CLOWER CREEK
STORMWATER STUDY

Sarasota County
Board of County Commissioners

March, 1992

ST 90223-3E

BRILEY, WILD
AND ASSOCIATES

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INTRODUCTION

1.10 General

Clower Creek is located south of the City of Sarasota just north of the Town of Vamo in western Sarasota County. The location of the Creek is shown on Figure 1-1. Clower Creek is an irregular shaped channel almost one mile long which drains an approximately one-half square mile urbanized basin into Little Sarasota Bay.

Development in the Clower Creek Basin has raised concerns of an increased quantity of flow and a resultant increase in sedimentation in Clower Creek. Homeowners in the Pelican Cove residential area at the downstream portion of Clower Creek have targeted the construction of several mall projects adjacent to the upstream portion of the Creek as the cause of the increased sedimentation and flows. The increased sedimentation has required more frequent dredging of the harbor entrance to the Pelican Cove Marina. Increased flows in the Creek have caused stream bank erosion which if it continues, may eventually undermine adjacent patios and carports.

This study of the Clower Creek Basin will assist Sarasota County in developing a stormwater management plan which will improve the quality and reduce the quantity thereby, improving the quality of stormwater runoff into Little Sarasota Bay. The Sarasota Bay Estuary Program has identified stormwater runoff as a major contributor to the ecological problems of Sarasota Bay. The Estuary Program is assisting in the funding of the Clower Creek Project as this project directly addresses one of the goals of the Sarasota Bay Project, i.e., to reduce the quantity and improve the quality of stormwater runoff.

1.20 Authorization

Recognizing the need to implement better stormwater management strategies in the Clower Creek area, the Board of County Commissioners of Sarasota County authorized Briley, Wild and Associates, Inc. (BWA) in May, 1990, to prepare the Clower Creek Stormwater Improvement Study. Work on the Project was delayed for nine months in order to gather actual stormwater runoff and water quality data.

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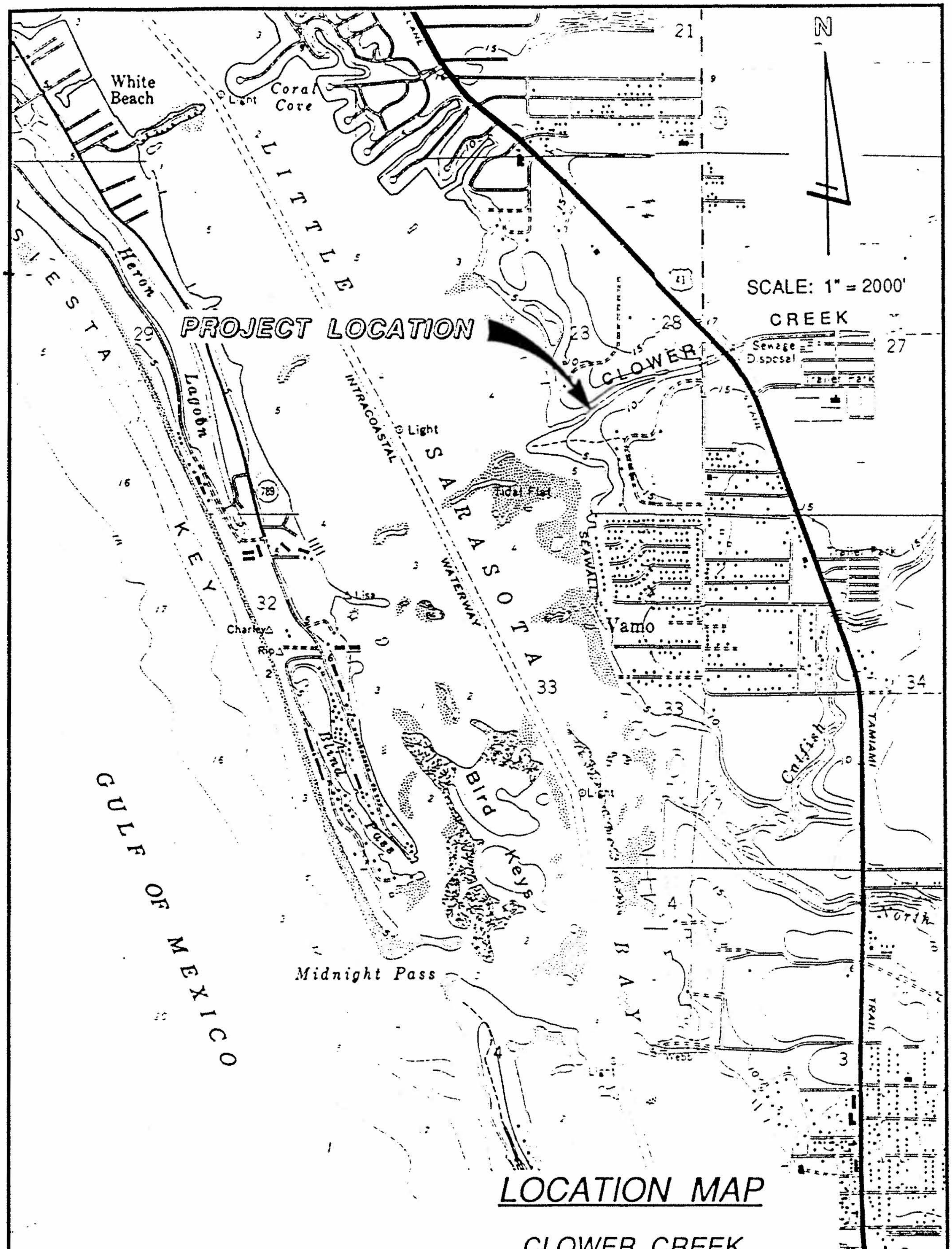

LOCATION MAP

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

Prepared by
Briley, Wild & Associates, Inc.
Consulting Engineers & Planners

Figure 1-1

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1.30 Project Scope

The scope of this project includes the identification of the existing stormwater management system, examination of the existing and future physical characteristics of the study area; compilation of existing data, reports, policies and regulations concerning stormwater management; determination of stormwater flows, preparation of preliminary designs and cost estimates of recommended improvements and the development of recommendations for implementation of the proposed program.

1.40 General Approach

The approach taken initially required definition of the existing drainage basins tributary to Clower Creek, the physical characteristics of the basins which affect stormwater runoff and the existing drainage facilities in the Basin. A combined effort between Sarasota County and the Southwest Florida Water Management District (SWFWMD) provided the available design information on the projects permitted by those agencies. SWFWMD also provided contoured aerial maps of the basin and a survey of the Creek was provided by Sarasota County. Florida Department of Transportation (FDOT) and Sarasota County Transportation Department also provided design information on the roadway drainage facilities in the Basin.

With this background data, a detailed computer model of the drainage basins was developed to compute the stormwater runoff, route the runoff through the storage facilities, combine the runoff from each drainage basin and determine the resultant flows in the Creek. A flow monitoring and rainfall gaging station was installed by BWA personnel with the assistance of County staff. These stations were monitored by Sarasota County personnel to collect actual storm event data. A water quality sampling program was developed to provide stormwater quality data.

Upon completion of the analysis of the existing system, the design methodology and criteria was established for the development of improvements to the system. Preliminary design and cost estimates were prepared for the nine alternative improvements. Actual storm event data was used in the evaluation of each alternative to determine its effectiveness in reducing the quantity and improving the quality of the stormwater runoff.

Results of the analysis of the existing system and the preliminary evaluation of the nine alternatives were presented to the following agencies for their input on the permitability of each of the alternatives: South Florida Water Management District, Department of Transportation, Department of Environmental Regulation, Sarasota County and the National Estuary Program Technical Advisory Committee. Representatives of the Department of Natural Resources were unable to attend the three scheduled presentations.

1.50 Editorial Comment

We have devoted particular efforts to define and delineate the means and techniques we employed to develop the hydraulic and hydrologic computer model of the Clower Creek basin in Section 3.0. This chapter describes the model in a detail which will enable a technical reviewer to reconstruct the model with data contained within this report.

SECTION 2.0
EXISTING DRAINAGE SYSTEM

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EXISTING DRAINAGE SYSTEM

2.10 Introduction

The chapter provides basin and sub-basin descriptions and descriptive data on the drainage system. We suggest that the reader have ready reference to Figure 2-1 as the text is reviewed.

2.20 General

The boundary of the approximately 300 acre Clower Creek Drainage Basin is shown on Figure 2-1. This boundary was determined using drainage system maps and contoured aerials supplied by Sarasota County and Southwest Florida Water Management District (SWFWMD) and by our site verification surveys.

