	4.77	5.46	5.66	6.22
114	Channel Expansion Point	2.64	2.71	2.85	2.92	3.18
116	Confluence w/ G-4 Branch	2.61	2.67	2.78	2.84	3.06
118	Dearborn St. Bridge (U/S)	2.64	2.7	2.82	2.89	3.1
120	Dearborn St. Bridge (D/S)	2.55	2.58	2.65	2.71	2.9
121	MAIN BRANCH	2.52	2.53	2.56	2.58	2.66
122	SR. 776 (U/S)	2.5	2.5	2.5	2.5	2.5
202	Elm St. (D/S)	11.75	11.84	11.93	12.04	12.48
203	Elm St. Weir	12.64	12.7	12.73	12.72	12.76
204	Elm St. (U/S)	11.36	11.71	11.92	12.03	12.48
206	Artist Ave. (D/S)	11.22	11.35	11.65	11.75	12.34
208	Artist (U/S)	10.13	11.04	11.65	11.75	12.34
209	Madder Lane Rd. (U/S)	10.1	11.04	11.66	11.75	12.35
210	Madder Lane Rd. (U/S)	10.1	11.03	11.7	11.78	12.38
212	Viridian Street (U/S)	9.87	10.98	11.59	11.68	12.26
213	Blackburn St. Pond	9.7	10.97	11.58	11.64	12.25
214	Viridian Street (D/S)-Elm Street (U/S)	9.7	10.97	11.59	11.67	12.26
216	Elm Street (D/S)	9.52	10.49	10.88	11.18	12.25
218	Shell Rd (U/S)	9.49	10.47	10.86	11.17	12.25
220	Shell Rd. (D/S)	8.86	10.04	10.86	11.17	12.25
222	SR 776 (U/S)	8.79	10.01	10.82	11.13	12.24
224	SR 776 (D/S)	8.7	9.76	10.08	10.17	10.5
226	Tangerine Woods Blvd. (U/S)	8.67	9.74	10.06	10.14	10.47
228	Tangerine Woods Blvd. (D/S)	8.63	9.69	9.9	9.94	10.06
230	Access Rd. (U/S)	8.62	9.68	9.86	9.89	9.97
232	Access Rd. (D/S)	7.77	8.15	8.56	8.72	9.3
234	USGS Gage	7.61	7.96	8.54	8.7	9.26
235	Station 59+00	7.6	7.95	8.49	8.64	9.2
236	Station 54+00	7.59	7.94	8.47	8.62	9.18
251	McCall Rd. (U/S)	11.76	11.86	11.96	12.06	12.5
252	McCall Rd. (D/S)	11.85	11.91	11.98	12.06	12.5
254	Wentworth St. (U/S)	11.92	12.04	12.23	12.29	12.63
256	Wentworth St. (D/S)-Driveway Culvert (U/S)	11.92	12.09	12.24	12.29	12.63
258	Driveway Culvert (D/S)	11.92	12.11	12.24	12.3	12.63
260	Driveway Culvert (U/S)	11.92	12.11	12.24	12.3	12.63
262	Driveway Culvert (D/S)	11.92	12.13	12.24	12.3	12.63
264	New York Ave. (U/S)	11.92	12.13	12.24	12.3	12.63
266	New York Ave. (D/S)	11.32	11.88	12.24	12.3	12.63
268	Perry Ave. (U/S)	11.32	11.88	12.24	12.3	12.63
270	Perry Ave. (D/S)-SR 776(U/S)	11.11	11.66	11.99	12.04	12.22
272	SR 776 (D/S)	11.06	11.6	11.93	11.97	12.12
274	Dearborn St. /SR 776 Intersection (U/S)	11.05	11.6	11.92	11.96	12.11
276	Dearborn St. /SR 776 Intersection (D/S)	9.88	10.89	11.87	11.91	12.05
278	Broadway Street (U/S)	9.87	10.89	11.87	11.91	12.05
280	Broadway Street (D/S)	9.09	9.71	10.43	10.46	10.56

Table 5.6
Gottfried Creek Future Landuse/ Existing Conditions
Peak Flood Stage Summary

Junction Number	Node Location	Future Landuse/ Existing Conditions Peak Flood Stage Summary 2-Year Storm Peak Elev. (ft NGVD)	5-Year Storm Peak Elev. (ft NGVD)	10-Year Storm Peak Elev. (ft NGVD)	25-Year Storm Peak Elev. (ft NGVD)	100-Year Storm Peak Elev. (ft NGVD)
282	Beverly Circle (U/S)	9.04	9.68	10.42	10.45	10.55
284	Beverly Circle (D/S)	8.6	9.09	9.66	9.69	9.77
286	Harwich Circle (U/S)	8.53	9.04	9.64	9.66	9.75
288	Harwich Circle (D/S)	8.09	8.59	9.12	9.13	9.19
290	Lee Circle (U/S)	8.04	8.56	9.1	9.11	9.18
292	Lee Circle (D/S)	7.39	7.77	8.1	8.11	8.15
294	Sandy Island Circle (U/S)	7.18	7.61	7.99	8	8.04
296	Sandy Island Circle (D/S)	5.68	5.82	5.89	5.9	5.9
297	Stratford Dr. (U/S)	2.69	2.77	2.89	2.97	3.23
298	Stratford Dr. (D/S)	2.62	2.67	2.79	2.87	3.15
302	North of G-17	7.83	8.11	8.55	8.69	9.24
303	G-17	7.71	8.02	8.49	8.64	9.2
304	G-16A	7.62	7.95	8.44	8.59	9.15
306	Weir at G-16A	7.58	7.93	8.43	8.58	9.14
414	Post Office Entrance Rd. (U/S)	10.72	11.1	11.86	11.88	11.96
416	Post Office Entrance Rd. (D/S)	11.63	11.7	11.79	11.79	11.79
418	William Ln. (U/S)	11.6	11.65	11.71	11.71	11.71
420	William Ln. (D/S)-Pine St.	11.41	11.45	11.51	11.52	11.55
422	Stiver Ln.	8.94	9.11	9.37	9.45	10.56
423	River Rd. (U/S)	8.21	8.49	8.88	9.01	10.47
424	River Rd. (D/S)	7.38	7.58	7.83	7.9	8.2
426	Dearborn St. (U/S)	5.73	5.9	6.15	6.22	6.51
428	Dearborn St. (D/S)	2.86	3.01	3.19	3.27	3.54
502	Secondary Branch (U/S)	9.15	9.61	9.85	9.99	10.23
504	Secondary Branch (U/S)	9.13	9.6	9.84	9.98	10.23
506	Access Rd. (U/S)	9.13	9.59	9.84	9.98	10.23
508	Access Rd. (D/S)	9.13	9.59	9.84	9.98	10.23
509	Secondary Branch	9.11	9.58	9.83	9.97	10.21
510	Access Rd. (U/S)	9.02	9.51	9.78	9.92	10.17
511	Access Rd. (D/S)	9.02	9.51	9.78	9.92	10.17
512	Secondary Branch	8.22	8.88	9.21	9.36	9.62
514	Oxford St. (U/S)	5.64	7.15	8.57	8.82	8.97
516	Oxford St. (D/S)	5.31	6.38	7.29	7.52	7.8
518	Shell Rd. (D/S)	4.92	5.47	5.76	5.97	6.4
520	Secondary Branch at Confluence	3.94	4.38	4.67	4.94	5.38

uses, existing drainage conditions scenario. The modeling data were also used to define the extent of the 100-year floodplain. Ground elevations were obtained from the SWFWMD topographic maps. Figure 5.8 and the attached Plate 2 show the digitized 100-year floodplain map.

IDENTIFIED STORMWATER SYSTEM FLOOD CONTROL PROBLEMS

As indicated in Section 4, the LOS criteria include flood protection and water quality conditions. Flood-related problems were identified by examining existing records, conducting field visits and contacting basin residents, and examining the results of the hydraulic analysis conducted herein. Locations of the reported problems are indicated in the attached Plate 3. This information was obtained from the County's Customer Response Tracking System. In general, five problem areas have been identified in the Gottfried Creek basin that experience flooding problems, water quality problems, or both. These are shown in the attached Figure 5.9 and include:

1. Area adjacent to the Englewood lateral
2. Area in the vicinity of the Perry Lane and SR 776 intersection
3. Area along South River Road, northeast of the Pine Street Park entrance
4. Area around the confluence of the creek's main branch and the Englewood lateral
5. The creek's main branch

The first three areas listed above are experiencing primarily flood control problems. However, there are associated water quality problems. The other two areas have mostly water quality concerns. Following is a description of the problems, as they relate to flood control. Water quality problems and the associated levels of service are described in Section 6.

Area Adjacent to the Englewood Lateral

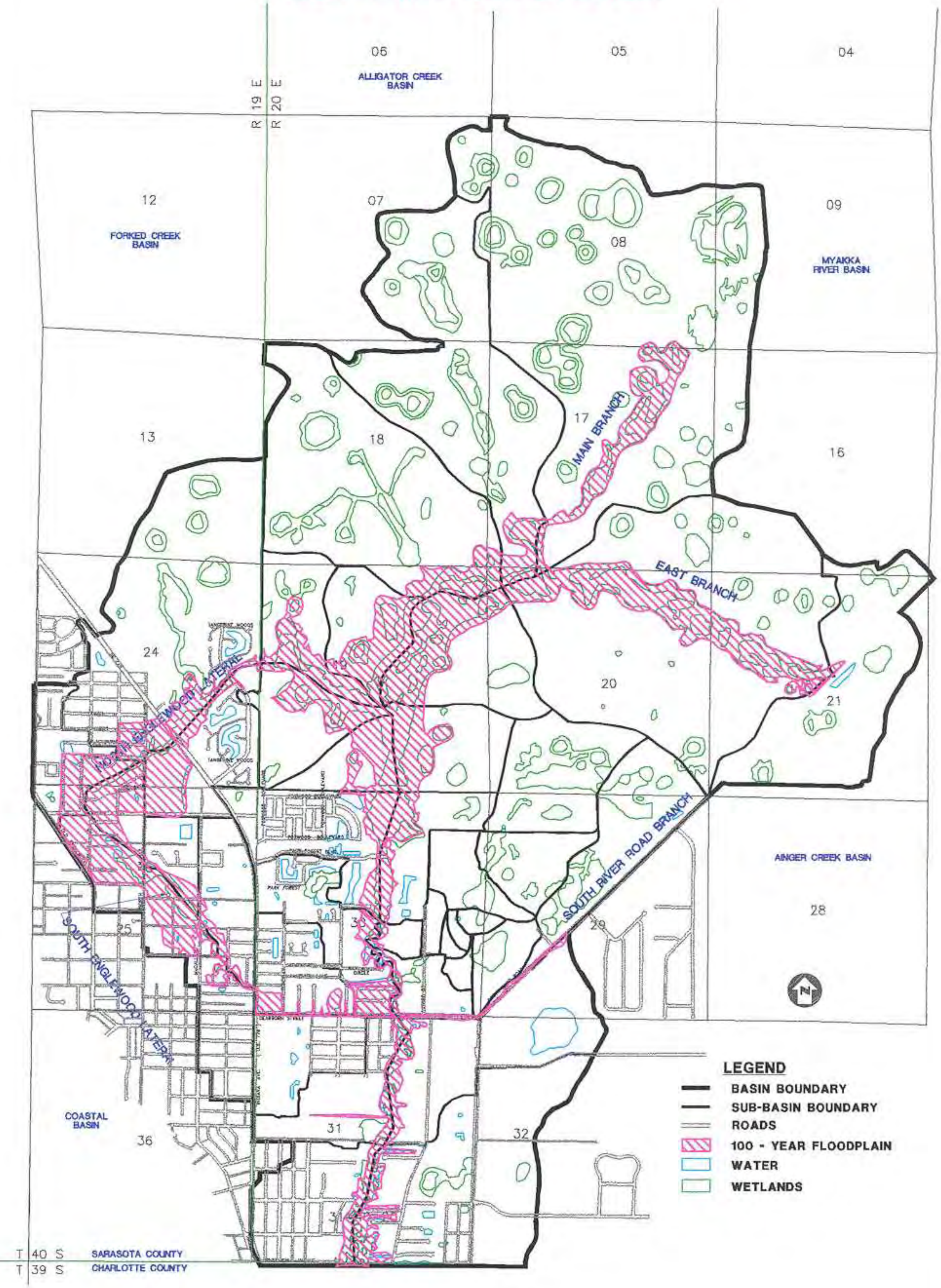
Main problems in the stormwater system in this area, described from upstream to downstream, are as follows:

- **Culvert Across Artist Avenue.** The 30-inch diameter CMP culvert across Artist Avenue is installed in opposite direction to the flow. The culvert's upstream and downstream inverts are 5.80 and 6.14 ft msl., respectively, a difference of about four inches. In addition, during the site visits it was observed that about 50 percent of the pipe diameter was silted and unusable. The upstream and downstream drainage channels also showed the need for maintenance activities. These conditions are causing excessive head losses that result in flooding in the Artist Avenue area along Olive Street.
- **Ditch Section Between Van Gogh Road and Viridian Street.** A ditch approximately 1,800-ft long conveys stormwater runoff from Van Gogh Road