The Basin is comprised of approximately 150 acres of commercial development and 95 acres of residential development. The remainder of the Basin is approximately 25 acres of State and County roadways and 30 acres presently undeveloped. The following subsections briefly describe Clower Creek and the drainage systems of the major developments of the Clower Creek Basin.

2.30 Basin Description

For purposes of analyzing the existing stormwater management system, the Clower Creek Basin was divided into 20 sub-basins. The sub-basin designations and locations are shown on Figure 2-1.

2.31 Clower Creek

Clower Creek is a relatively small drainage ditch approximately one mile long. Prior to development, the headwaters of the Creek was a small depressional area east of the Sarasota Square Mall and Park East Mobile Home Park. The construction of a road along the eastern boundary of the Basin has permanently disconnected the Creek from the depressional area. The headwaters of the Creek are presently just west of this road, south of the Sarasota Square Mall and north of Park East Mobile Home Park (Sub-basin E).

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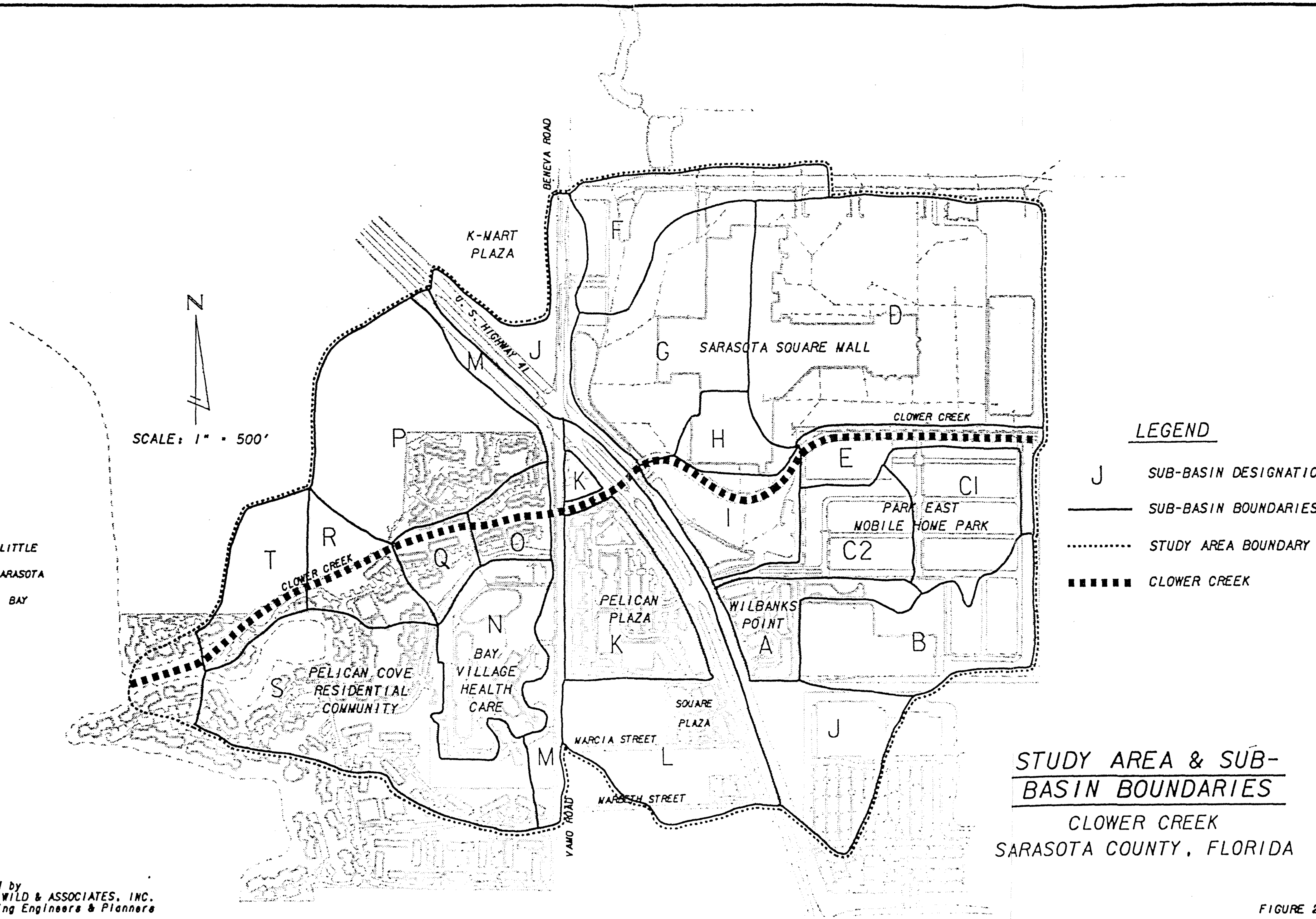

STUDY AREA & SUB-BASIN BOUNDARIES

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

Prepared by
BRILEY, WILD & ASSOCIATES, INC.
Consulting Engineers & Planners

FIGURE 2-1

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The upper 1,200-feet of the Creek is a V-shaped ditch approximately 8-feet deep with an average top width of 40-feet. This portion of the Creek is a fairly uniform natural channel overgrown with weeds and underbrush. This section of the Creek collects piped stormwater discharge from the east pond of the Sarasota Square Mall and a small portion of the Park East Mobile Home Park. Overland flow also enters the Creek from the south.

Downstream of the upper natural section, the Creek flows under the Sarasota Square mall. During construction of the Mall, approximately 1100 feet of the Creek was relocated in a 78-inch concrete pipe south of its original course. The relocation south was in order for the pipe not to be under Mall buildings. Several small storm sewers from the Mall and a large pipe from the Park East Mobile Home Park discharge directly into this piped portion of the Creek.

The piped Clower Creek discharges under U.S. 41 through two six-foot square box culverts. Runoff from the eastern portion of U.S. 41 and the overflow from the three western ponds of Sarasota Square Mall enters the Creek upstream of the U.S. 41 culverts.

Downstream of U.S. 41, the Creek is a trapezoidal shaped channel approximately 35-feet wide at the top, 20-feet wide at the bottom and 6-feet deep. This 300-feet of the Creek between U.S. 41 and Vamo Road is fairly uniform and overgrown with weeds and underbrush. Runoff from the U.S. 41 drainage system and the overflow from the Pelican Plaza pond enters this section of the Creek.

Clower Creek crosses under Vamo Road through two 72-inch concrete culverts. Runoff from the Vamo Road drainage system enters the Creek just west of these culverts. The remaining 2,500-feet of the Creek is a natural irregular shaped channel approximately 5-feet deep varying from a top width of 15 to 100-feet with a bottom width varying from 2 to 50-feet. Stormwater from the Bay Village Health Care Center and the Pelican Cove development enters the Creek in this portion. This area of the Creek has experienced stream bank erosion. The lower 1,500-feet of the Creek is tidally affected by Little Sarasota Bay.

2.32 Commercial Development

Most of the commercial areas in the Clower Creek Basin are located adjacent to U.S. 41. The commercial sites consist of Sarasota Square Mall, Pelican Plaza, Wilbanks Point and Square Plaza shopping centers, Bay Village Health Care Center and several small businesses. The majority of the commercial sites have on-site stormwater retention/detention ponds. These ponds generally provide detention for the 25-year 24-hour peak discharge rate and treat the first one-half inch of runoff.

The Sarasota Square Mall is the largest commercial development in the Clower Creek Basin with approximately 95 acres. The Mall was divided into five sub-basins, four of which drain into on-site ponds and the fifth (Sub-basin H) which drains a portion of the roof area directly into the piped portion of Clower Creek. The Mall is located in the northeastern portion of the Basin, east of U.S. 41 and Beneva Road and south of Sarasota Square Boulevard. Runoff from the parking areas is conveyed through storm drains to four ponds which discharge through overflow structures. The pond in the northwest portion of the Mall (Sub-basin F) discharges through a weir structure and pipe into the central pond (Sub-basin G). The central pond and the southwest pond (Sub-basin I) discharge through weir structures and pipes to Clower Creek just east of U.S. 41. The discharge of the eastern pond (Sub-basin D) is through a weir structure and pipe to the headwaters of Clower Creek.

Wilbanks Point Shopping Plaza (Sub-basin A) is located just south of the Sarasota Square Mall east of U.S. 41. Runoff is conveyed through a stormwater piping system to a small pond just east of the development. The overflow from the pond is routed into the large 5 acre pond to the south which drains a portion of the Park East Mobile Home Park. The overflow from this large pond is piped to Clower Creek.

A new commercial development called the Plaza at Palmer Ranch (in Sub-basin J) is currently under construction south of Wilbanks Point. The stormwater management system of this site is routed through pipes and swales to detention areas, a portion of which discharges to U.S. 41 and Clower Creek.

Pelican Plaza (Sub-basin K) is an approximately 15 acre shopping center located just th of the intersection of U.S. 41 and Vamo Road. Storm drains collect and convey the majority the runoff under Clower Creek to a pond located north of the Creek. Some runoff from U.S. 41 Vamo Road areas adjacent to this pond is also collected into this pond. The pond discharges ugh a control structure to the Creek just east of Vamo Road. A small retention area located on st side of the shopping center collects some runoff from the west parking area and Vamo This retention area has no control structure and the overflow appears to sheet flow west into Road storm sewer system.

The approximately 2.5 acre Square Plaza shopping center (in Sub-basin L) is located just south of Pelican Plaza west of U.S. 41. Runoff from the shopping area is collected and conveyed through storm drains to two ponds which discharge southerly to the storm sewer system on Marcia Street. The Marcia Street system drains to a storm sewer on the west side of U.S. 41.

The Bay Village Health Care Center (Sub-basin N) is located west of Vamo Road. An addition is proposed to this approximately 15 acre site. Presently there is no surface water management system. The stormwater is collected in storm drains and piped directly to Clower Creek. The proposed system will collect runoff in a storm sewer system and convey it to a proposed pond. A discharge control structure will be constructed in the pond with the overflow piped to Clower Creek.

With the exception of the Sarasota County Tax and Tag Office which provides on-site retention/detention, the runoff from the remainder of the commercial development in the Basin is directed into the Department of Transportation system along U.S. 41. This system will be discussed in a subsequent section.

2.33 Residential Development

There are approximately 95 acres of residential area in the Clower Creek Basin. Unlike the commercial areas in the Basin, the residential areas generally provide no surface water management. There are essentially three areas of residential development, the Pelican Cove community, Park East Mobile Home Park, and the area along Marcia and Marbeth Streets.

The portion of the Pelican Cove development which is contributory to Clower Creek comprises 50 acres of the residential area in the Basin. The Pelican Cove area was divided into six sub-basins. This development is located west of Vamo Road and extends west to Little Sarasota Bay. The majority of the site is south of Clower Creek. This project was constructed prior to the present surface water management criteria. Runoff from the roofs of the houses adjacent to the Creek are generally collected and piped directly to the Creek. Runoff from the remainder of the roofs, parking areas and streets is conveyed through storm drains, overland sheet flow or swales. This runoff discharges either to the small tributary north of Clower Creek, directly to the Creek, to the marina area or directly to Little Sarasota Bay. The runoff from Sub-basins O, Q and R discharge directly to the Creek, Sub-basin P's runoff discharges to the small tributary north of Clower Creek and the runoff from Sub-basin S flows into the marina area. The portion of the development discharging directly to Little Sarasota Bay was not included in the study area.

Park East Mobile Home Park is an approximately 35 acre site in the southeastern portion of the Clower Creek Basin. This development was constructed prior to the requirements of a surface water management system; however, a five acre pond provides retention/detention for a portion of the mobile home park. Runoff from approximately 10 acres (Sub-basin B) flows south through a storm sewer into the pond. Overflow from the Wilbanks Point shopping center also flows into this pond. A weir control structure routes drainage from the pond into a storm sewer. Runoff from the remaining 25 acres of the development (Sub-basins C1 and C2) is collected and conveyed in a storm sewer system which combines with the overflow pipe from the pond. The drainage at this junction flows to the piped portion of Clower Creek under the Sarasota Square Mall.

The residential development on Marcia and Marbeth Streets (Sub-basin L), south of Pelican Plaza, east of Vamo Road and west of U.S. 41 is essentially single family homes. Runoff from this approximately 10 acre area sheet flows to the roadway and drains easterly to U.S. 41 through roadside swales or storm sewers.

2.34 Roadways

There are several roadway drainage systems in the Clower Creek Basin. U.S. 41 is the major route in the area, intersecting the Basin from the southeast to the northwest. South of U.S 41 is County maintained Vamo Road. North of U.S. 41 is Beneva Road. Sarasota Boulevard is located east of Beneva Road. Approximately 25 acres of the roads contribute runoff to Clower Creek.

The Department of Transportation drainage system of U.S. 41 is mainly roadside swales with several isolated storm sewers. The eastern swale system (in Sub-basin J) collects runoff from the east lanes, Beneva Road and some development adjacent to the roadway. The runoff from this system enters the Creek just upstream of the two six-foot square box culverts which carry Clower Creek under U.S. 41. The runoff from the remainder of the road south of these culverts, the overflow from Square Plaza, and the discharge from Marcia and Marbeth Streets are collected in a storm sewer and roadside swale system on the west side of U.S. 41 (Sub-basin L). This flow discharges into Clower Creek just downstream of the box culverts. Runoff from the northwestern portion of U.S. 41 (in Sub-basin M) collects in roadside swale which may flow either into the Vamo Road system or through a culvert under Vamo Road to the Pelican Plaza pond or directly to Clower Creek.

Runoff from Sarasota Square Boulevard (in Sub-basin F) is conveyed through a storm drain to the northwest pond of the Sarasota Square Mall. As discussed earlier the overflow from this pond discharges to the central pond of the Mall which discharges to Clower Creek upstream of the U.S. 41 box culverts.

The drainage system along Vamo Road north of Marbeth Street (Sub-basin M) discharges to Clower Creek at the Pelican Cove property line downstream of the culverts carrying Clower Creek under Vamo Road. Very poorly defined swales are found on the east side of the road. A newly installed storm sewer system is on the west side. This system collects drainage from the roadway and adjacent areas and conveys it to Clower Creek. North of Clower Creek, a roadside swale on the west side of the road, collects drainage from the roadway and surrounding land and at times from a portion of U.S. 41. A pipe intercepts this runoff and routes it downstream of the Vamo Road culverts. A small area of Vamo Road adjacent to the Pelican Plaza pond may contribute runoff to the pond.

2.35 Undeveloped Areas

Approximately 30 acres of the Basin is presently undeveloped. At the onset of the study, the 12 acre area located east of U.S. 41 and south of Wilbanks Point shopping center was undeveloped and densely wooded. Runoff sheet flowed from this site into the drainage swales of U.S. 41. This area is presently under construction for a new shopping plaza. The proposed drainage system is discussed in the commercial development sub-section.

The remaining undeveloped area in the Basin is located north of the Pelican Cove development and west of U.S. 41 (in Sub-basins P, R and T). This 28 acre area is very heavily wooded with a well defined slope toward Clower Creek. The area adjacent to U.S. 41 may develop commercially in the future but the remainder of the site would most likely be developed residentially.

For purposes of this study, it has been assumed that a surface water management system would be provided when these vacant areas develop such that the post-development peak discharge would not exceed the pre-development peak discharge.

2.40 Soil Characteristics

One of the major factors affecting stormwater runoff is the characteristics of soils over and through which water travels. Extensive studies by the Soil Conservation Service (SCS) of the United States Department of Agriculture have helped to delineate these relationships. Figure 2-2, which was developed from the SCS Soil Survey of Sarasota County published in 1959 identifies the natural soil types in the Clower Creek study area. With the amount of development that has occurred in this basin since the soils mapping was performed, significant alteration of the upper portion of the soils has occurred. However, for the purposes of the study, native soil types were used in the development of runoff curve numbers from the pervious areas.

Figure 2-2 shows that there are approximately 12 soil types in the Basin. Descriptions of the six predominant soils, as excerpted from the Soil Survey, Sarasota County, appears below.

> *Adamsville Fine Sand (Aa).* This somewhat poorly drained, noncoherent, moderately deep soil has developed from beds of sands, 42-inches or more deep, that overlie finer textured alkaline material. The upper layers are acid, but the deeper layers are neutral to mildly alkaline. Runoff is slow because of the nearly level relief and porosity of the soil material. Internal drainage is rapid. Internal moisture depends on the level of the water table. The water table is normally 30 to 36-inches below the surface but may drop to 60-inches or more in dry seasons or rise to the surface in very wet seasons.
>
> *Immokalee Fine Sand (Ia).* This somewhat poorly drained sandy soil has a characteristic organic pan layer below 30-inches. It developed from thick stratified beds of acid sands in flat or nearly level areas. Runoff is very slow. Internal drainage is slow to rapid and is influenced seasonally by the high water table.
>
> *Lakewood Fine Sand (Lb).* This soil developed from thick beds of incoherent acid sands. It occurs on low-lying, nearly level ridges and is excessively drained and droughty. It is distinguished by a characteristic shallow white layer over thick strata of yellowish sands.