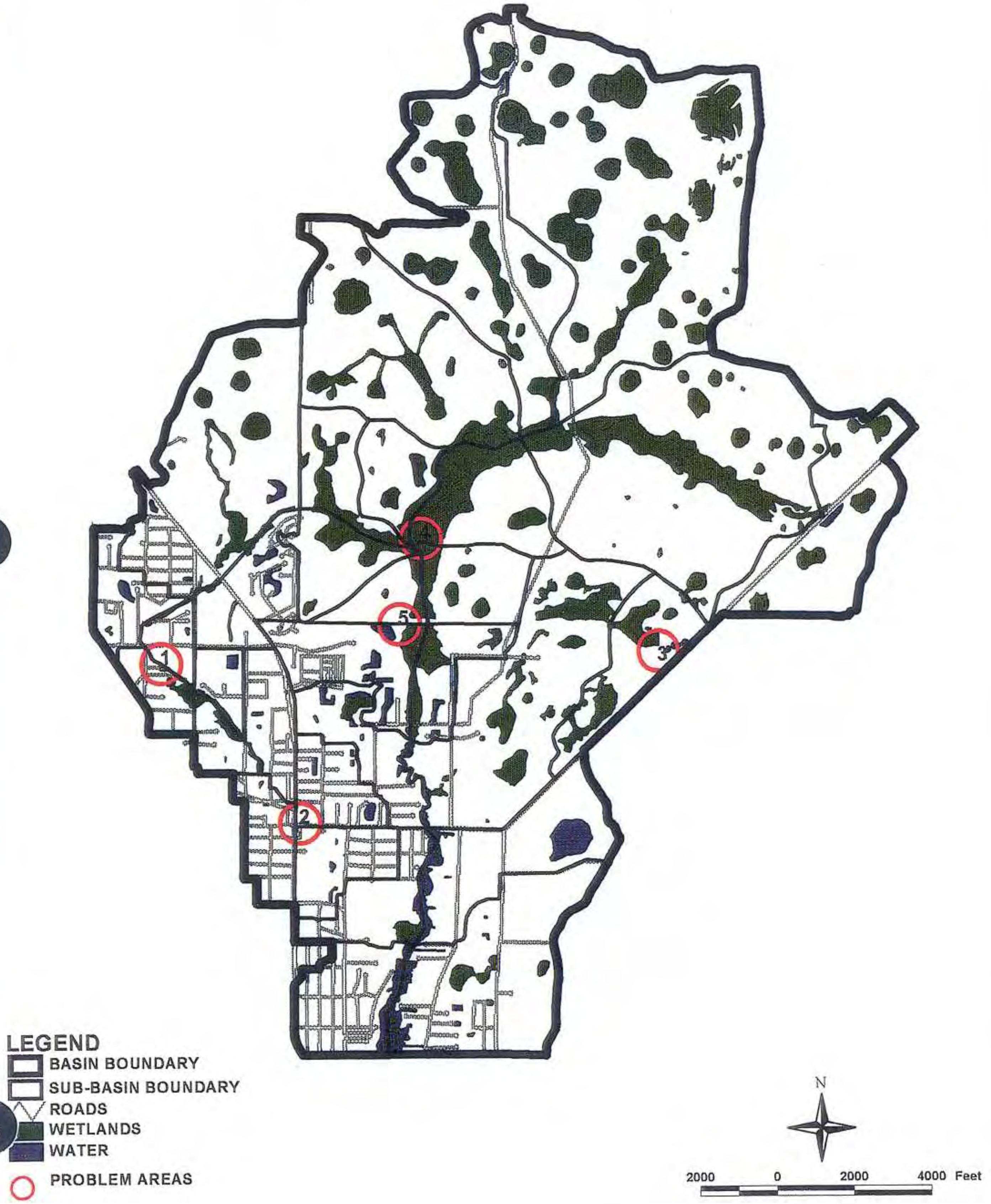
FIGURE 5.8

100 - YEAR FLOODPLAIN

GOTTFRIED CREEK BASIN



PROBLEM AREAS
GOTTFRIED CREEK BASIN



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to Viridian Street. The most downstream section of this ditch is substantially narrower than the upstream portion, which results in unnecessary head losses in the system and contributes to the flooding conditions along the relatively low-lying area around Van Gogh Road and Madder Lane.

Pond Outfall at Viridian Street and Elm Street. The 53 x 34-inch RCP outflow structure across Elm Street of the pond located at the intersection of Viridian and Elm Streets is inadequate to handle the 100-year peak flows. In addition, the invert of this outfall culvert is located about two feet above the invert of the inflow pipe. This results in runoff water flowing south/southwest, in an upstream direction, until the runoff volume exhausts the storage available in the upstream ditches and ponds. Subsequently, the flow direction changes to the normal north/northeast direction.

- **Culvert Downstream from Elm Street Crossing.** A 53 x 34-inch RCP culvert exists about 50 feet downstream from the Elm Street crossing which presently has no use as a drainage facility. That structure is creating unnecessary head losses that impact flood elevations upstream.

- **Culverts across SR 776, approximately 1.5 miles north of Dearborn Street.** The three 36-inch RCP culverts across SR 776 experience surcharge conditions even for peak flows expected from the two-year design storm. Flooding stages do not reach road elevation, but produce backwater effects that result in flooding conditions upstream. The replacement of these culverts represents the most important drainage improvement for the affected area that extends from the west side of SR 776 to Artist Avenue. This project is quite timely because the Florida Department of Transportation (FDOT) is currently finalizing the design of the SR 776 improvements in this area. A copy of the Basin Master Plan report and the computer model's output and input files have been provided to FDOT for their evaluation.

- **Culverts Across Florida Power & Light (FPL) Easement, east of SR 776.** FPL maintains an easement that runs north-south east of SR 776 and crosses Gottfried Creek east of the Tangerine Woods subdivision. The culvert structure consists of two sets of culverts. Each set includes a 30-inch and a 36-inch concrete pipe. These structures are inadequate to handle the expected peak flows.

Area Northeast of the Dearborn Street and SR 776 Intersection

Flooding problems have been reported in this area, particularly along Wentworth Street. Localized flooding problems are being caused by drainage structures located adjacent to the Englewood Elementary school. The analysis of the secondary drainage system is out of the scope of this study. However, it is recommended that those drainage problems be resolved. Modeling results have shown that the primary drainage system will have the capacity to handle the expected current and future peak flows.

Area Along South River Road, Northeast of the Pine Street Park Entrance

As indicated in Section 2, house flooding has been reported along South River Road, north of the Pine Street Park entrance. Flooding has also been reported along South River Road at this location. This is particularly important because South River Road is an evacuation Route. A recommended improvement project is described in Section 7. In addition, maintenance of the culvert and ditches leading to the WENG Radio ditch is necessary.

FLOOD PROTECTION LEVELS OF SERVICE DEFICIENCIES

The Sarasota County Land Development Regulations Ordinance No. 95-021 defines LOS objectives for flood protection at the Gottfried Creek basin. Table 5.6 shows the identified LOS provided by the existing drainage system, along with the identified deficiencies. This table was developed based on the results of the hydrologic/hydraulic model developed for the basin, as well as the field verification work conducted as part of this study. The results are consistent with the findings on actual flooding conditions, as described in Section 2.

Levels of Service for Buildings

Field surveying was conducted to obtain finished floor elevations of residences in the basin suspected of not meeting levels of service for flood control. In addition, homeowners were consulted regarding the occurrence of flooding during the June 1992 and July 1995 storms. No emergency shelters, essential services, or employment/service centers were found to experience flooding during a 100-year storm event. As shown in Table 5.6, it was estimated that a total of 8 buildings, all residences, would be flooded during the 100-year flood event. Table 5.6 also lists corresponding addresses. Most of the are located along the northern portion of the Englewood lateral Flooding conditions result primarily from the lack of adequate drainage structures.

One of the residences experiencing flooding in the Gottfried Creek basin is located on South River Road, north of the WENG Radio Station. This area flows partially toward the Ainger Creek basin. As this study did not include the analysis of flooding conditions in Ainger Creek, a detailed hydraulic analysis was not conducted. However, evaluation of the culvert capacity across South River Road indicated that the expansion of a portion of the WENG Radio culvert structure is necessary, along with flood attenuation in order not to aggravate conditions in Ainger Creek.

Levels of Service for Road Access

In terms of road access, and as shown in Table 5.7, the Gottfried Creek basin shows LOS deficiencies at various locations in the urban Englewood area west of SR 776. The evacuation routes of S.R. 776, Dearborn Street and River Road were found to meet LOS criteria. Flooding conditions on River Road occur upstream from the Angers Creek crossing. The problem at McCall Road is limited to an approximate 300-ft road stretch because, as shown in the topographical maps, the pavement

TABLE 5.7
FLOOD PROTECTION LEVELS OF SERVICE DEFICIENCIES
EXISTING CONDITIONS

	Road	Storm Frequency				
	Elev. (ft)	2-YR	5-YR	10-YR	25-YR	100-YR
I. BUILDINGS (See detail below)						
A. Emergency Shelters/Essential Services		0	0	0	0	0
B. Habitable		0	0	0	0	7
C. Employment/Service Centers		0	0	0	0	0
ROAD ACCESS (Elevation in ft msl)						
A. Evacuation						
South River Road at Post Office	**12.13**	**10.53**	**11.49**	**11.52**	**11.59**	**11.73**
South River Road and Pine St.	**12.01**	**8.89**	**9.17**	**9.30**	**9.42**	**10.58**
Gottfried Creek crossing at S.R. 776	**12.23**	**8.61**	**10.24**	**10.77**	**11.46**	**12.20**
Indiana Av. and Dearborn St	**13.39**	**11.38**	**11.95**	**12.00**	**12.06**	**12.15**
B. Arterials						
Dearborn St. and Lee Circle	**10.05**	**8.90**	**10.08**	**10.14**	**10.18**	**10.24**
Dearborn St. at N. Broadway Rd	**12.19**	**10.70**	**11.93**	**11.98**	**12.03**	**12.11**
Dearborn St., at Oxford Rd.	**10.00**	**7.33**	**7.65**	**7.78**	**7.88**	**8.21**
Dearborn Street bridge	8.92	2.53	2.58	2.61	2.65	2.76
C. Collectors						
Artist Av. at Olive Av.	11.20	10.04	11.27	11.62	11.79	12.30
Elm St at Viridian Street	11.41	9.73	11.21	11.57	11.71	12.22
Gottfried Creek crossing at Elm St. crossing	11.63	9.37	10.53	10.83	11.50	12.21
Park Forest bridge	13.40	3.92	4.84	5.32	5.69	6.15
Tangerine Woods Blvd. crosssing	14.45	8.48	9.85	10.03	10.22	10.45
D. Neighborhood						
Blackburn St. crossing	10.50	9.55	11.21	11.57	11.70	12.21
Gottfried Creek crossing at McCall Rd	10.81	11.76	11.88	11.95	12.14	12.47
Madder Ln. and Van Gogh Rd.	10.64	10.01	11.28	11.62	11.79	12.31
Wentworth St. & New York Av.	12.18	11.96	12.21	12.26	12.36	12.62
Culvert at Park Forrest	9.50	8.81	9.33	9.57	9.76	10.05
Oxford St. east branch crossing	8.49	4.90	5.63	6.19	6.85	7.59

Residential Flooding

Residences not meeting LOS	Floor	Storm Frequency				
Address	Elev. (ft)	2-YR	5-YR	10-YR	25-YR	100-YR
555 Artist Avenue	11.96	10.04	11.27	11.62	11.79	12.30
450 Blackburn Street	12.00	9.55	11.21	11.57	11.70	12.21
700 Harmony Lane	**12.06**	**10.01**	**11.28**	**11.62**	**11.79**	12.31
736 Harmony Lane	**11.94**	**10.01**	**11.28**	**11.62**	**11.79**	12.31
655 Olive Street	**12.07**	**10.04**	**11.27**	**11.62**	**11.79**	12.30
745 Olive Street	11.86	10.04	11.27	11.62	11.79	12.30
761 Olive Street	12.04	10.04	11.27	11.62	11.79	12.30
1520 S.River Road	12.00					>12.00

1) Areas not meeting specified LOS are denoted by: 12.30

2) The elevation of the Blackburn St. residence is estimated. The location of the house on River Road was outside the modeling area for this project

398 Coconut Street
Chapan Boulevard
2010 Allen Street

elevation at this collector reaches over 12.50 ft msl about 150 ft away from the creek crossing.

A portion of Artist Avenue, a collector road, floods during the extreme storm events. Various neighborhood streets such as Olive Avenue, Van Gogh Road, Madder Lane and Viridian Street are expected to experience flooding conditions during large storm events. These problems result primarily by the constriction caused by the existing Englewood lateral northern SR 776 crossing. It is important to point out that in some cases, although the LOS for road access is being met, structural flooding is occurring because houses in this area are located at, or below, the grade of the road.

Flooding conditions are expected on the eastern portion of the neighborhood streets of Gray Road and Yale Street. In addition, numerous low areas in neighborhoods north of Perry Lane, west of S.R. 776, east of Elm Street, and south of Pine Glen Drive, would be flooded during various storm events. Although Dearborn Street, an evacuation route, does not flood during a 100-year storm event, various neighborhood streets feeding into Dearborn Street would experience flooding. In spite of the flooding, LOS criteria are being met at all these locations. A portion of Beverly Circle, a neighborhood street, would experience flooding during a 25 year and 100-year storm events but the LOS would be maintained. Similar conditions area expected for neighborhood streets such as Harwich Circle, Lee Circle and Sandy's Island. Conditions in this area are expected to improve once the County completes the drainage works associated with the Dearborn Street Improvements project.

SECTION 6
WATER QUALITY MODELING AND ANALYSIS OF WATER QUALITY LEVELS OF SERVICE

SECTION 6
WATER QUALITY MODELING AND
ANALYSIS OF WATER QUALITY LEVELS OF SERVICE

GENERAL

Stormwater runoff pollution due to nonpoint sources for the Gottfried Creek basin was calculated using the Watershed Management Model (WMM) supplied by Sarasota County. The model uses a spreadsheet format to estimate annual nonpoint source loads from direct runoff based upon runoff volumes and event mean concentrations (EMCs). The EMC is defined as the total pollutant discharged during the storm divided by the total runoff volume. Estimates of EMCs for a number of pollutants and land use categories were supplied for this study by Sarasota County.

DATA REQUIREMENTS

Data required to run the WMM was collected into various database files and also input interactively during program execution. Necessary data included acreage's by land use type for existing and future uses, EMCs for each pollutant type, average annual precipitation, annual baseflow, percent impervious for each land use, best management practices (BMPs) removal efficiencies, and percentage of land serviced by BMPs. The WMM estimates annual runoff pollution loading for nutrients such as dissolved phosphorus, total phosphorus, total nitrogen, and total Kjeldahl nitrogen; heavy metals such as cadmium, copper, lead, and zinc; oxygen demand in terms of the 5-day biochemical oxygen demand (BOD5) and chemical oxygen demand (COD); total suspended solids; and total dissolved solids. The pollution loads estimates for each basin, major subbasin, or subbasin are calculated based on acreages by land use category, rainfall/runoff ratios, EMCs, and the average annual rainfall. In addition, the model provides estimates of runoff pollution load reduction due to the implementation of BMPs. All BMPs existing in the study area are wet detention ponds.

The first step in running the WMM was to match the existing and future Florida Land Use and Cover Classification System (FLUCCS) codes for the 31 subbasins in the Gottfried Creek basin to the 12 corresponding land use categories used in the model's land use file. This was done by aggregating the FLUCCS categories into a corresponding model category. It was further assumed that there were no failing septic systems within the study area and, therefore, there were no wastewater or septic loads added to the nonpoint source loads from direct runoff. This was done because there are no available data in the area regarding septic tank operation. Impacts due to this type of pollution source were estimated based on the analysis of water quality data for the stream itself.

Subsequently, the impervious area file was created by obtaining corresponding land use categories and percent impervious values from Sarasota County and the WMM User's Manual. The following values were used:

Land Use	Percent Impervious
Forest/Open	0.8
Pasture/Range Land	0.5
Agricultural/Cropland	0.5
LDSF Residential	17.0
MDSF Residential/Inst.	29.0
HDSF Residential	75.0
Commercial/CBD	90.0
Office/Lt. Industrial	70.0
Heavy Industrial	80.0
Water	100.0
Wetlands	0.5
Roads	90.0
Extractive	40.0

The EMC file used in this application was left intact. This would allow Sarasota County to compare estimated pollutant loads from the basin with loads from other County basins. It would also allow the County to set priorities when developing Capital Improvement Plans (CIPs).