Leon Fine Sand (Lc). This somewhat poorly drained soil is characterized by a dark-colored organic pan layer in the subsoil at depths between 14 and 30-inches. The parent material consists of deep, unconsolidated layers of acid sand. The soil forms a part of a level or nearly level landscape. Runoff is very slow because of the relief and sandy texture. Internal drainage is rapid to slow and is affected by seasonal fluctuation of the water table.

Manatee Loamy Fine Sand (Mc). This dark, poorly to very poorly drained soil has developed from shallow accumulations of sandy sediments laid down by marine waters on a prior deposit for clayey materials. The clayey materials were interspered with marl at irregular depths. Manatee loamy fine sand occupies sloughs and shallow intermittent ponds having a level to nearly level relief. Runoff and internal drainage are very slow. During the rainy season, the soil is saturated and covered with several inches of water for long periods.

Pomello Fine Sand (Pf). This moderately well drained to somewhat excessively drained soil has a well-developed organic pan at depths greater than 42-inches. Its parent materials were thick beds of unconsolidated, acid sand. Pomello fine sand occurs on a nearly level to level relief. Little rainfall flows from the surface; most of the moisture soaks into the ground and drains downward. During some rainy periods the soil is saturated to the surface. During dry months the moisture content may be low and the soil droughty.

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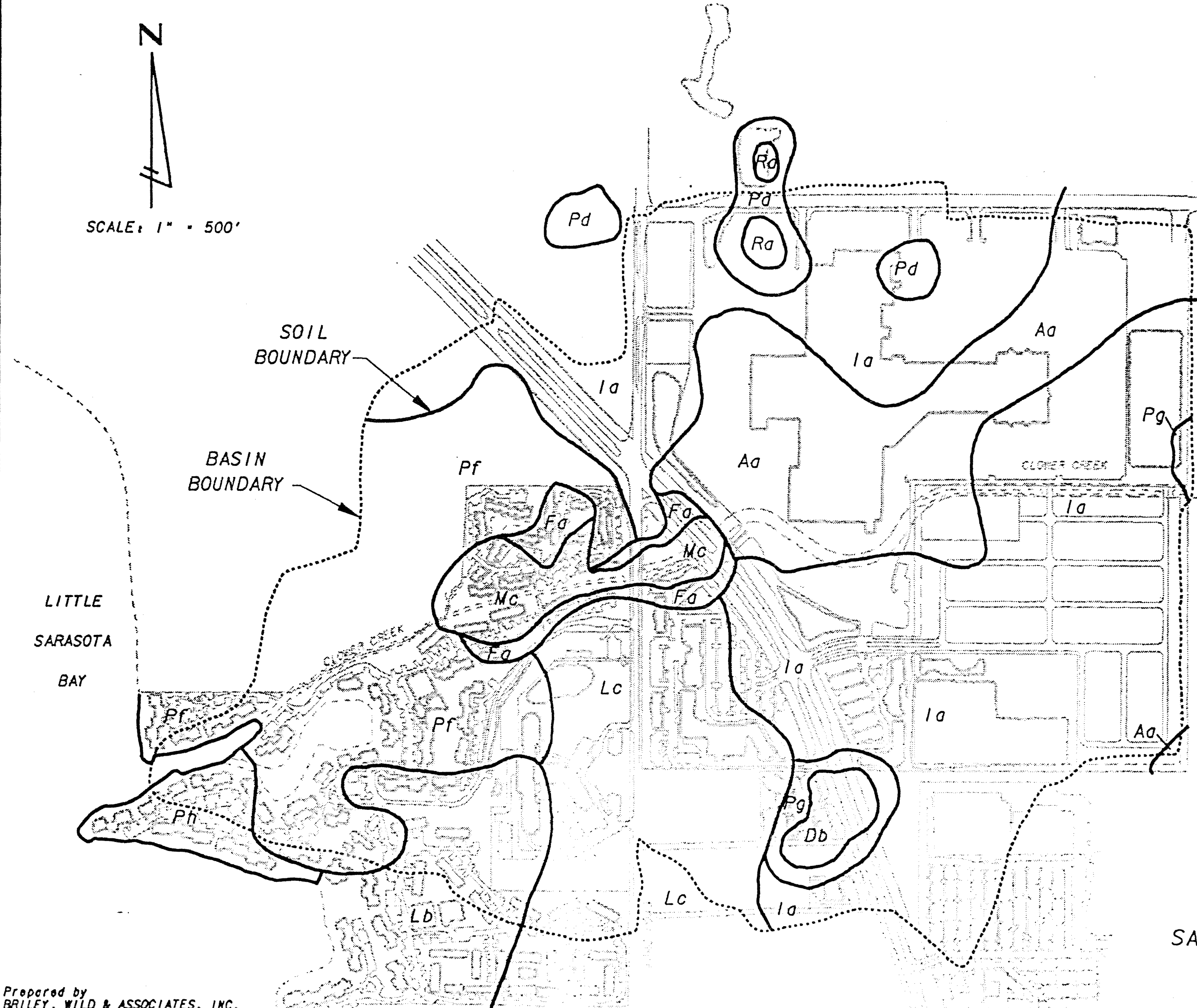


SOILS LEGEND

SOIL SYMBOL	SOIL TYPE	HYDRO. SOIL GROUP
Aa	ADAMSVILLE FINE SAND	C
Db	DELRAY FINE SAND SHALLOW PHASE	A/D
Fa	FELDA FINE SAND	B/D
Ia	IMMOKALEE FINE SAND	B/D
Lb	LAKEWOOD FINE SAND	A
Lc	LEON FINE SAND	A/D
Mc	MANATEE LOAMY FINE SAND	D
Pd	PLUMMER FINE SAND	B/D
Pf	POMELLO FINE SAND	C
Pg	POMPANO FINE SAND	A/D
Ph	POMPANO FINE SAND SHALLOW PHASE	B/D
Ra	RUTLEGE FINE SAND	D

SOILS MAP

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

R-893

Prepared by
BRILEY, WILD & ASSOCIATES, INC.
Consulting Engineers & Planners

FIGURE 2-2

SECTION 3.0
HYDROLOGIC AND HYDRAULIC
ANALYSIS PROCEDURES

SECTION 3.0
HYDROLOGIC AND HYDRAULIC ANALYSIS PROCEDURES

3.10 Introduction

This section outlines the procedures used to simulate stormwater runoff and quantify flood elevations throughout the Clower Creek basin. The Advanced Interconnected Pond Routing Model (AdICPR) developed by Peter J. Singhofen, P.E., was used to analyze the existing drainage system and simulate the effects of proposed improvements. This model was selected due to (1) the complexity of the drainage network in the Clower Creek basin and (2) the impact which downstream water elevations have on the effectiveness of drainage from the area. It is designed in such a way that the simultaneous interactions of each sub-basin are captured during a series of storm event simulations. This modeling method facilitates both identifying problem areas throughout an existing drainage system and evaluating the effectiveness of proposed improvements.

3.20 Hydrologic Design Procedures

3.21 General

The AdICPR model uses generally accepted procedures to compute the flows (surface runoff) from each of the twenty drainage sub-basins in the Clower Creek basin. These procedures include establishing a design rainfall for a particular frequency and the computation of direct runoff (rainfall-excess increments) from the design rainfall employing the Soil Conservation Service (SCS) runoff curve number procedures. The design hydrograph of each sub-basin was computed by the SCS unit hydrograph method. Further, we used the modified Puls method for flood routing to delineate attenuated stormwater levels in the ponds and channel areas.

Required input parameters for the hydrograph computations are the design rainfall amounts and distribution, hydrograph peak flow factor, total area, composite runoff curve number (CN), and the time of concentration (Tc) of each sub-basin. These parameters are discussed in the following sub-sections. Table 3-1 contains a summary of the hydrograph input data for each of the twenty Clower Creek sub-basins. The input data required for flood routing include the elevation/area data for reservoir storage and the dimensions and elevations of the culvert structures and channel systems in each sub-basin.

TABLE 3-1
HYDROGRAPH PARAMETERS

Sub-Basin	Area, ac	Runoff Curve Number	% Directly Connected Impervious Area	Time of Concentration, Min.	Peak Flow Factor
A	6.60	75	85.2	16.0	484
B	15.28	82	39.9	24.0	323
C1	10.60	89	13.0	23.0	484
C2	8.28	89	31.2	25.9	484
D	48.8	75	85.6	23.3	484
E	6.48	79	21.4	17.8	323
F	10.88	75	87.5	18.3	484
G	21.76	75	90.4	19.3	484
H	4.48	0	100	11.2	484
I	9.08	75	90.9	6.6	484
J	23.2	81	0	197.	256
K	14.16	75	85.7	18.0	484
L	22.92	84	0	62.2	323
M	8.24	82	0	36.5	323
N	12.16	81	12.8	18.8	323
O	4.16	85	7.0	17.5	323
P	24.88	80	3.0	47.6	323
Q	4.04	86	8.0	18.0	323
R	6.72	82	4.0	23.8	323
S	26.88	84	18.4	33.2	323
T	8.04	80	9.1	23.8	323

3.22 Design Rainfalls

In order to evaluate the capacity of the existing stormwater management system for purposes of this study, design hydrographs resulting from the following design rainfalls were computed and routed through the existing system by the AdICPR Model. Rainfall was uniformly applied over the entire basin.

Rainfall Frequency and Duration	Inches
5 year - 4 hour	4.3
10 year - 24 hour	7.0

For the four hour duration storm, the standard Florida Department of Transportation rainfall distribution was used. For the 24-hour duration storm, the standard Type III rainfall distribution of the SCS was used. The model distributes the design rainfall amounts over the desired time period.

In order to develop the proposed improvements, the 10 Year Frequency - 24 Hour Rainfall of 7.0 inches was applied to the drainage basin. Again, the standard 24 hour distribution of the SCS was used.

3.23 Composite Runoff Curve Numbers

Rainfall is converted to runoff by the use of a runoff curve number. A weighted (composite) runoff curve number (CN) was computed for the pervious area and non-directly connected impervious area of each sub-basin. CN is a parameter used in estimating soil moisture prior to a storm event. It is determined based on the following factors: hydrologic soil group, land use, plant cover and hydrologic condition. The soils map in Section 2.0 illustrates the hydrologic soil group of each soil type in the Basin. The land use, vegetation, and hydrologic condition were determined using the aerial maps provided by SWFWMD and field investigation.

The composite curve number for each sub-basin was calculated by multiplying the area of each land use in each hydrologic soil group by the appropriate SCS curve number, summing the results and dividing by the area of the sub-basin. The resultant CN's are listed on Table 3-1.

3.24 Directly Connected Impervious Area

The directly connected impervious area (DCIA), comprises those impervious surfaces that are hydraulically connected to the drainage system (i.e. streets with curb and gutter and paved parking lots with storm sewer systems). These impervious areas are connected to the sub-basin outlet point (i.e. the node) without flowing over any pervious areas. Essentially, all of the rainfall falling on these areas runs off to the node, therefore, a runoff curve number of 98 is inherently assigned to the percent of the sub-basin that is directly connected. The computed % DCIA for each sub-basin is listed on Table 3-1.

3.25 Times of Concentration

The time of concentration (Tc) is the time it takes for runoff to travel from the hydraulically most remote part of the watershed to the point of reference downstream. The SCS velocity method was used to compute the Tc in each of the twenty sub-basins. In this method, the flow path is divided into three portions: a sheet flow portion, a shallow concentrated flow portion and a channel flow portion. The travel time through the sheet flow portion is computed by a kinematic wave equation. An overland flow equation is used to calculate the travel time through the swale portion. Manning's equation is used for the channel travel time. Table 3-1 summarizes the computed Tc's.

3.26 Peak Flow Factor (K)

The peak rate factor (K) is a parameter used to reflect the effect of watershed storage on the shape of the runoff hydrograph. High values of K are assigned to watersheds with little or no storage effects and low values are assigned to watersheds with significant ponding effects. A peak flow factor of 256 was used to compute the hydrograph in undeveloped sub-basins with flat topography and considerable natural surface storage. A peak flow factor of 323 was used in developed sub-basins with flat topography with minimal storage available. A 484 value was used in the commercial areas where essentially no natural surface storage occurs.

3.30 Hydrograph Computation and Flood Routing

3.31 General

As previously stated, initial inputs to the AdICPR model are the various hydrograph and flood routing parameters. After inputting this data, the model, when executed, computes the runoff hydrograph of each sub-basin and stores each hydrograph into a computer file. In sequential steps, the program then moves the hydrographs downstream by the process of hydrograph summation and flood routing through reservoir storage in the various sub-basins.

3.32 Hydrograph Computation

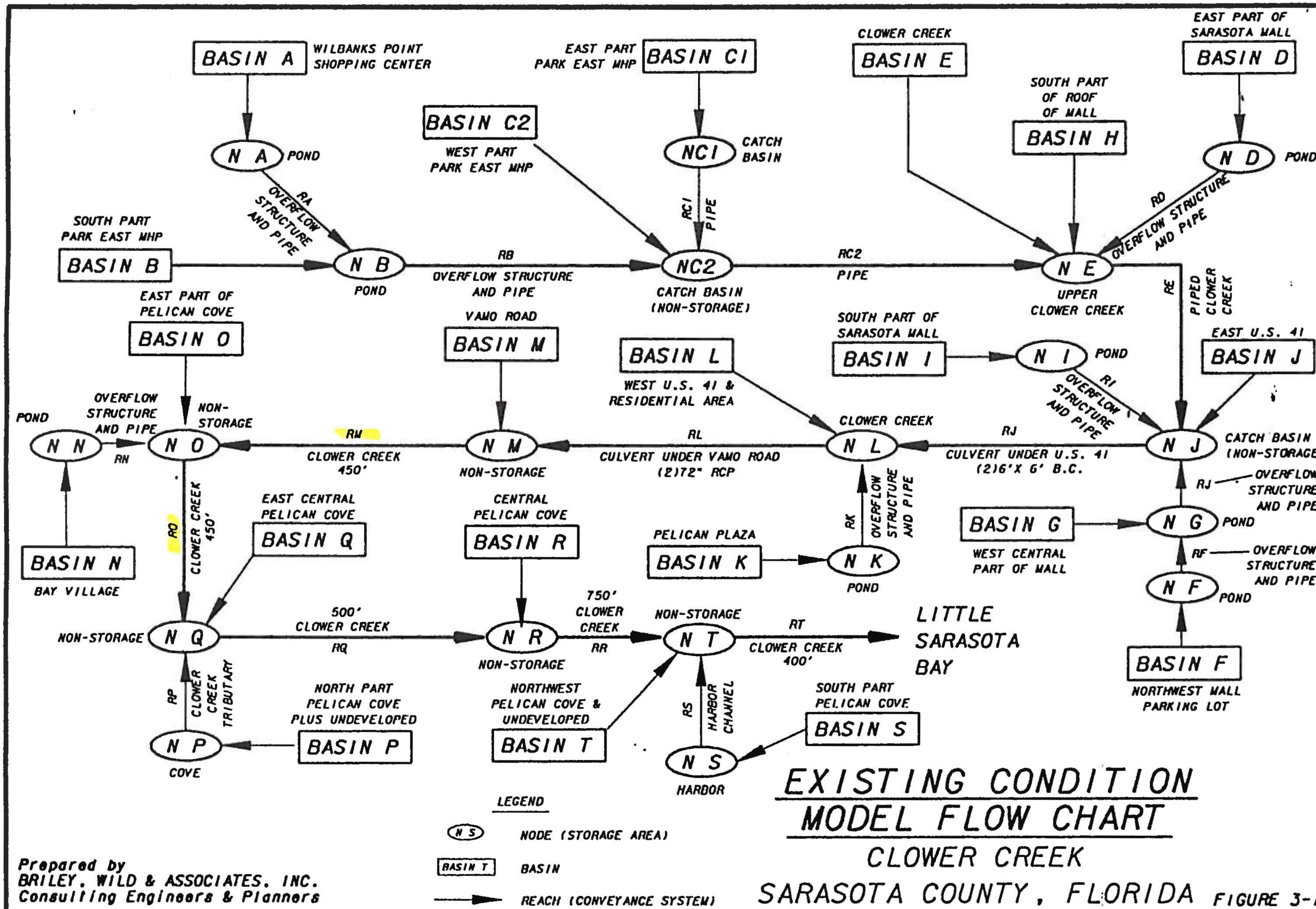
As discussed in subsection 3.20, the SCS unit hydrograph method was used to compute the design hydrographs for each of the twenty sub-basins in the Clower Creek study area. The resultant peak flow rates, times to peak, and volume of runoff are listed in Table 3-2 for the 10 year frequency, 24 hour duration design storm event.