The last file created for the WMM was the BMP coverage file. For that purpose, aerial photographs were surveyed and the percentage of each subbasin and land use type served by existing BMPs was estimated and input into the model.

Some additional data input interactively during program execution into the model is listed below.

Annual Precipitation	57.95 in/year
Base Flow	0 in/year
Pervious Area Runoff Coefficient	0.150
Impervious Area Runoff Coefficient	0.95

DATA ANALYSIS

The water quality analysis was conducted assuming both existing and future (buildout) conditions. In this manner, it was possible to compare existing pollutant loads with those expected as a result of future development. Results are described in the following paragraphs.

Existing Conditions

The computer model was used to calculate pollutant loads for each major subbasin. Results indicated that major subbasin III, which represents the upper portion of the creek as well as the creek's east branch, shows the highest total annual pollutant load. However, looking at individual water quality constituents, the most BOD5, COD, dissolved phosphorus, lead, copper, zinc, and cadmium loads come from major subbasin I that includes the main branch of the creek, including the developed area south of Dearborn Street. This is because, in addition to amount of runoff, water quality loads are dependent on the EMCs. Most water quality constituents have the highest EMCs associated with developed land use categories, except for TSS and TKN. The highest EMCs for TSS and TKN are associated with open land, pasture, and agricultural land.

A summary of the water quality model output for existing land use conditions is shown in Table 6.1. Although the sum of the loads for each subbasin is not an accurate representation of total loads because there are computation overlaps, it was considered that it provided an adequate means of making general comparisons among the various basin segments. Overlapping occurs, for example, between TSS and metals as a portion of the metals will be in non-dissolved form and attached to the solids.

Since another indication of pollution load within a subbasin is the loading per unit acre, such estimates are also shown in Table 6.1. In that case, the highest loading per unit acre in the basin for BOD5, COD, total phosphorus, lead, and TKN is derived in major subbasin II, which is the area drained by the Englewood lateral. The highest loading per unit acre for TSS and zinc in subbasin I, and the highest loading for TDS, dissolved phosphorus, NO2 and NO3, and copper is in major subbasins I and II. These results can be attributed to the high amount of development in major subbasins I and II. The combination of a relatively high acreage of open land with the highest percentage of developed land in major subbasin I contribute to the high TSS.

Looking more closely at major subbasin I in the Gottfried Creek basin, the highest loadings per acre of BOD5, COD, TSS, and TDS are in subbasin 15107. These high loadings also can be attributed to a high amount of development in the subbasin. Subbasin 15107 has the highest amount of high density residential acreage with some low and medium density residential as well as some commercial and industrial acreage.

The highest loadings per acre of BOD5, COD, TSS, and TDS are in subbasin 15203. High values of TSS also occur in subbasins 15201 and 15204. These loadings are due to the high degree of developed land in the areas. The TSS and TKN loadings result from the existence of open land, pasture, and agricultural land. Subbasin 15203 has the highest amount of commercial and industrial acreage in major subbasin II.

Future Conditions

Future pollutant loading conditions were analyzed in similar manner as for existing conditions. Two loading scenarios were considered. In a first scenario, it was assumed that the existing runoff pollution control devices would be available in the

TABLE 6.1
GOTTFRIED CREEK, EXISTING LAND USES
EXISTING RUNOFF QUALITY CONTROLS
NONPOINT SOURCE LOADING SUMMARY

AVERAGE ANNUAL RUNOFF

Major Subbasin	Runoff (ac–ft/yr)	Percent of Total
1	3326	41.2
2	2349	29.1
3	2404	29.8
TOTAL	8079	100

AVERAGE ANNUAL POLLUTANT LOADS

		Main Branch Major Subbasin 1			Englewood Lateral Major Subbasin 2			East Branch Major Subbasin 3			TOTAL	
Water Quality Constituent	(units)	Percent of Total	Pollutant Load (lbs/yr)	Pollutant Load (lbs/yr/ac)	Percent of Total	Pollutant Load (lbs/yr)	Pollutant Load (lbs/yr/ac)	Percent of Total	Pollutant Load (lbs/yr)	Pollutant Load (lbs/yr/ac)	Percent of Total	Pollutant Load (lbs/yr)
BOD	(lbs/yr)	43	75,012	30.4	31	54,878	34.6	26	44,602	13.9	100	174,492
COD	(lbs/yr)	43	510,269	207.1	33	383,345	241.4	24	281,953	88.0	100	1,175,567
TSS	(lbs/yr)	39	1,230,942	499.5	24	746,656	470.1	38	1,198,524	374.1	100	3,176,122
TDS	(lbs/yr)	42	909,066	368.9	28	591,836	372.6	30	649,123	202.6	100	2,150,024
Total–P	(lbs/yr)	40	2,025	0.8	29	1,453	0.9	31	1,539	0.5	100	5,017
Dissolved–P	(lbs/yr)	47	971	0.4	30	631	0.4	23	483	0.2	100	2,085
TKN	(lbs/yr)	41	8,981	3.6	31	6,792	4.3	28	5,989	1.9	100	21,762
NO2&NO3	(lbs/yr)	41	2,611	1.1	27	1,679	1.1	32	2,015	0.6	100	6,305
Lead	(lbs/yr)	53	555	0.2	45	470	0.3	2	17	0.0	100	1,042
Copper	(lbs/yr)	52	263	0.1	35	177	0.1	12	61	0.0	100	502
Zinc	(lbs/yr)	50	614	0.2	32	396	0.2	18	229	0.1	100	1,239
Cadmium	(lbs/yr)	55	11	0.0	38	8	0.0	8	2	0.0	100	20
Total			2,741,320			1,788,320			2,184,538			6,714,179

future. However, no additional runoff control would be added as land is developed. Although this is unrealistic assumption, it illustrates the additional load that would result from new development. Results shown in Table 6.2 indicate that, in this case, the total pollutant load discharged into the creek would increase by 62 percent from existing conditions.

In scenario 2, it was assumed that future development would meet current stormwater pollutant control requirements, consistent with state water quality standards (Chapter 17-3 and Section 17-4.242 FAC). Results shown in Table 6.3 indicate that, due to the additional water quality controls, total pollutant load for future conditions would be approximately 7 percent lower than that calculated for existing conditions. However, the total future load for major subbasin 1 would be slightly higher (2 percent) than the existing load. This is because major subbasin 1 encompasses the main branch of the creek, including the developed area south of Dearborn Street. This area has limited runoff treatment capabilities. Therefore, pollutant loads from the areas to be developed in the future would be added to the current discharges. It should be noted that retrofitting the stormwater system in the areas developed prior to the existing water quality regulations to include structural runoff pollution control measures would be costly. It is our recommendation that non-structural options such as more frequent street and catch basin cleaning be consider by the County to minimize pollutant loads.

Figure 6.1 graphically displays total pollutant loads by subbasin for existing conditions, as well as for the two scenarios associated with future conditions.

WATER QUALITY LEVELS OF SERVICE DEFICIENCIES

As indicated in Section 4, Sarasota County has not established levels of service criteria for water quality control. However, recommended LOS were developed as part of this study to help establish both baseline conditions and master plan objectives. The methodology used to determine water quality LOS deficiencies was based on existing data analysis as well as Best Management Practices (BMP) coverage.

Data Analysis

As discussed in Section 4, in this study it has been assumed that meeting the LOS should be defined as both meeting the State of Florida designated water quality criteria and reaching a calculated water quality index (WQI) of at least 53, which is the average value for the WQI fair category, as defined by FDEP. The WQI of 53 was chosen to establish an initial water quality goal. As conditions improve, the WQI value could be adjusted.

In Section 1 it was indicated that Gottfried Creek is a designated Class III stream and its designated uses are the "recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife" (62-302.400 FAC). The 1994 non-point source assessment conducted by FDEP categorized the Gottfried Creek basin as threatened. Inclusion in the threatened category indicates that the water quality in the basin is meeting the designated uses. However, in the absence of any future management activities, it is suspected that within five years at least some of the surface

TABLE 6.2
GOTTFRIED CREEK, FUTURE LAND USES
EXISTING RUNOFF QUALITY CONTROLS
NONPOINT SOURCE LOADING SUMMARY

AVERAGE ANNUAL RUNOFF

Major Subbasin	Runoff (ac–ft/yr)	Percent of Total
1	4949.4	36.5
2	2882.7	21.3
3	5717.8	42.2
TOTAL	13550	100.0

AVERAGE ANNUAL POLLUTANT LOADS

		Main Branch Major Subbasin 1			Englewood Lateral Major Subbasin 2			East Branch Major Subbasin 3			TOTAL	
Water Quality Constituent	(units)	Percent of Total	Pollutant Load (lbs/yr)	Pollutant Load (lbs/yr/ac)	Percent of Total	Pollutant Load (lbs/yr)	Pollutant Load (lbs/yr/ac)	Percent of Total	Pollutant Load (lbs/yr)	Pollutant Load (lbs/yr/ac)	Percent of Total	Pollutant Load (lbs/yr)
BOD	(lbs/yr)	36	121,693	50.2	21	72,915	45.9	43	144,884	30.1	100	339,492
COD	(lbs/yr)	35	863,244	355.9	22	535,942	337.5	44	1,087,774	225.8	100	2,486,960
TSS	(lbs/yr)	33	1,443,611	595.1	18	786,584	495.3	49	2,174,074	451.4	100	4,404,270
TDS	(lbs/yr)	36	1,292,183	532.7	20	719,902	453.3	44	1,554,794	322.8	100	3,566,879
Total–P	(lbs/yr)	32	3,396	1.4	20	2,189	1.4	48	5,168	1.1	100	10,753
Dissolved–P	(lbs/yr)	34	1,631	0.7	20	938	0.6	46	2,206	0.5	100	4,775
TKN	(lbs/yr)	34	15,354	6.3	21	9,579	6.0	44	19,825	4.1	100	44,758
NO2&NO3	(lbs/yr)	32	3,787	1.6	20	2,354	1.5	48	5,754	1.2	100	11,896
Lead	(lbs/yr)	53	1,365	0.6	24	614	0.4	23	606	0.1	100	2,585
Copper	(lbs/yr)	36	521	0.2	20	293	0.2	44	634	0.1	100	1,448
Zinc	(lbs/yr)	43	1,130	0.5	20	534	0.3	36	945	0.2	100	2,609
Cadmium	(lbs/yr)	37	23	0.0	21	12	0.0	42	26	0.0	100	61
Total			3,747,937			2,131,858			4,996,689			10,876,484

TABLE 6.3
GOTTFRIED CREEK, FUTURE LAND USES
FUTURE RUNOFF QUALITY CONTROLS
NONPOINT SOURCE LOADING SUMMARY

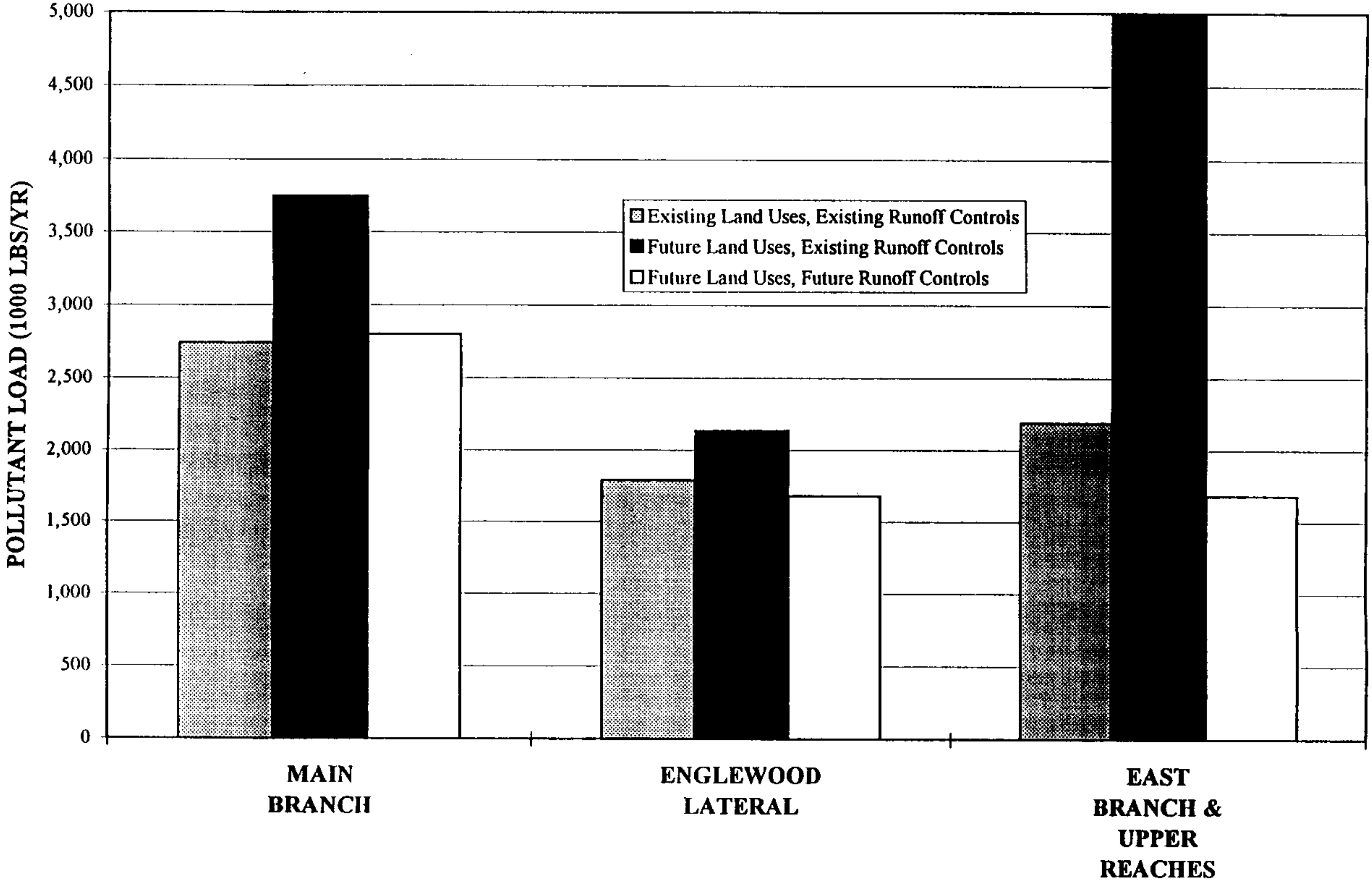
AVERAGE ANNUAL RUNOFF

Major Subbasin	Runoff (ac-ft/yr)	Percent of Total
1	4982.9	42.2
2	2846.5	24.1
3	3,982	33.7
TOTAL	11812	100.0

AVERAGE ANNUAL POLLUTANT LOADS

		Main Branch Major Subbasin 1			Englewood Lateral Major Subbasin 2			East Branch Major Subbasin 3			TOTAL	
Water Quality Constituent	(units)	Percent of Total	Pollutant Load (lbs/yr)	Pollutant Load (lbs/yr/ac)	Percent of Total	Pollutant Load (lbs/yr)	Pollutant Load (lbs/yr/ac)	Percent of Total	Pollutant Load (lbs/yr)	Pollutant Load (lbs/yr/ac)	Percent of Total	Pollutant Load (lbs/yr)
BOD	(lbs/yr)	43	105,370	42.8	26	64,447	40.6	31	75,083	23.4	100	244,901
COD	(lbs/yr)	42	746,040	302.9	26	470,569	296.3	32	568,827	177.6	100	1,785,436
TSS	(lbs/yr)	51	846,608	343.7	31	508,515	320.2	18	304,026	94.9	100	1,659,149
TDS	(lbs/yr)	45	1,079,327	438.2	26	620,989	391.1	30	717,931	224.1	100	2,418,246
Total-P	(lbs/yr)	40	2,604	1.1	26	1,721	1.1	34	2,251	0.7	100	6,575
Dissolved-P	(lbs/yr)	46	1,117	0.5	28	678	0.4	26	624	0.2	100	2,419
TKN	(lbs/yr)	41	13,286	5.4	26	8,397	5.3	33	10,919	3.4	100	32,602
NO2&NO3	(lbs/yr)	39	3,364	1.4	24	2,071	1.3	37	3,238	1.0	100	8,673
Lead	(lbs/yr)	59	834	0.3	34	483	0.3	8	109	0.0	100	1,426
Copper	(lbs/yr)	47	357	0.1	28	214	0.1	25	188	0.1	100	759
Zinc	(lbs/yr)	50	923	0.4	25	461	0.3	25	457	0.1	100	1,841
Cadmium	(lbs/yr)	50	14	0.0	31	9	0.0	19	5	0.0	100	28
Total			2,799,845			1,678,553			1,683,658			6,162,055

FIGURE 6.1
POLLUTANT LOAD COMPARISON



waters in the watershed will not support their designated use. Therefore, the stream is currently meeting the water quality LOS concerning designated uses. However, the development of runoff pollution control measures is necessary to ensure meeting the LOS in the future.