TABLE 3-2
HYDROGRAPH SUMMARY

Sub-Basin Designation	Peak Flow Rate, cfs	Time To Peak, hrs.	Volume Of Runoff, in.
A	29.3	12.3	6.5
B	46.1	12.4	5.7
C1	42.7	12.3	5.8
C2	32.8	12.3	6.1
D	201	12.3	6.5
E	20.5	12.3	5.1
F	47.7	12.3	6.6
G	95.2	12.3	6.6
H	21.2	12.2	6.9
I	42.3	12.2	6.6
J	13.0	14.5	4.8
K	62.0	12.3	6.5
L	38.5	12.7	5.1
M	18.5	12.5	4.9
N	38.2	12.3	5.1
O	14.1	12.3	5.4
P	46.0	12.6	4.8
Q	12.5	12.3	4.9
R	18.9	12.4	5.0
S	68.2	12.4	5.5
T	22.0	12.4	4.9

3.33 Flood Routing

The AdICPR model works on a node-reach concept. This concept involves identifying locations in the drainage system where stormwater stage elevations need to be assessed. Each of these locations is considered a node. Nodes are connected together with conveyance elements (channels, culverts, etc.) which are called reaches. Discharge rates are computed for these reach elements. The entire system of nodes and reaches forms the nodal network and serves as the computation framework for AdICPR. A layout of the node and reach diagram developed for the analysis of the Clower Creek basin is shown on Figure 3-1.



EXISTING CONDITION MODEL FLOW CHART

CLOWER CREEK

SARASOTA COUNTY, FLORIDA

FIGURE 3-1

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The design hydrographs of each sub-basin are routed through the nodes and reaches to the boundary point of the study area. Historic tidal stage data for Little Sarasota Bay was used to establish the initial stage/time condition for the boundary node. Stage/area relationships of the remaining nodes were also required as input to the model. Input data required for the reaches included the dimensions, inverts and type of culverts; and the length, bottom elevations and cross sections of the swales, ditches and channel. Manning's roughness coefficients for all reaches were also developed and entered. Appendix 1 contains a printout of the input data for the nodes and reaches for the existing condition.

Table 3-3 lists the nodal maximum values resulting from the 10 year - 24 hour storm event applied to the existing drainage system. The maximum stage, peak inflow and outflow are shown for each node. The existing reach maximum flows and stages resulting from the design storm event are tabulated in Table 3-4.

TABLE 3-3
EXISTING NODAL MAXIMUMS

Node Designation	Stage (ft.)	Inflow (cfs)	Outflow (cfs)
NA	14.38	29.2	10.3
NB	12.58	56.4	13.9
NC1	14.64	42.2	8.0
NC2	13.01	48.1	16.6
ND	15.13	199	61.1
NE	11.59	113	88.0
NF	15.88	47.5	4.3
NG	14.98	100	25.9
NI	14.05	42.2	8.6
NJ	9.34	135	125
NK	11.50	61.8	12.0
NL	9.26	171	171
NM	9.01	189	186
NN	14.86	37.9	8.2
NO	8.64	207	199
NP	7.07	46.0	48.7
NQ	6.98	260	247
NR	4.88	266	258
NS	3.74	68.1	60.5
NT	3.71	332	324
NU	3.50	324	-

TABLE 3-4
EXISTING REACH MAXIMUMS

Reach Designation	Time (hrs)	Flow (cfs)	From Node Designation	Stage (ft)	To Node Designation	Stage (ft)
RA	12.58	10.3	NA	14.4	NB	11.9
RB	18.67	13.9	NB	12.3	NC2	11.9
RC1	12.92	8.0	NC1	14.6	NC2	12.3
RC2	17.67	16.6	NC2	12.3	NE	10.0
RD	12.75	61.1	ND	15.1	NE	11.5
RE	12.58	88.0	NE	11.6	NJ	9.3
RF	25.50	4.3	NF	14.6	NG	11.9
RG	13.58	25.9	NG	14.6	NJ	8.8
RI	12.58	8.6	NI	14.0	NJ	9.3
RJ	12.67	125	NJ	9.3	NL	9.2
RK	16.00	12.0	NK	11.0	NL	7.4
RL	12.75	171	NL	9.3	NM	9.0
RM	12.67	186	NM	9.0	NO	8.6
RN	15.42	8.2	NN	14.2	NO	7.2
RO	12.75	199	NO	8.6	NQ	7.0
RP	12.75	48.7	NP	7.1	NQ	7.0
RQ	12.75	247	NQ	7.0	NR	4.9
RR	12.75	258	NR	4.9	NT	3.7
RS	12.50	60.5	NS	3.7	NT	3.7
RT	12.67	324	NT	3.7	NU	3.5

SECTION 4.0
FIELD MEASUREMENT RESULTS

SECTION 4.0
FIELD MEASUREMENT RESULTS

4.10 General

As part of the Clower Creek study, a water quality and flow measurement program was undertaken. This section summarizes the field data collected in the Clower Creek basin and the resultant pollutant loadings entering Little Sarasota Bay.

4.20 Flow Measurement Program

The flow measurement program consisted of three parts, continuous rainfall recording, continuous channel stage recording, and instantaneous velocity measurement. A flow monitoring station was constructed in Clower Creek on the upstream side of the Brookhouse Drive bridge. A rainfall monitoring station was constructed in the parking area just north of this bridge. The station locations are shown on Figure 4-1. Velocity measurements were taken at various points across the channel at the flow monitoring station location. Personnel from Sarasota County Stormwater Division were trained to operate and maintain the monitoring equipment and to collect velocity measurements during storm events.

4.21 Rainfall Gaging

A rainfall gage to continuously record rainfall amounts (depth) in inches was installed in the Clower Creek basin in a parking lot adjacent to the Creek just north of the bridge at Brookhouse Drive. The gage was constructed using a Stevens Type F level recorder and a funnel which collected and conveyed the rainfall to a stilling well in which the depth was recorded. In order to use a smaller stilling well, the funnel and stilling well pipe were designed to proportion the depth of rainfall at a one to sixteen ratio. A plastic rain gage was also installed as a method to check the equipment. A wooden structure was constructed to house the equipment and allow easy operation and maintenance of the monitoring equipment.

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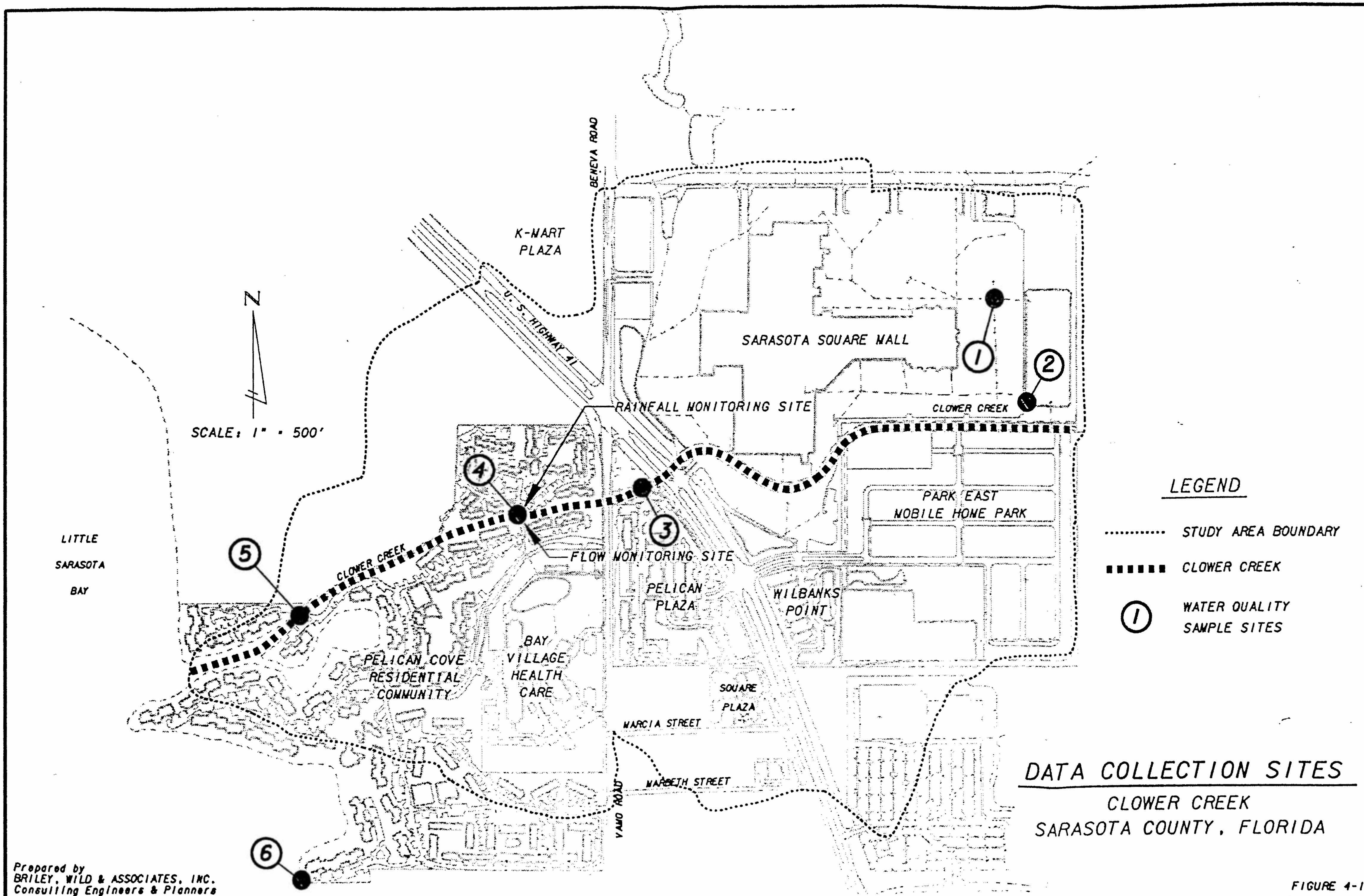