To assess the LOS based on the WQI, data available from the Sarasota County Natural Resources Department were analyzed. These data encompassed the period 1988 through 1990 and included two sampling stations, 593 and 624. Station 593 is located at East Wentworth Circle, about 0.25 miles north of the Dearborn Street bridge. Station 624 is located at the Deer Creek Mobile Home Park boat ramp, about one mile south of the Dearborn Street bridge. In addition, data collected at Station 571 on Lemon Bay, just north of the Sarasota-Charlotte county line were used for comparison purposes.

The data were used to calculate the WQI for each of the stations. Per FDEP guidelines, in the final calculation of the WQI, missing water quality categories may be ignored. In this case the WQI calculation for Gottfried Creek did not include the oxygen demand and biological diversity category because the data were not available. Nutrient calculations were based strictly on nitrogen concentrations because the data indicate that the stream is nitrogen limited. This condition is common in the west coast of Florida.

Results are shown in Table 6.4. The WQI of 59 at Station 593 indicated that water quality is in the fair category, bordering the poor water quality limit. The most critical parameters are the biological and oxygen concentration. Conditions improve substantially at Station 624. The WQI of 49 places the stream in the fair category, but the calculated value is close to the upper limit of the good quality category. By comparison, the WQI of 21 at the Lemon Bay Station 571 indicates water quality well in the good quality category. Therefore, data showed that the stream it is not meeting the LOS criteria at the station upstream of the Dearborn Street bridge. Data are not available to conduct a more detailed analysis, but it is suspected that the problem is due to the lack of runoff pollution control in the area drained by the Englewood lateral. Water quality control measures should be implemented.

The biological conditions data available for this study were further analyzed by looking at the fecal coliform/fecal streptococcus ratio (FC/FS). FC/FS ratios between 0.7 and 4.4 usually indicate that wastes may be derived from human or animal sources. Ratios higher than 4.0 indicate human sources. Data for 1989 and 1990 show that the arithmetic mean of the ratios at Station 593 was 2.27 and 2.37, respectively. However, maximum values at that location amounted to 6.00 and 6.92, respectively. According to the Sector Plan, the FC/FS ratio in 1991 was consistently above 1.0 and exceeded 4.4 in two out of five samples. Therefore, data indicate that pollution due to human or animal wastes is likely to be present. Causes of this problem could be septic tank effluents and/or runoff from grazing activities upstream.

It must be noted that the water quality data available for this analysis (1989-1990) reflected conditions existing several years ago. Current data may show that conditions

TABLE 6.4
ANALYSIS OF WATER QUALITY CONDITIONS AND CALCULATION OF WATER QUALITY INDEX

		1990			1989			1988				
Parameter	Sampling Station*	Max. Value	Min. Value	Mean	Max. Value	Min. Value	Mean	Max. Value	Min. Value	Mean	Overall Mean	WQI
Total Coliform	566	400	100	126	300	100	125	2300	100	148	133.0	17
	567	1000	100	213	3900	100	181	1000	100	159	184.3	23
	623	13000	1000	1623	10000	100	1026	6600	600	1197	1282.0	64
	573	100	100	100	300	100	115	100	100	100	105.0	11
Fecal Coliform	566	30	10	12	80	10	17	20	10	12	13.7	14
	567	170	10	31	70	10	23	60	10	20	24.7	23
	623	500	100	192	6000	30	2.6	940	40	235	143.2	61
	573	10	10	10	60	10	13	10	10	10	11.0	11
Dissolved Oxygen	566	5.8	3.7	4.8	7.8	3.4	5.5	8.8	4.6	5.9	5.4	52
	567	6.1	3	4.4	7.4	3.6	5.3	8.1	3.7	5.5	5.1	65
	623	6.2	2.2	3.9	7.3	2.5	4.4	7.7	2.4	5	4.4	4.8
	573	7.8	4.4	5.9	7.7	2.9	5.7	8.7	3.8	6.5	6.0	45
Turbidity	566	5.6	2.4	3.7	5.2	1.9	3.8	4.5	2.1	3.2	3.6	26
	567	4.6	3.1	3.7	3.8	2.1	3.1	3.7	2	2.7	3.2	22
	623	11.5	3.4	7	9.8	3.9	5.8	11	2.2	4.3	5.7	51
	573	6.3	2.9	4.4	4.3	1.8	3	6.2	1.9	3.6	3.7	27
Total Nitrogen	566	1.19	1.14	1.16	1.21	0.98	1.13	1.05	0.62	0.84	1.04	57
	567	1.83	1.18	1.37	1.16	0.78	0.99	1.05	0.79	0.88	1.1	58
	623	2.21	0.94	1.63	1.44	0.9	1.19	1.73	0.78	1.32	1.38	59
	573	1.08	0.93	1.03	0.98	0.58	0.85	0.82	0.5	0.64	0.8	53
Total Phosphorus	566	0.63	0.3	0.44	0.45	0.26	0.31	0.62	0.14	0.35	0.4	76
	567	0.59	0.38	0.49	0.44	0.27	0.35	0.6	0.22	0.37	0.4	77
	623	0.8	0.29	0.64	0.41	0.3	0.35	0.43	0.2	0.28	0.4	78
	573	0.5	0.38	0.44	0.33	0.12	0.21	0.46	0.1	0.22	0.3	72

WQI Summary:

Sampling Station:	566	567	623	573
WQI:	37.6	42.0	44.3	34.0

* Sarasota County Natural Resources Department Sampling Stations

have improved in recent years. For example, according to the Natural Resources Conservation Service (NRCS), a successful range management plan has been in place at Taylor Ranch since 1994. NRCS staff indicated that the level of current grazing activities at the Ranch could not result in adverse water quality impacts. In addition, the Englewood Water District is in the process of starting the construction of a centralized wastewater collection system to serve the Englewood area. It is expected that septic systems in the area will be eliminated within the next five years.

Best Management Practice (BMP) Coverage

As indicated in Section 4, PLRGs have not been established for Lemon Bay. However, it was considered adequate herein that the Gottfried Creek basin should follow the stormwater pollution reduction guidelines established by the Sarasota Bay National Estuary Program (SBNEP). As part of the restoration strategy for Sarasota Bay, it is established that one of the environmental quality objectives would be to reduce contaminant loads by 27 percent and nitrogen loads by seven percent. This could be accomplished if stormwater treatment technologies are applied to 50 percent of a watershed. Sarasota County supports the SBNEP goal that, on a countywide average basis, the BMP coverage should be 50 percent.

In this study, it was considered adequate to determine the basin's BMP coverage. Table 6.5 shows the BMP coverage for all subbasins where at least 20 percent of the land has been developed. It was assumed that subbasins showing less that 20 percent development do not require this type of analysis because they either are located in areas of relatively recent development where the drainage system has been designed per the new stormwater regulations. The table shows that only three subbasins meet the 50 percent BMP coverage, the area encompassed by the Tangerine Woods subdivision, the Park Forest subdivision, and the relatively small developments located northeast of the Dearborn Street-Indiana Avenue intersection. It was concluded that, in order to meet the LOS, runoff pollution control through BMPs should be provided, particularly for the older developments in the urban Englewood area.

TABLE 6.5
BMP COVERAGE BY SUBDRAINAGE BASIN

BASIN_ID	Developed Area (%)	Current Coverage* (%)
15101	0.87	9
15102	0.47	5
15103	0.50	0
15104	0.61	0
15106	0.70	44
15107	0.72	10
15201	0.76	0
15202	0.81	73
15203	0.99	13
15204	0.73	0
15205	0.56	0
15206	0.69	9
15207	0.56	20
15208	0.50	71
15209	0.63	25
15210	0.86	15
15211	0.23	29

* = BMP coverage of developed area

SECTION 7
PROPOSED SOLUTIONS

SECTION 7
PROPOSED SOLUTIONS

GENERAL

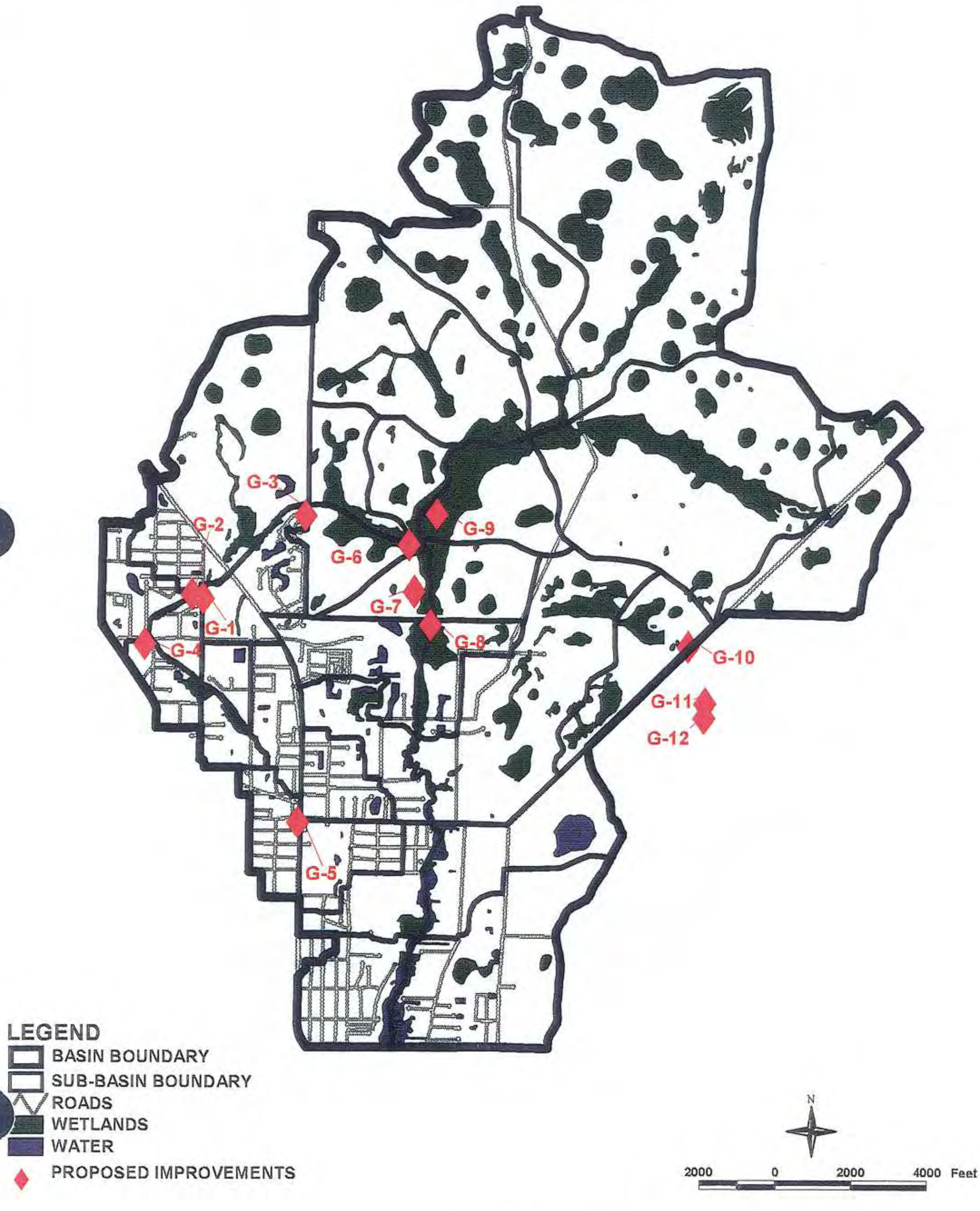
Until recently, stormwater management planning was based exclusively on flood control objectives. However, as the need to control the quality of stormwater runoff has become more important, overall planning objectives now focus on the identification of solutions that maximize those two often conflicting purposes. From the flood control standpoint, the most effective approach is usually to avoid incompatible land uses within flood-proned areas. In addition, construction within the floodplain in many cases results in significant environmental impacts. In terms of water quality, the most effective approach is to maintain/rehabilitate natural patterns of water movement and storage.

As indicated in Section 5, the flooding problem areas within the Gottfried Creek basin include the urban Englewood subbasin from Artist Avenue to the confluence of the Englewood lateral and the main creek branch, and the upper portion of South River Road that currently drains to the Ainger Creek basin. The main area of concern for water quality is the main creek branch from the Englewood lateral confluence to the Sarasota/Charlotte County border. The problems in the vicinity of the Dearborn Street and SR 776 intersection will be addressed by the Dearborn Street improvement project currently being implemented by the County.

Various individual projects were identified in this study to improve flood control and water quality conditions within each problem area. Subsequently those projects were combined to create alternatives, which were then evaluated based on the following evaluation criteria: cost, environmental impacts, regulatory and permitting issues, and community acceptance. A "no action" plan, representing an alternative solution should all other alternatives prove to be not implementable, was also considered in all cases. The recommended alternatives included the projects located as shown in Figure 7.1. Project descriptions, recommended implementation time, and cost estimates are provided in the attached Tables 7.1 and 7.2. A detail breakdown of the cost estimates is included in Appendix C.

Following is a description and evaluation of the various alternatives considered for identifying the recommended projects.

LOCATION OF PROPOSED IMPROVEMENTS
GOTTFRIED CREEK



PARSONS ENGINEERING SCIENCE, INC.

TABLE 7.1
PROPOSED PROJECTS
ENGLEWOOD LATERAL IMPROVEMENTS

PROJECT ID	PROJECT DESCRIPTION	IMPLEM. TIME	COST (*) (1000$)
G-1	Remove existing culvert and improve approximately 300 ft of existing ditch upstream of Viridian Street.	S	10
G-2	Replace existing culvert across Elm Street with double 54-inch diameter culverts. Eliminate culvert located about 50 feet east of the Elm Street crossing. Restore about 250 feet of ditch cross-section	S	20
G-3	Coordinate with FDOT to replace culverts on the north SR 776 crossing dowsnstream from the Viridian Street pond with triple 60" RCPs. Replace existing culverts across the Florida Power easement with double 54-inch diameter pipes	S	40
G-4	Clear and snag approximately 250 ft of existing ditch in the Artist Avenue area. Maintain existing culvert	S	5
G-5	Construct proposed Dearborn Street Improvements	S	----
G-6	Remove erosion deposits and provide erosion protection in about 700 ft of creek channel. Regrade banks to a 3:1 slope.	S	80
G-7	Regional water quality facility. Clear, snag, and remove existing spoil berms along the creek banks between the confluence of the main branch with the Englewood lateral and the Park Forest bridge. Place diversion structures to route flows through adjacent wetlands for water quality treatment	M	1,100
G-8	Replace culverts across Florida Power easement with double 72-inch diameter pipes.	S	50
G-9	Proposed future regional detention facility: It will cover about 60 acres of currently undeveloped land north of an existing weir structure	L	1,000

* Costs are in 1995 dollars and include engineering, permitting, and contingencies
S = Short-term
M = Medium term
L = Long-term

TABLE 7.1 (Continued)
PROPOSED PROJECTS
ENGLEWOOD LATERAL IMPROVEMENTS

PROJECT BENEFITS

- Improve channel conveyance from SR 776 to the Park Forest bridge
- Improve drainage in the northwest subbasin from Madder Lane to SR 776. Reduce flood levels between 9 inches and 1 foot.
- Restore natural conditions in the area from the confluence of the east and west branches to the Park Forest bridge
- The regional detention facility will provide detention and attenuation for all the area upstream of the facility. The extent of the floodplain upstream from the facility will remain the same. The system should be designed to maintain seasonal water levels in the existing wetlands
- Meet drainage levels of service in the urban Englewood area west of SR 776.
- Meet water quality levels of service in the basin, particularly in the urban Englewood area west of SR 776.

TABLE 7.2
PROPOSED PROJECTS
SOUTH RIVER ROAD IMPROVEMENTS

PROJECT ID	PROJECT DESCRIPTION	IMPLEM. TIME	COST (*) (1000$)
G-10	Maintain culvert across River Road	S	---
G-11	Replace about 300 linear feet of the existing 29"x45" culvert	S	20
G-12	Construct stormwater detention facility approximately 1,300 ft downstream from the existing WENG Radio culvert in the Angiers Creek basin	M	850

* Costs are in 1995 dollars and include engineering, permitting, and contingencies
S = Short-term
M = Medium term
L = Long-term

PROJECT BENEFITS

- Meet levels of service in the Gottfried Creek basin and relief flooding conditions in the Aingier Creek basin

ENGLEWOOD LATERAL IMPROVEMENTS

Proposed Alternatives

As described in Section 4, the flooding problems in the urban Englewood area are caused by a series of flow constraints that extend from the Artist Avenue crossing to the Florida Power easement located about 1,600 ft north of the Park Forest bridge. The following three alternatives were identified to improve the drainage conditions.

Alternative 1, Flood Relief. This alternative includes a number of basic projects necessary to meet the flood control LOS. It considers the replacements of the drainage structures across Artist Avenue, Elm Street, and the FP easements. In addition, it includes the regrading of a portion of channel in the vicinity of the confluence of the Englewood lateral and the main Gottfried Creek branch.

Alternative 2, Flood Relief and Erosion Protection. In addition to all the projects included in Alternative 1, this alternative considers a channel improvement project that would consist of providing erosion control in an area from about 700 feet upstream of the Englewood lateral confluence to the Park Forest bridge. Furthermore, the confluence of the creek tributaries downstream from the Taylor Ranch control weir would be regraded and stabilized to provide for a smooth channel transition and uniform grade embankment.

Alternative 3, Regional Water Quality Project for Flood and Water Quality Control. This alternative includes all the projects considered for Alternative 2. In addition, the channel improvement project includes the removal of the existing spoil embankments along the west bank of the creek between the Englewood lateral confluence and the Park Forest bridge. The work would also consist of regrading the banks to a 6:1 or lower slope ratio. Wetland areas that are currently isolated from the creek by the existing spoil embankments would be reintegrated into the system. A project included in this alternative would encompass the creation of stormwater wetland habitats parallel to the creek from the confluence of the two branches to a small depressional area located about 800 feet downstream. The main purpose of this project would be to provide water quality treatment opportunities for the runoff from the Englewood area.

Evaluation of Alternatives

Costs: Preliminary capital cost estimates are indicated below. Operation and maintenance (O&M) costs were not considered in the evaluation of alternatives because, in this case, it is likely that those costs would be proportional to the capital expenditures. Therefore, their estimation would not impact the evaluation results.

Alternative	Capital Cost (1,000$)
1	240
2	750
3	1,100

Environmental Impacts: Alternative 1 is directed strictly towards solving the flood control problems. Its implementation would not address the water quality LOS for the basin. The existing erosion and siltation problems would continue and there would be no opportunity for treating stormwater runoff generated upstream of the Englewood lateral confluence. The benefits resulting from the implementation of this alternative would be of short-term impact because, over time various of the improved facilities would revert to the existing conditions.

Alternative 2 would result in a better control of the erosion/siltation problems. This, in turn, would result in reduction of the TSS concentrations in the main branch of the creek. However, the water quality LOS issues would not be addressed as there would be no treatment opportunities for stormwater runoff generated in the developed areas upstream of the Englewood lateral confluence.

Alternative 3 best addresses the water quality LOS issues in the basin. Its implementation would result in providing stormwater treatment for the area of the creek drained by the Englewood lateral because the rehabilitated wetlands adjacent to the creek would become actual water quality control projects. These wetlands would be actual BMPs treating the urban runoff from upstream. In addition, the rehabilitation of the wetland areas would serve as a means to enhance the environment and create environmental preservation areas.

A project of this type would improve water quality downstream and would help retain fresh water flows to restore the saline water habitat impacted on the tidal portion of the creek. Projects associated with the rehabilitation effort could also include the development of stormwater wetlands along the creek. Projects would require the installation of diversion weirs that would force creek flows for treatment through the rehabilitated wetland systems. Those weirs would be designed so as to provide treatment for frequent storm flows, probably up to the one-year return period, without impacting flood stages for infrequent, flood-causing, storms. A conceptual design of these stormwater wetlands is provided in Figure 7.2.

Regulatory/Permitting Issues. If projects are limited to culvert replacement as well as clearing and snagging, such as in Alternative 1, a general Environmental Resource Permit (ERP) from SWFWMD for culverts replacement would be required No permits would be required for clearing and snagging. These activities may only require site visits with SWFWMD staff for coordination purposes.

CONCEPTUAL STORMWATER WETLAND

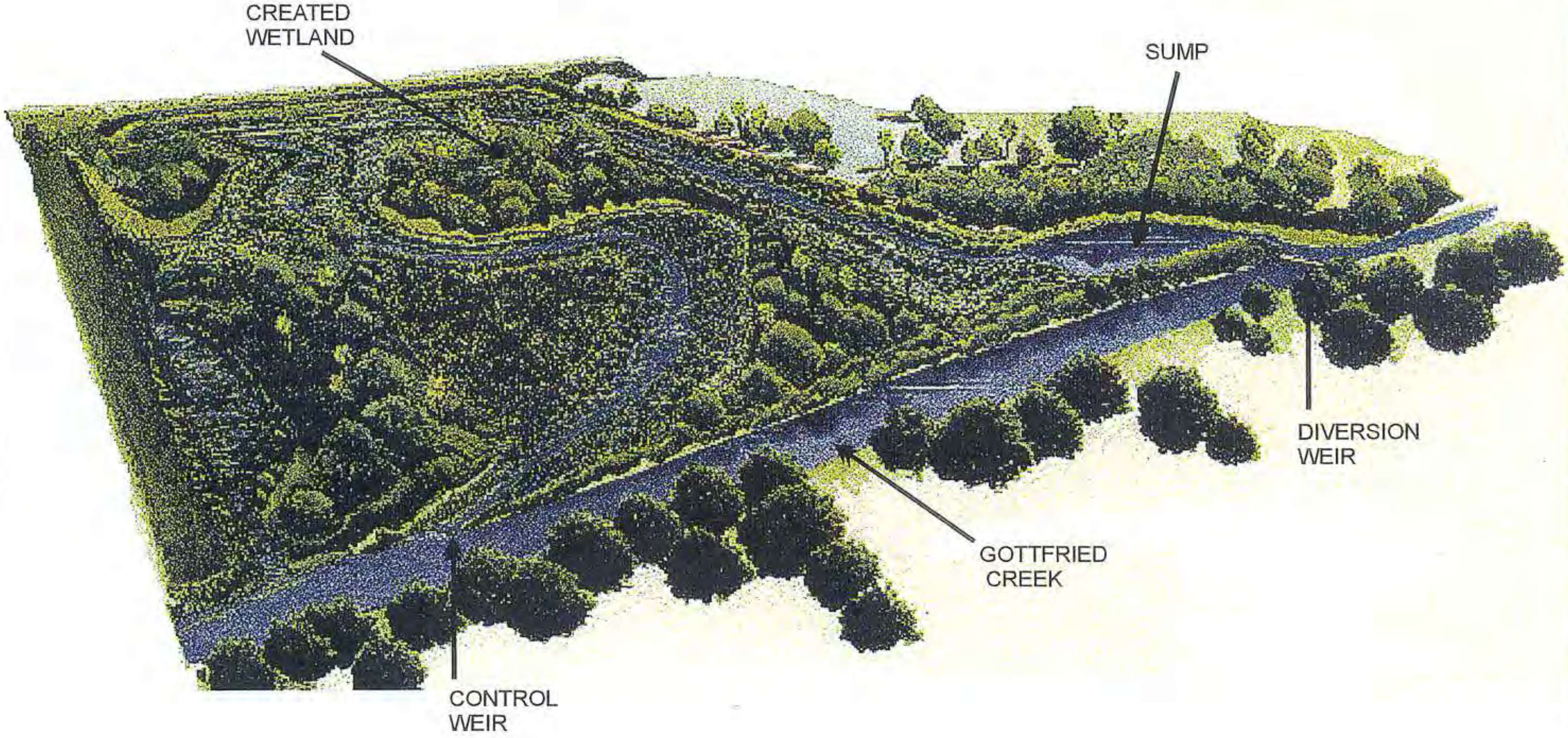


FIGURE 7.2

Alternative 2 would require a general ERP if the total disrupted area is less than an acre. Otherwise, an individual permit would be required. To obtain the permit and initiate the work, the County would have to acquire a drainage easement along the channel. This would not be a limitation because, according to current policies, the County would not initiate a project along a creek unless an easement is available. Temporary disruptions of existing vegetation along the creek would be relatively minor, except where bank regrading is necessary.

Alternative 3 would require an individual ERP. The County's Natural Resources Department would support this type of County effort. SWFWMD would also support the project because it would result in long-term environmental benefits. However, permitting requirements would be stringent as there would be concerns for short-term impacts such as turbidity problems during construction and temporary impacts to existing vegetation due to access requirements. The projects considered herein could be designed to provide for mitigation banking credits that could be applied to other County projects.

Community Acceptance. Alternative 1 would be attractive to the community because of its low cost. However, the cost per ESU for either option is not unrealistic. Environmental groups in the area are likely to support Alternatives 2 or 3.

Conclusion

Based on the previous discussion, it is believed that either Alternatives 2 or 3 would be more advantageous than Alternative 1 because of their long-term environmental benefits. In consideration of the added environmental benefits associated with Alternative 3, and because implementation costs are within reasonable financing expectations, we recommend the implementation of this alternative. In addition, this alternative addresses both the flood control and water quality LOS. The attached Table 7.1 include more detailed descriptions of the proposed projects associated in this alternative, provide estimates of costs and implementation times, and summarize general project benefits.

SOUTH RIVER ROAD IMPROVEMENTS

As discussed in Section 5, flooding conditions have been identified in the area upstream of the box culvert at South River Road that drains towards the Ainger Creek basin. In order to alleviate the flooding, the analysis conducted herein included the review of existing construction plans for the Pine Street Park and the WENG Radio ditch piping projects. SWFWMD one-foot contour aerial maps and field surveys were used to analyze drainage conditions and to develop alternative plans to alleviate the flooding problems.

The area draining towards South River Road encompasses approximately 160 acres. Stormwater runoff drains in a southwest direction, via sheet flow and a series of natural and man-made ditches, and is intercepted by a ditch that runs along the west side of South River Road. Peak flow amounts to approximately 71 cfs during a 100-year 24 hr storm event. Approximately 35 cfs are intercepted by an existing 3' x 2' Box Culvert located under South River Road and discharges to the Ainger Creek Basin via a series of manmade ditches and culverts. The remaining 36 cfs flow along the west side of South River Road and ultimately outfalls to Gottfried Creek.

Alternative 1, Use of Pine Street Park Facilities. Sarasota County is in the process of constructing the Pine Street Park. The County has already completed phase I of the project which included two baseball fields along with parking areas and associated stormwater management facilities. Phase I along, with a portion of phase II, which includes two soccer fields, four baseball fields and associated parking and stormwater management facilities, drain towards South River Road.

Alternative 1 would require that the County modify the design of the stormwater management facilities within the Pine Street Park project to retain the runoff from the 100-year storm event from 42.5 acres within the existing and proposed ponds. Existing and proposed developments within the Pine Street Park project, total approximately 30 acres. An additional 12.5 acres could be directed into the Pine Street Park stormwater management facilities resulting in the retention of runoff from approximately 42.5 acres (30.0 + 12.5 acres) or 26 percent (42.5/160 x 100) of the basin area. Therefore, reducing the total flow to the ditch along South River Road by 26 percent from 71 cfs to 53 cfs.