DATA COLLECTION SITES
CLOWER CREEK
SARASOTA COUNTY, FLORIDA

FIGURE 4-1

R-893

Four rainfall events were monitored during the data collection period. The rainfall data is graphed on Figure 4-2. As shown on Figure 4-2, the most significant rain event was 4.2-inches on October 10, 1990. Water quality data from this storm event were not collected as storm conditions were considered hazardous. Water quality samples were collected for the other three storms and are discussed later in this section.

4.22 Flow Measurement

As previously stated, the determination of flow rates in Clower Creek required the construction of a gaging station to continuously record water surface elevations during various rainfall events. The gaging station consisted of a battery operated Stevens Type F float recorder mounted on top of a 10-inch perforated PVC pipe. In this type of recorder a float moves up and down inside the perforated pipe depending on water depth. The float operates a pen which records vertical movement with time on a continuously moving strip chart. A cross-section of the channel at the location of the gage and velocity measurements during the storm event are required to compute the actual flow rate at each particular depth. The velocity measurements were taken using a Marsh McBirney portable velocity meter.

Stream stage and flow data from the monitored storm events were collected. This data is graphed on Figure 4-3 and the peak flow rates summarized in the following table.

TABLE 4-1
RAINFALL/FLOW DATA

Date	Rainfall (inches)	Peak Flow Rate (cfs)
9-30-90	0.87	16.6
10-10-90	4.20	86.1
3-13-91	1.66	28.3
3-18-91	0.56	9.4

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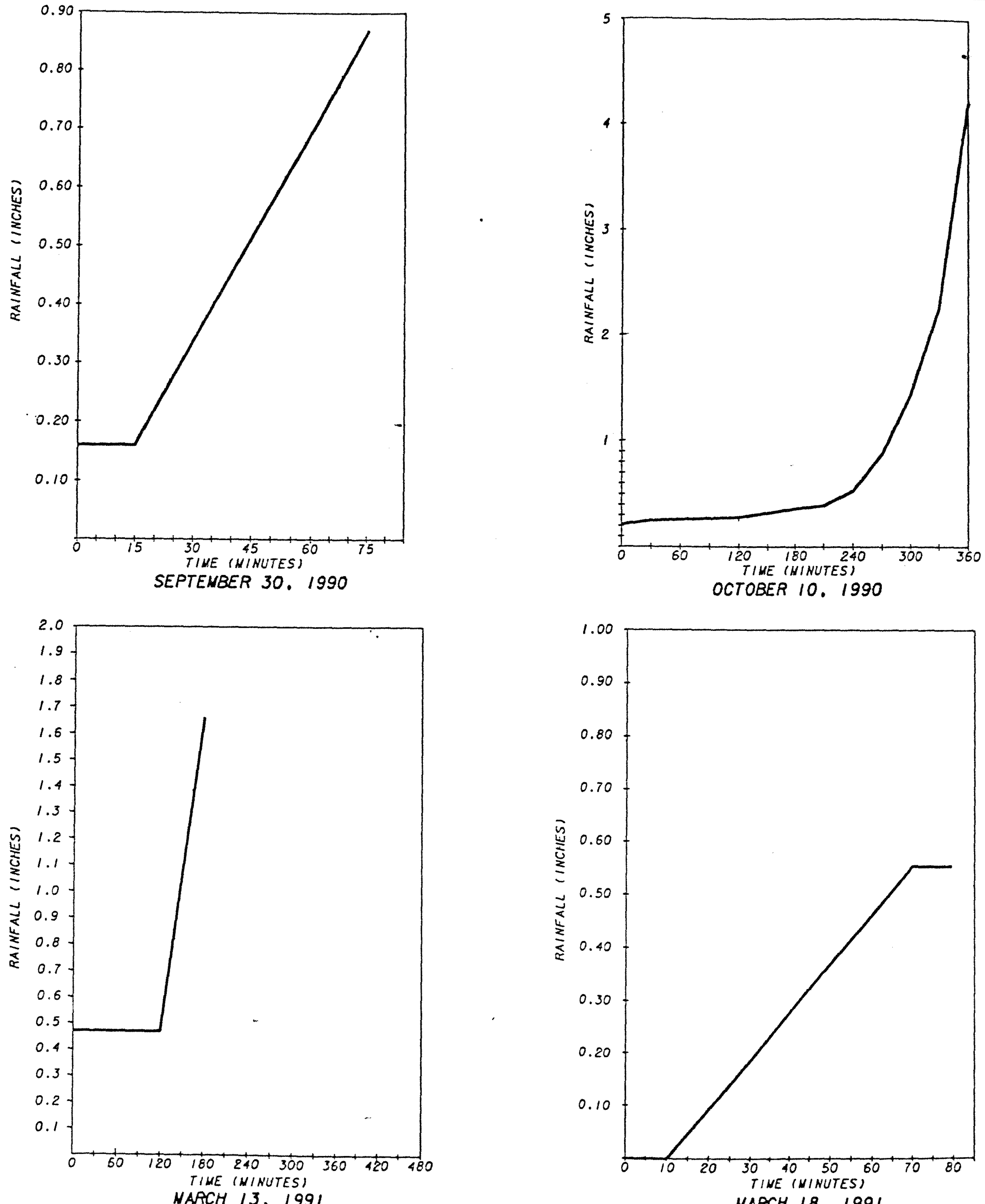