This alternative assumes that the flow to Gottfried Creek is held constant. The 53 cfs entering the ditch would be divided such that 36 cfs flow to Gottfried Creek and 18 cfs to Ainger Creek. According to the computer output data, 8.64" of runoff is generated from a 100-year storm event under future conditions (worse case). Therefore, the retention of the runoff from 42.5 acres will require an additional 30.6 ac-ft (8.64"/12"/ft x 42.5 acres = 30.6 ac-ft) of storage. Normal water levels (NWL) in the vicinity of the park are at elevation 10.80 ft (refer to Pine Street Park construction plans). High water levels (HWL) are at elevation 11.88 feet. This results in the need for an additional 30.6 acre retention pond with one foot of storage. The lack of land availability at the park for implementing this option is a major consideration.

Alternative 2, Ditch Along South River Road. Alternative 2 would require that flow from part of the area currently contributing to the WENG Radio Ditch be diverted to the existing ditch that runs along South River Road. It has been estimated that 18 of the 71 cfs peak flow would continue flowing to Ainger Creek, whereas 53 cfs would be diverted towards Gottfried Creek. This alternative would require an enlargement of the existing ditch and culverts along River Road from the Pine Street Park entrance to Gottfried Creek. Design should consider that, as part of the Pine Street and Dearborn Street improvements project, a 30-inch RCP is proposed at a location upstream of the intersection of Pine Street and South River Road. To handle the additional flow, that culvert would have to be increased to a 54-inch RCP. An outfall must also be created to handle the additional flow to Gottfried Creek. Assuming the 30" RCP will remain, an additional 30' RCP will be required.

The tailwater at the downstream end of the proposed 30" RCP is estimated at elevation 9.9'; corresponding to the crown of the 30" RCP. Existing South River Road centerline elevation is at 12.4 feet. Therefore, the maximum head allowed at that culvert is 2.5 feet (12.4 - 9.9 = 2.5). Ten culverts exist in series upstream/of the proposed 30" RCP. The average length per culvert is 85 linear feet. The average/proposed hydraulic head per pipe to accommodate 53 cfs is 0.25 feet. The culvert size needed to accommodate the flow of 53 cfs assuming a length of 85 ft at a hydraulic head of 0. 25 feet is 54 inches.

The open ditch to be expanded is proposed as a trapezoidal channel. Average channel slope between the existing Box Culvert at South River Road is .0001 (0.3ft/3,6001f). By using Manning's Nomographs for Open Channel Flow the hydraulic radius was determined to be 1.4 feet. A trapezoidal channel with a bottom width of 16 feet and side slopes of 4:1 (using an n= 0.03) will carry a maximum water flow rate of approximately 57 cfs.

Alternative 3, Expansion of Culvert and Creation of Detention Facility. This alternative considered the expansion of the culvert across South River Road and the construction of a stormwater detention facility located east, and approximately 1,300 linear feet downstream, of South River Road in the Ainger Creek Basin. Existing seasonal high water (SHW) levels in the vicinity of the stormwater detention facility is at elevation 7.0 feet. The topography ranges between elevations 9.2 and 9.8 feet. As in Alternative 1, the construction of a detention facility to adequately detain 30.6 acre-ft of storage, with depth storage of approximately two feet (9-2 - 7.0 = 2.2 feet) will result in a 15.3 acre (30.6 acre-ft/2 ft = 15.3 acres) detention facility. A potential site for this facility was identified. The site is located on the west side of the WENG Radio ditch, approximately 2000 ft south of the ditch's upstream end.

Evaluation of Alternatives

Costs: Preliminary capital cost estimates shown in Appendix C indicate the following:

Alternative	Capital Cost (1,000$)
1	1,020
2	750
3	860

Similarly to the previous evaluation, O&M costs were not considered in the evaluation of these alternatives because it is likely that those costs would be proportional to the capital expenditures.

Environmental Impacts: Alternative 1 would result in the largest environmental impacts because the expansion of Pine Street Park detention facilities are likely to impact existing sensitive environmental areas. Alternative 2 would not result in any significant environmental impact during construction. However, its implementation would result in a larger amount of untreated runoff discharged into Gottfried Creek. Alternative 3 would provide opportunities for runoff pollution control and possible opportunities to develop areas of significant environmental value, as part of the proposed detention facility.

Regulatory/Permitting Issues. Consistent with the potential environmental impacts, Alternative 1 would require substantial modifications of the construction permits for the park facilities. In addition, the redesign and permitting issues would alter schedules and delay construction.

Alternative 2 would probably require general ERP permits for the reconstruction of the ditch along South River Road. However, significant redesign work would be required for the Pine Street Dearborn Street improvement project. The implementation of this alternative would probably result in project construction delays.

Alternative 3 would probably be supported by the regulatory/permitting agencies as it would provide positive environmental benefits in terms of water quality treatment and flood control.

Community Acceptance. All options would probably be acceptable to the community. However, there would be less community support for those alternatives that result in construction delays of projects that are underway.

Conclusion

Based on the previous discussion, it is recommended that Alternative 3 be implemented. The no action alternative is not applicable because it would result in the continued violation of the County's LOS.

REGIONAL STORMWATER MANAGEMENT FACILITY

Description

Regional Stormwater Management Facilities (RSMF's) are stormwater detention/retention ponds designed to provide attenuation and/or treatment of surface discharge on a regional basis or for an entire basin. A RSMF may also be utilized for aquifer recharge, storage for water supply, wetland creation and mitigation banking and for mitigation of floodplain impacts. Future developments upstream would purchase the right to discharge a volume of runoff depending on specific and individual characteristics.

Benefits associated with the development of RSMF's includes

- **Solutions to Regional Problems.** Optimum results are achieved when drainage planning and design are integrated at the regional level. This approach provides local governments with adequate control of the physical components of the stormwater management facility within a basin. RSMF's also allow for better coordination early in the planning stages.

- **Solutions to Problems Associated With Volume and Peak Flow of Stormwater Runoff.** Urbanization disrupts the natural equilibrium of streams. It tends to reduce the natural flood storage capabilities and to increase both the volume of runoff and the runoff travel time. By constructing RSMF's, adequate provisions can be made to mitigate the loss of storage capacity and to reduce peak flows to the receiving waterbody.

- **Multipurpose Uses.** In addition to solving typical problems associated with stormwater runoff, RSMF's can provide drainage management strategies that meet a number of objectives, including water quality enhancement, groundwater recharge, wildlife habitat and wetland creation, control of erosion and sediment deposition, and creation of open space for recreational purposes.

- **Enhancement of the Natural Features and Drainageways. The design of urban stormwater facilities generally require that a significant amount of land be devoted to the construction of stormwater facilities. In many cases, this results in the elimination of natural features and the creation of unsightly structures designed to meet minimum regulatory requirements. Natural features can be planned, preserved and enhanced and made part of the design of RSMF's. Good designs that incorporate the use of natural features will maximize the economic and environmental benefits, particularly in combination with open space and recreational uses. These natural features include drainageways, depressions, wetlands, floodplains, permeable soils, and vegetation. These features provide natural filtration, help control the velocity of runoff, extend the time of concentration, filter sediments and other pollutants, and recycle nutrients.**

- **Reduced Maintenance Costs.** Rather than multiple associations and developments being responsible for the maintenance of several stormwater facilities within a basin, it is simpler and more cost effective to establish scheduled maintenance of a single regional facility. Failure to provide proper maintenance reduces both the hydraulic capacity and pollutant removal efficiency of the system.

- **Maximum Utilization of Developable Land.** Through RSMFs, developers would be able to maximize the utilization of the proposed development for the purpose intended by minimizing the land normally set aside for the construction of stormwater management facilities (an average of 20% of total land area is utilized for detention/retention ponds).

Proposed Gottfried Creek RSMF

A RSMF is being proposed for implementation in the Gottfried Creek basin. It would be located north of the Englewood lateral confluence, in the Taylor Ranch area. The facility would cover an area of approximately 60 acres and it's control structure would be an about 1,200-foot berm constructed in the area the Berry Ranch Citrus Grove weir is currently located. The RSMF would be designed with flow-through culverts such that it would be inundated during large storms, while existing hydroperiods in the wetlands upstream would be maintained.

Other than the general advantages of a RSMF, this facility would include:

- Most of the land within the RSMF is within environmental areas not subject to development. Therefore, the developable land gains would be significant.

- Earthwork necessary to create the facility would be minimal compared to the same type of work if individual detention ponds are created within small pocket developments in the watershed. Therefore, the general construction cost savings would be significant.

- Computer modeling results indicate that the development of this facility, as proposed, would not result in flooding impacts downstream.

A disadvantage associated with this facility is that the additional future flow, not attenuated, upstream from the facility might increase the width of the 100-year floodplain in locations close to the headwaters of the watershed. The computer model developed for this study did not include the creek reaches at those locations. Therefore, more detailed studies would be necessary.

In conclusion, we believe that it would be to the County's and the current land owner's benefit if this RSMF is developed. Furthermore, an easement could granted to the County for the construction of this facility. The County would have to guarantee the land owner that flood control within the area to be served by this facility would not be required for future development. Furthermore, the feasibility study should consider that the design does not create conflicts with the permitted Taylor Ranch Citrus Grove project.

OTHER PROPOSED IMPROVEMENTS

To implement the proposed improvements, as well as to provide adequate stormwater system maintenance, Sarasota County must acquire the necessary easements and rights-of-way. Section 8 of this report provides an evaluation of the current maintenance program in the County, makes operational recommendations, and proposes locations for easement acquisitions.

FINANCING

Short-Term and Medium-Term Proposed Projects

The Sarasota County Stormwater Environmental Utility finances the implementation of the County's stormwater projects through stormwater utility assessments. Capital improvement projects are financed based on costs assessed by "benefit area". A benefit area is generally thought of as the extent of a drainage basin. Utility rates are established based on a Equivalent Stormwater Units (ESU). An ESU represents the stormwater contribution to the system by a typical user in the County.

As shown in Table 7.1, the cost associated with the construction of the short- and medium-term improvements amounts to about $3.2 million. County records indicate that there a total of 5740 ESUs in the Gottfried Creek Basin. Assuming a 10-year implementation period for this projects at an eight percent discount rate, the annual contribution per ESU would be approximately $60.

Future Regional Stormwater Management Facility

The responsibility for the development of RSMF's rests primarily at the local government level and is an inseparable part of urban infrastructure planning and design. However, the problems with RSMF's involve cash flow and construction timing. The construction fee generated from a single property or development is rarely large enough to fund the construction of a regional facility. Therefore, either multiple developments must occur simultaneously or, more realistically, the project must be initially funded from alternative sources.

There are several alternatives for financing the construction of RSMF's, and they include

•**Special Assessment:** A special assessment could be levied on property owners that may benefit from the construction of the RSMF. The benefit that accrues to each property by virtue of the project provides the foundation for levying a special assessment. The amounts assessed must be proportional to and not more than the benefits received, and must not exceed the cost of the project.

•**Bonds:** RSMF's construction may be financed by the issuance of bonds. There are two basic types of bonds, general obligation and revenue bonds.

•**Development/Impact Fees:** A unit fee based upon acreage involved for all developments in the basin. The amount of the fee will depend on the cost of the facilities, including right-of-way required in the basin, and the fee will vary from basin to basin. The basin development fee should be charged only for facilities required because of development, and not to finance improvements required to solve previously existing problems.

•**Fee in Lieu of On-Site Detention/Retention:** This fee provides the option that affords the opportunity to construct on -site detention/retention facilities in accordance with established design criteria, or to pay a fee into a fund dedicated to the construction of regional detention facilities serving multiple properties.

•**Service Charges:** A fee related to the service provided. The principle is that each property owner pays a fee for the service of handling the drainage originating from that property. The fee will pay for the construction of a RSMF.

•**General Tax Revenues:** Even though this financing method is best suited for operation and maintenance activities, basic tax revenues could be used for the planning, design and right-of-way acquisition of a RSMF. The cost for construction could be generated from land owners proposing to develop properties that discharge to the RSMF.

•**Dedicated Ad Valorem Taxes:** Taxes could assessed to pay for the construction of RSMF's. In Hillsborough County, for example, citizens voted to create an ELAPP program for the acquisition and preservation of environmentally sensitive land. A dedicated ad valorem tax is associated with the value of a property rather than the property's contribution of stormwater runoff.

The Construction of the Gottfried Creek RSMF would require an initial investment to be paid later by those benefiting from its operation. As the RSMF would not benefit existing developments, financing through the ESU may not be feasible. We believe that initially the facility should be financed by dedicated ad valorem taxes. As indicated previously, because of the added land value, we believe that it would be to the County's and the current land owner's benefit if the land easement is granted to the County for the construction of this facility. The investment would be recovered in the future by any of the other finance alternatives listed previously. Mitigation banking could be an important source of revenue.

IMPLEMENTATION IMPACTS OF THE RECOMMENDED PROJECTS

The impacts associated with the implementation of the recommended projects would result in meeting the established LOS for both flood protection and water quality. In terms of flood protection, construction of the proposed projects would lower the maximum flood elevations in the Englewood lateral by approximately two feet for the 100-year storm conditions. This is illustrated in the attached Table 7.3 and the hydraulic grade line plots depicted in Figure 7.3. The attached Plate 1 shows the extent of the 100-year riverine floodplain for both existing and proposed conditions.

The water quality impact of the proposed projects is difficult to quantify. However, runoff pollution control opportunities provided by the proposed regional water quality facility (project G-7) would result in substantial improvements in Gottfried Creek.

Future
Flood
Profiles

FIGURE 7.3a
EXISTING AND PROPOSED 100-YEAR STORM: HYDRAULIC GRADE LINE PLOTS
GOTTFRIED CREEK

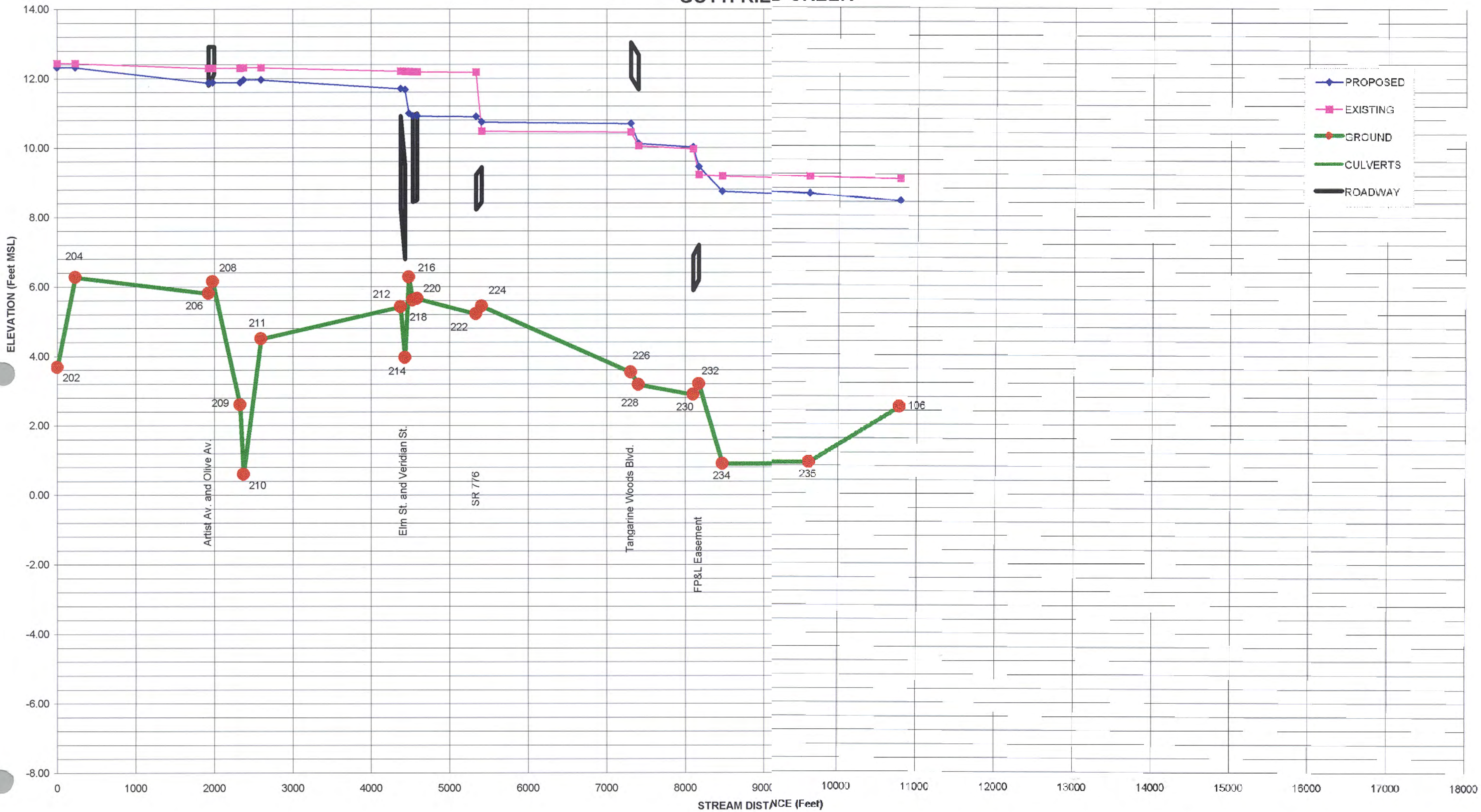


FIG. 7.3b

EXISTING AND PROPOSED 100-YEAR STORM: HYDRAULIC GRADE LINE PLOTS

GOTTFRIED CREEK

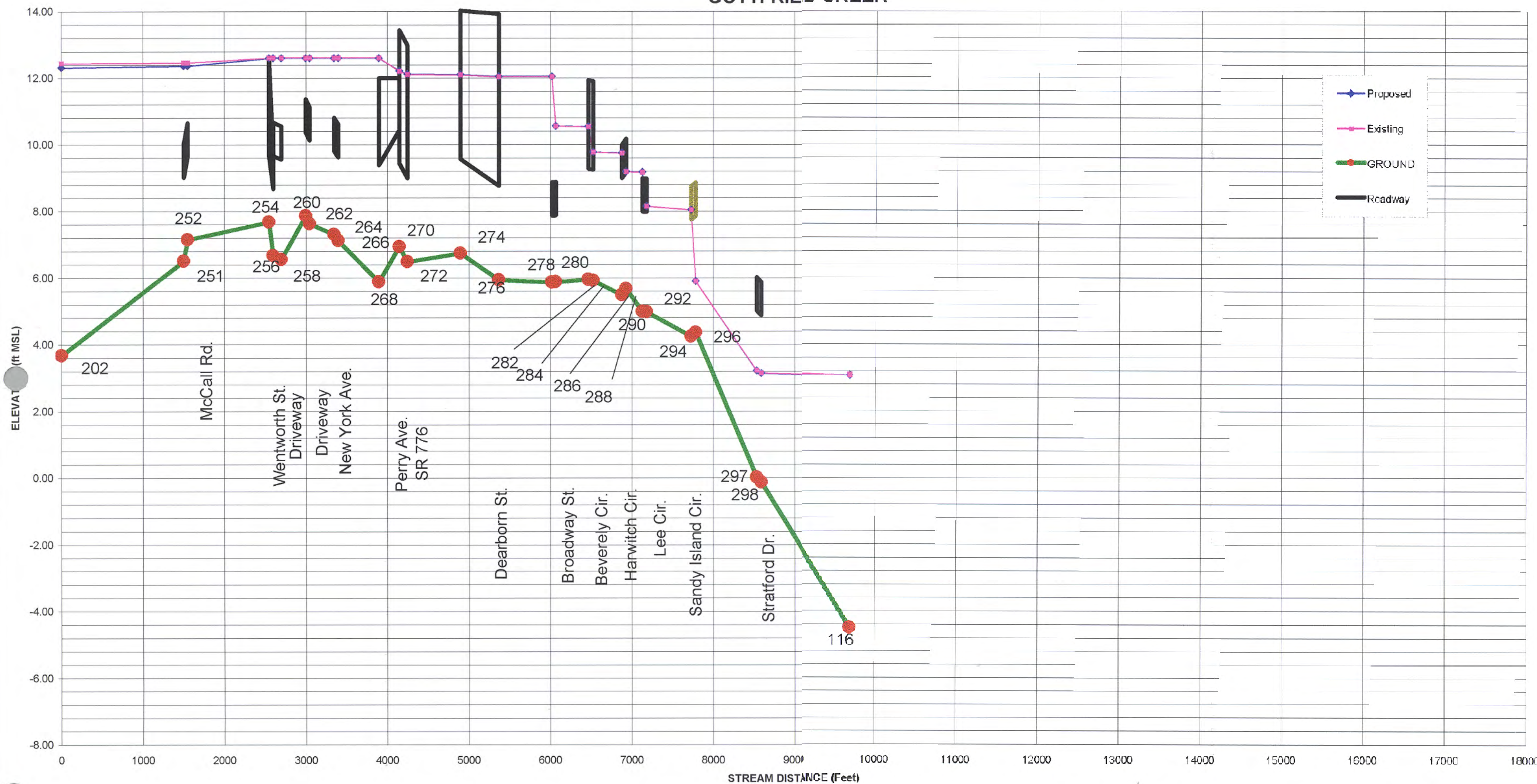


FIGURE 7.3c
EXISTING AND PROPOSED 100-YEAR STORM: HYDRAULIC GRADE LINE PLOTS
GOTTFRIED CREEK

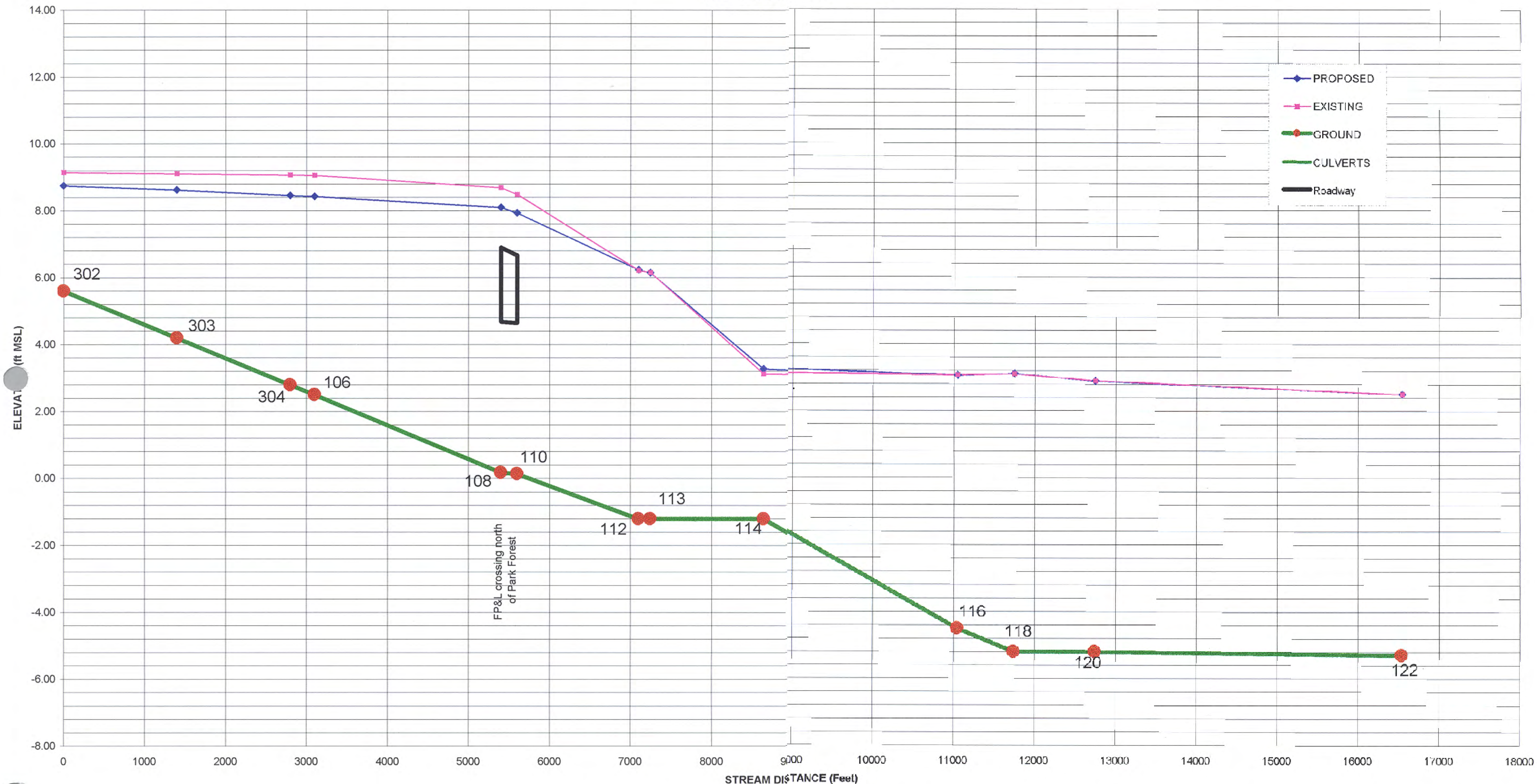
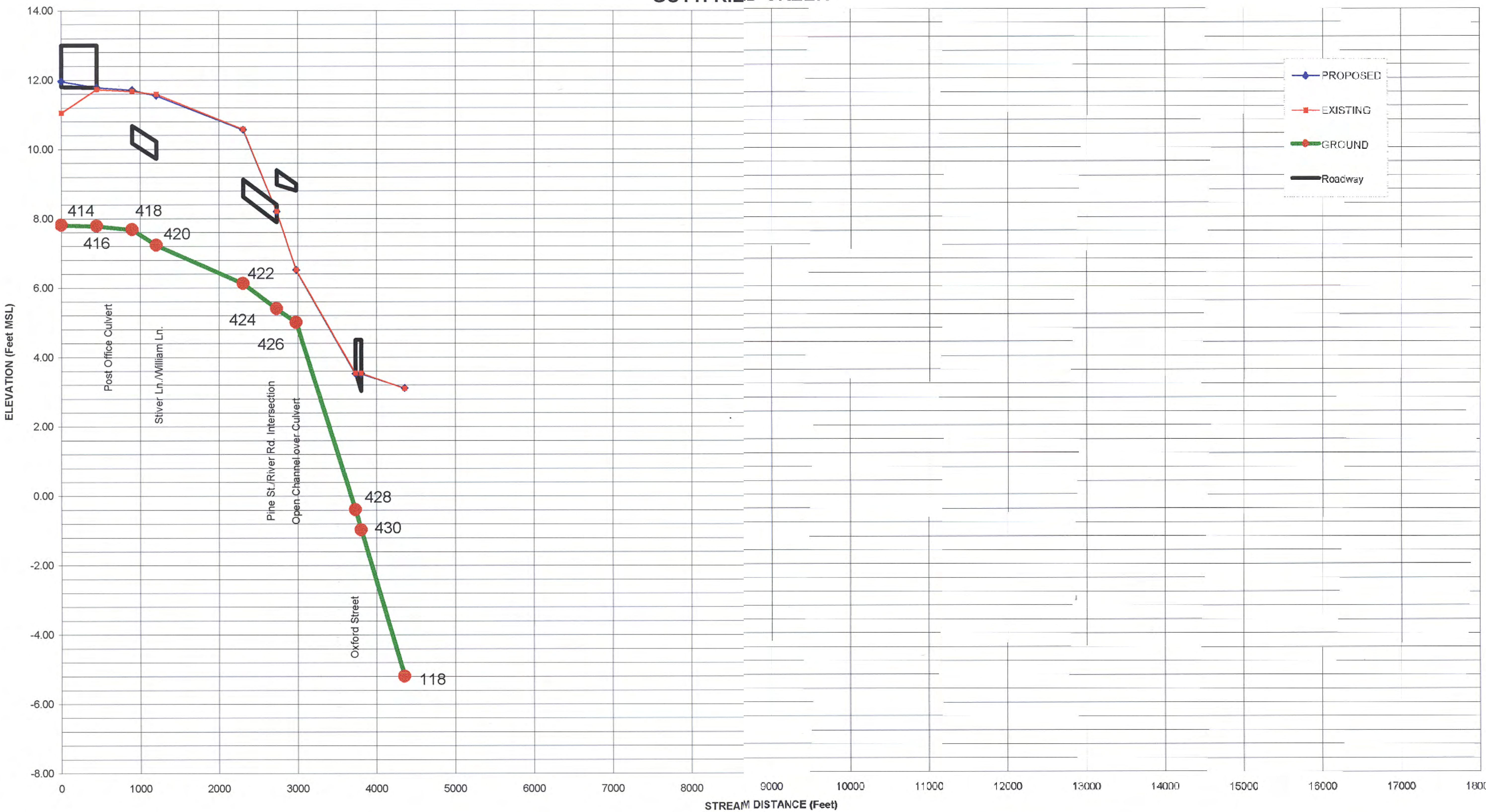


FIGURE 7.3d
EXISTING AND PROPOSED 100-YEAR STORM: HYDRAULIC GRADE LINE PLOTS
GOTTFRIED CREEK



SECTION 8
OPERATION AND MAINTENANCE ACTIVITIES

SECTION 8
OPERATION AND MAINTENANCE ACTIVITIES

GENERAL

During the public meetings conducted during the development of this plan, it became apparent that the public perception is that many of the flooding problems in the Gottfried Creek basin are caused by lack of adequate maintenance. In this study, several in-person and telephone meetings were held with Sarasota County's Transportation Department maintenance personnel to learn about their current maintenance procedures. During that process, it became apparent that, in the past, Sarasota County conducted maintenance on a re-active mode in response to either complaints from the citizens or as-needed based on visual inspections by the maintenance staff. Furthermore, the County employed a subjective method for assigning stormwater management O&M activities. Some facilities including stormwater conveyance systems such as ditches and canals were maintained less frequently while others received routine maintenance.

However, over the last two years, the County has been in the process of implementing a more adequate stormwater maintenance program based on the recognition that it is cost efficient to have a stormwater facility well-maintained and ready to convey the runoff from the next storm with minimal damage to surrounding property and the environment. It has been recognized that a stormwater management facility must be monitored, inspected and regularly maintained to insure effective operation and long life of existing structures. In addition, it is Sarasota County's objective to operate the system in such a way that it will sustain the aesthetic values of the community. Poor operation and inadequate maintenance not only reduce the usefulness of facilities but can cause the facility to become an eyesore, nuisance, health hazard, or failure - all unacceptable to the public. For that purpose, a major reorganization of the Maintenance Department has taken place and computerized maintenance support systems are being developed.

CURRENT O&M PRACTICES

The Transportation Department maintenance staff includes about 110 people. This group is in charge of maintaining all roads and stormwater drainage courses in the entire County. Occasionally prison inmates are used to maintain swales and some ditches, but the County is not certain about their future availability. In addition, outside contractors have been used to supplement the County personnel. This practice is expected to continue for the cleaning of Class A canals under the Canal Cleaning Frequency System, which is currently under development and is discussed later in this Section.

In general, the Sarasota County stormwater O&M program presently includes the following activities:

- Clearing and regrading has been done once every 3 to 4 years. Clearing is done either by machines or manually by hand depending on the size of the ditch, availability of maintenance easement, and amount of cleaning required. When completed, the computerized maintenance support system will allow the County to schedule clearing activities based on conditions specific to each facility such as flood relief and adjacent land uses.

- Where access is available, each ditch is mowed approximately 3 to 4 times per year.

- Culverts are cleaned only after they are more than 1/3 silted. There are special permitting considerations involved due to turbidity that may be caused during silt removal.

- Lake maintenance includes spraying the lake with herbicides 4 times per year.

- Strictly tidal, saline water portions of any drainage course are not maintained.

- Routine mowing of all roadside ditches is planned to occur at least once every two months but in reality that has not always been possible.

In terms of the Gottfried Creek basin, the Maintenance Department reported that:

- No maintenance is carried out in the strictly tidal, saline portions of the canals in the Gottfried Creek basin which include all of the main channel below Dearborn Street Bridge.

- Frequent flooding in the Gottfried Creek basin seems to occur west of SR 776 along the Englewood lateral. However, due to very limited access, little maintenance is carried out in this area except for occasional manual cleaning of some ditches and canals with the help of prison inmates.

- Retention ponds on the School Board and Library properties in the Gottfried Creek basin do not seem to operate efficiently.

- Countywide, street cleaning of residential areas is conducted only on streets with curb and gutter sections. This basically indicates that no street cleaning of this type is conducted in the Gottfried Creek basin.

MAINTENANCE PROBLEMS AND RECOMMENDED SOLUTIONS

General

How and when O&M tasks will be performed are clearly the most important issues associated with cost effective maintenance programs. It is often the case that stormwater management facilities receive attention only when serious problems become evident, or when the local agency begins to notice that complaints are compounding. It is usually easy to defer maintenance activities because those facilities function intermittently and seldom at full capacity. A point that has often been neglected is that O&M requirements should be addressed during the design and construction phase of a project and not after project completion. This is particularly important when addressing access requirements, costs, and the design of low maintenance stormwater management facilities. It is said that over a twenty year interval maintenance cost will equal or exceed the initial construction cost.

O&M costs are difficult to quantify because they vary with storm frequency, design features, location, type of facility, accessibility, type of flow device, etc. In addition, maintenance tasks include both low cost routine tasks and more expensive non-routine tasks, such as rehabilitation or sediment removal.

In general, O&M of stormwater management facilities should include the following goals:

- Inspect facilities regularly to monitor their effectiveness and need for repair.
- Maintain the aesthetic value of the drainage facilities.
- Participate in design and construction review meetings to insure that maintenance activities are being planned, designed and constructed properly.
- Document effectively the maintenance activities, crew and equipment productivity, and analyze the repair costs and longevity.
- Have drainage systems repaired, cleaned, and ready before the next rainy season arrives.

The following describes recommended maintenance considerations:

Maintenance Easements

In Sarasota County, a large number of canals are not maintained by the County due to the lack of maintenance easements. Our research revealed that practically no right-of-way or maintenance easement exists along County Canal no. 38-461 (Englewood lateral) east of SR 776. Maintenance access in these areas has been subject to the land owners' wishes. In addition, County half section maps do not seem to show several private ponds along this canal, and only one pond at the northeast intersection of Viridian Street and Elm Street has recently been turned over to the County for stormwater related maintenance.

East of SR 776, right-of-way or maintenance easements appear to exist only inside the boundaries of the Tangerine Woods subdivision, and some along the north side of Dearborn Street west of Sandy's Island Street. The rest of the canals included in the study area do not appear to have easy legal access for maintenance purposes.

It is recommended that the County implement a program to acquire the necessary easements to properly maintain and operate stormwater management facilities. This is especially important in flood sensitive areas were the potential for flooding is high. Easements are necessary along the entire length of the Englewood lateral and along the main branch of the creek from the confluence of the Englewood lateral to the Charlotte County line. Furthermore, it is recommended that the County acquires an easement, and if possible the right -of-way along the branch that originates northwest of South River Road. This area would serve as an environmental conservation and habitat restoration corridor for future development. The extent of the recommended easement acquisition program is shown on the attached Plate 3.

Mowing and Clearing

The mowing of grass and clearing of channels is the main type of maintenance work performed by maintenance crews. Usually, this activity constitutes the largest routine maintenance expense. Mowing should periodically be performed to side slopes, embankments, emergency spillways, and other grassed areas of stormwater and conveyance facilities to prohibit wood growth and control weeds. Where possible, the use of water-tolerant, pest tolerant, and slow growing grasses is recommended. However, to preserve/restore the functional value of the original vegetation, planting of wetland species would be more appropriate. The creation of longitudinal wetlands/sloughs would provide opportunities for water quality control.

Erosion Control

Erosion and local scour can result in channel degradation and the undermining of the structural stability of the embankments. In addition, it results in the loss of channel bed materials. Excessive suspended sediment in streams may result in undesirable environmental impacts, aesthetic problems, and high maintenance cost. Practice has shown that it is impossible to fully control erosion at bends in channels, under bridges, along embankments and spillways. However, the use of proper control measures in areas of high velocities and poor soil stability, erosion will normally not be a problem.

Erosion protection should be addressed during the design phase of each project recommended in this study. Several varieties of natural and man-made materials are available for erosion control. Sideslopes designed on a 3:1 minimum slope and planted with native vegetation would provide adequate protection. For steeper sideslopes, the use of erosion protection aids such as mats and plastic grids would help stabilize the banks' soils. Other materials that provide armor protection (riprap, gabions, soil-cement, etc.), as well as retard walls to reduce velocities and rigid and flexible channel linings should also be considered. This option should be considered for the entire length of the Englewood lateral, as well as the creek's main channel.

Mosquito and Plant Control

Nuisance control is one of the most frequent maintenance items demanded by local residents. Odors, mosquitoes, weeds, and growth of undesirable vegetation are all potential problems in stormwater facilities. Sarasota County has created a group in the maintenance section to deal exclusively with this problem. Plant control is conducted such that channels are maintained at 90-day intervals. Spraying is done using chemicals such as Rodeo. Due to access limitations and relatively good conditions in the Gottfried Creek basin channels, no maintenance of this type is conducted in the study area. These practices should be initiated once the easements are acquired. To the extent possible, plant control should include removal of sprayed vegetation.

Debris and Litter Removal

As part of periodic mowing operations, debris and litter should be removed from stormwater detention facilities. Particular attention should be paid to floatable debris that can eventually clog the control structure or riser. It is usually more efficient to control these materials before they enter the stormwater system. Although debris and litter does not appear to be a serious problem in the study area at this time. This is due to the currently large undeveloped conditions in the basin. The problem could become serious in the future if adequate steps are not taken now. One of the approaches the County may consider is increasing the street cleaning frequency as well as the extent of cleaning coverage. Furthermore, the establishment of street cleaning schedules should be based on an analysis of rainfall patterns and accumulation periods.

Pond Sediment Removal

If properly designed, wet ponds will eventually accumulate enough sediment to significantly reduce storage capacity which can reduce the pollutant removal performance of the pond. A sediment clean-out cycle of ten to twenty years is recommended. The costs associated with sediment removal can be staggering and can range between $6.00 to $23.00/cubic yard due to size of pond, accessibility, the proximity of the disposal site and the method used to remove and transport the sediments.

Similarly, the various inlet/outlet and riser works in a pond will deteriorate and must be repaired or replaced. Structures should be inspected at least once annually. Porous pavement and exfiltration trenches may require more frequent inspections.

Sarasota County does not presently have a pond maintenance program in place to address these issues. Furthermore, the associated costs are not being considered at the planning stages. It is recommended that a pond assessment study be conducted, not only in the Gottfried Creek basin but throughout the County. Subsequently, if necessary a pond maintenance program should be developed.

Resetting of Culverts

One of the problems long suspected, and now confirmed through field surveys, is that a vast number of existing culverts in the study area have been set against the normal direction of flow. Examples of culverts showing this condition are those across Artist Avenue and Tangerine Woods Boulevard. While some of these culverts may be on private land, they all must be identified and ultimately adjusted to proper grade and direction. Some of this work is recommended as specific projects in the study. Prior to resetting of the culverts, a capacity analysis should be performed and the pipes resized to handle upstream flow in accordance with County requirements.

Data Collection and Management

Before a system can be maintained, it must be defined. Therefore, the first step in a maintenance program must be the development of a record system that not only describes what currently exists but is also easily updated to reflect new information that becomes available, and/or changes made by field personnel. To enable the County to undertake an efficient routine maintenance program, it is recommended that a data base be developed containing, information (fields) to identify, classify and track O&M activities. The example shown in Table 8.1 shows the information that could be included in the data base. Ideally, such a data base can easily be incorporated in an appropriate GIS interface for use and convenience. As indicated previously, at this time the County is in the process of developing a computerized O&M system. The stormwater structures database developed as part of this study could also be used as the basis for that work. It should be mentioned that not all of the above data may be readily available at the present time but may be incorporated and periodically updated by the Department as data become available.

RECOMMENDED MAINTENANCE SCHEDULES

In an attempt to develop an objective program that provides a comprehensive approach to stormwater maintenance, the County has developed, within the constraints of its limited resources, the Canal Cleaning Frequency System (a copy is attached as Appendix D). This system provides for the maintenance of all ditches, large or small, at least once every three years and more frequently depending on the conditions described below.

> Each canal is evaluated for three different categories; predominant land use along the canal, type of recurrent flooding along the canal, and the canal type. Points on a scale of 1 to 3 can be assigned to each canal or ditch for each of the above listed evaluation categories. For example, a main canal with a history of structural (first floor) flooding, in a predominantly high residential land use area can be assigned a total of 9 points (3 points in each category). Any canal scoring greater than 7 points will be classified as class A canal and cleaned every year. A canal scoring 5 to 7 points will be considered a Class B canal and cleaned once every two years, and a canal scoring less than 5 points will be a Class C canal with a cleaning frequency of once every three years.

Using the format developed by the County, Parsons Engineering-Science scored various of the conveyance systems within the study area. According to our scoring, as depicted in Table 8.2, all canals in the Gottfried Creek basin identified for the purpose of this study have a classification of either A or B.

TABLE 8.1

Database Fields for Channel Reaches:

Basin Identification	: 150304
Name or Number	: Gottfried Creek branch # 300
Description	: Reach # 3020
Predominant Location	: S19, T40S, R20E
Maintenance Classification	: B
Maintenance Frequency	: Once every 2 years
Upstream Elevation	: -3.0
Downstream Elevation	: -4.0
Direction of Flow	: Southwesterly
Length	: 2,800 feet
Average Slope	: 0.0007 %
Average Bottom Width	: 32 feet
Average Side Slope	: 8:1 (Hor:Vert)
Date Last Cleaned	: 08/01/94
Bench Mark Reference	: TBM # 91 (Gottfried Creek Master Plan)

Database fields for structures including lakes and ponds

Basin Identification	: 150105
Name or Number	: Dearborn Street Bridge
Description	: A 3-span concrete bridge
Predominant Location	: T40S, R20E, S30
Maintenance Classification	:By Highway Department
Maintenance Frequency	: Every Year
Upstream Elevation	: -5.0
Downstream Elevation	: -5.2
Direction of Flow	: Southerly
Length	: 49 feet
Size	: 76' x 12', Irregular
Culvert Material	: Concrete
Type of Pavement	:Above: Concrete Roadway
Average Side Slope	: 1:1
Date Last Cleaned	: 08/01/94
Bench Mark Reference	: TBM # 9 (Gottfried Creek Master Plan)

TABLE 8.2
CANAL CLEANING FREQUENCY SYSTEM SCORING SHEET

Canal Description	Land Use Residential High Density (RHD) = 3 Residential Low Density (RLD) = 2 Industrial (IND) = 1		Frequent Flooding Structural = 3 Yard = 2 Street or None = 1		Facility Demand Arterial 1 (Main) = 3 Arterial 2 = 2 Feeder = 1		Total Points	Class	Cleaning Frequency
	Type	Points	Type	Points	Type	Points			
* Approximately 8000' of Gottfried Creek main channel from south County line to 0.5 miles north above Dearborn St. bridge (Canal no. 38-462)	RLD	2	Street	1	Arterial 1	3	6	B	Once every 2 Years
Approximately 5,000' of Gottfried Creek Main Channel from 0.5 mile above Dearborn St. Bridge to Confluence witH Englewood lateral (Canal no. 38-464)	RLD	2	Street	1	Arterial 2	2	5	B	Once every 2 Years
Englewood lateral (Canal no. 38-461)	RHD	3	Street	3	Arterial 2	2	8	A	Once each Year
Gottfried Creek Branch 300 above confluence with Englewood lateral to River Road	RLD	2	Street	1	Feeder	1	4	C	Once every 3 Years
Gottfried Creek Branch 400 along River Road (Canal no. 38-461)	IND	1	Street	1	Arterial 2	2	4	C	Once every 3 Years

* Note: Strictly tidal, saline water portions of the creek are not maintained.

Maintenance tasks include both low cost routine tasks and more expensive non-routine tasks, such as rehabilitation or sediment removal. Staff from the O&M Department should be involved in all aspects of the drainage system, from planning and design through construction. Also, it is important to recognize that maintenance includes both scheduled and unscheduled tasks, and funds have to be provided for both.