RAINFALL

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

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FIGURE 4-2

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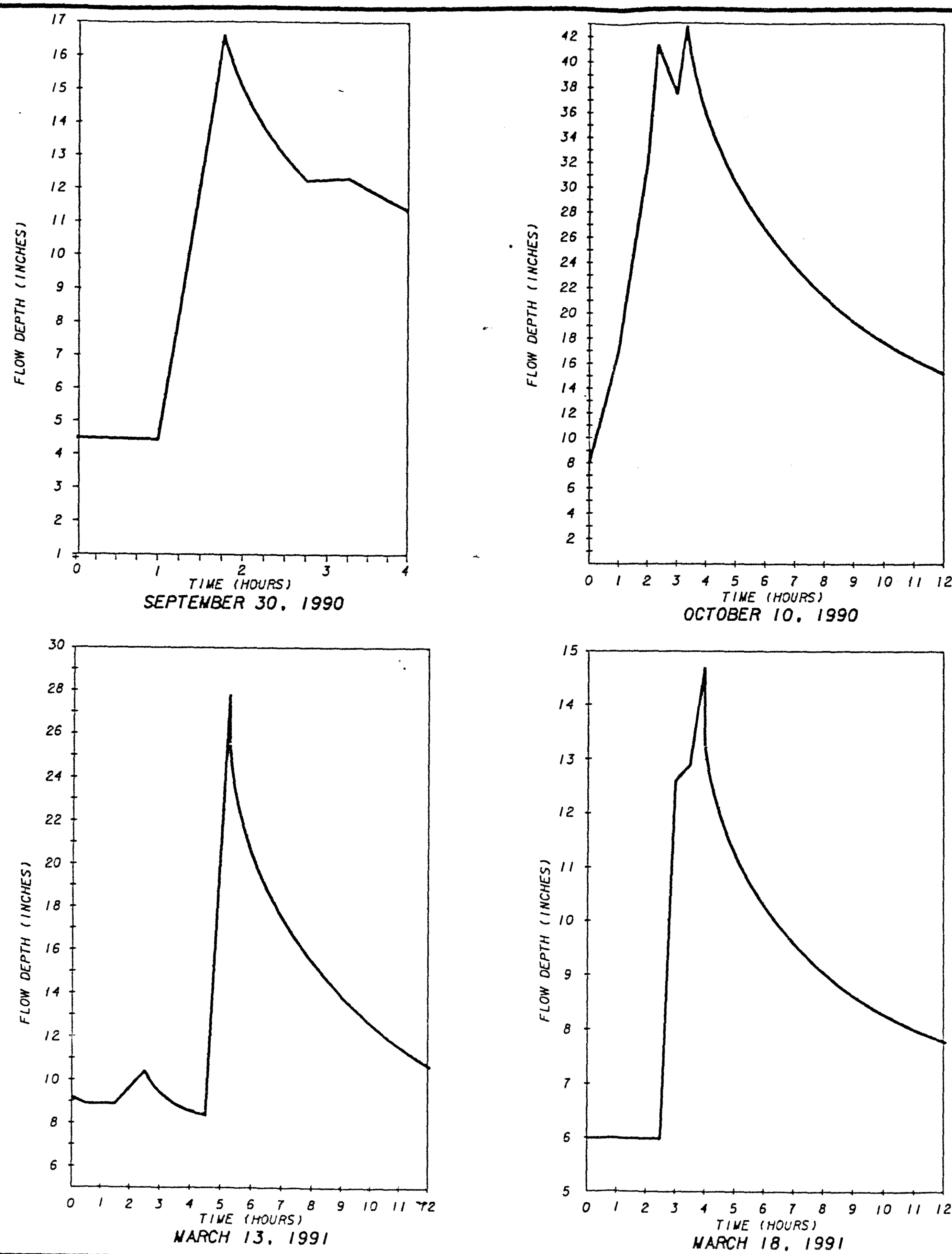

FLOW DEPTH

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

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FIGURE 4-3

Based on the rainfall and runoff data, a simultation of 1-inch of rainfall at a duration of one hour was performed by the AdICPR Model with the following results:

MODEL SIMULATION RESULTS

Rainfall (inches)	Actual Peak Flow Rate cfs	AdICPR Peak Flow Rate cfs
1.0	18.10	18.51

4.30 Water Quality Sampling and Analyses

In order to determine the pounds of each pollutant entering the receiving water, samples of the runoff were collected at successive time intervals during a particular rainfall/runoff event. The water quality sampling program consisted of six sites at which grab samples were collected. The location of the sites is shown on Figure 4-1. Site No. 6 is not in the Clower Creek Basin but was sampled to provide general information on runoff water quality discharged directly to the bay.

The samples were analyzed for Total Nitrogen, Total Phosphorous, Total Suspended Solids and Settleable Solids. Table 4-2 lists the sampling results by date of collection and Table 4-3 illustrates the average sampling results by site for samples collected at various times during an event.

In general, the concentration of pollutants was lower than that expected, especially the Settleable Solids values. As expected, the Total Suspended Solids concentration was higher downstream than upstream. The solids entering the channel from untreated areas was higher than that from areas with retention/detention facilities. The nutrient data did not vary significantly among sites.

TABLE 4-2

SUMMARY OF WATER QUALITY DATA BY SAMPLING EVENT

SAMPLING EVENT SEPTEMBER 30, 1990

Site Number	Time Of Collection	Settleable Solids, mg/l	Total Suspended Solids, mg/l	Total Nitrogen mg/l	Total Phosphorous mg/l
1	1400	<0.05	12.2	0.33	0.14
2	------	-----	-----	-----	-----
3	1405	0.1	16.8	1.08	0.24
4	1415	0.1	21.2	0.97	0.34
5	1425	0.2	45.6	0.84	0.38
6	1430	<0.025	4.4	0.54	0.20

SAMPLING EVENT MARCH 13, 1991

Site Number	Time Of Collection	Settleable Solids, mg/l	Total Suspended Solids, mg/l	Total Nitrogen mg/l	Total Phosphorous mg/l
1	1600	0.5	16.0	0.80	0.19
	1720	0.3	19.0	1.32	0.15
2	1555	0.1	41.0	1.24	0.084
	1715	<0.1	15.0	1.32	0.063
3	1610	0.2	38.0	1.25	0.17
	1730	<0.1	18.0	1.63	0.13
4	1620	0.5	44.0	1.80	0.76
	1750	<0.1	14.0	1.33	0.23
5	1630	<0.1	11.0	1.34	0.53
	1740	<0.1	15.0	1.05	0.17
6	1645	0.2	57.0	2.74	0.84
	1800	0.2	24.0	3.37	0.61

TABLE 4-2 (Con't)
SAMPLING EVENT MARCH 18, 1991

Site Number	Time Of Collection	Settleable Solids, mg/l	Total Suspended Solids, mg/l	Total Nitrogen mg/l	Total Phosphorous mg/l
1	------	-----	-----	-----	-----
2	1140	<0.1	28.0	0.89	0.25
	1245	<0.1	4.0	0.36	0.23
	1345	<0.1	8.0	0.46	0.23
3	1145	0.2	44.0	2.76	0.20
	1250	<0.1	20.0	2.19	0.20
	1350	<0.1	24.0	1.11	0.30
4	1150	<0.1	28.0	1.04	0.60
	1300	0.4	36.0	0.75	0.41
	1355	<0.1	20.0	0.59	0.21
5	1200	<0.1	12.0	0.96	0.30
	1305	0.2	36.0	2.21	0.42
	1405	<0.1	24.0	0.69	0.21
6	------	-----	-----	-----	-----

TABLE 4-3
SUMMARY OF WATER QUALITY DATA BY SITE

Site Number	Sampling Event	Average Settleable Solids, mg/l	Average Total Suspended Solids, mg/l	Average Total Nitrogen mg/l	Average Total Phosphorous mg/l
1	9-30-90	<0.05	12.2	0.33	0.14
	3-13-91	0.4	17.5	1.06	0.17
	3-18-91	-----	-----	-----	-----
2	9-30-90	-----	-----	-----	-----
	3-13-91	<0.1	21.0	1.28	0.042
	3-18-91	<0.1	9.7	0.57	0.24
3	9-30-90	0.1	16.8	1.08	0.24
	3-13-91	0.1	28.0	1.44	0.15
	3-18-91	0.1	29.3	2.02	0.23
4	9-30-90	0.1	21.2	0.97	0.34
	3-13-91	0.25	29.0	1.56	0.50
	3-18-91	0.13	28.0	0.79	0.41
5	9-30-90	0.2	45.6	0.84	0.38
	3-13-91	<0.1	13.0	1.20	0.35
	3-18-91	<0.1	24.0	1.29	0.31
6	9-30-90	<0.025	4.4	0.54	0.20
	3-13-91	0.2	40.5	2.56	0.72
	3-18-91	-----	-----	-----	-----

A comparison was made of the measured concentrations with data from the Environmental Protection Agency's Nationwide Urban Runoff Program (NURP). The NURP data provides expected pollutant concentrations resulting from certain land uses based on studies conducted throughout the country. The measured pollutant concentration of Total Suspended Solids and Total Nitrogen in the Clower Creek basin are considerably lower than that projected by the NURP data. The lower concentrations in Clower Creek would be expected because approximately half the runoff from the Clower Creek basin is treated in retention/detention facilities prior to discharge. The Total Phosphorous data was essentially the same. No NURP data is available for Settleable Solids. The data comparison is illustrated in Table 4-4.

TABLE 4-4
WATER QUALITY COMPARISON

Parameter	NURP Expected Concentration, mg/l	Measured Concentration, mg/l
Total Suspended Solids	74.0	26.4
Total Nitrogen	2.34	1.25
Total Phosphorous	0.38	0.44

4.40 Pollutant Loading

The data collected in the Clower Creek basin during the study period was used to estimate the pollutant load entering Little Sarasota Bay from rainfall alone. Flow weighted average pollutant concentrations were computed using the actual field data collected at the Brookhouse Drive site. The pollutant loading resulting from 1-inch of rainfall was determined by multiplying the flow weighted average concentrations by the computed volume of runoff resulting from 1-inch of rain. Statistics indicate that more than 90% of the rainfall events in Florida are 1-inch or less. To compute an annual loading, assuming 52-inches of rainfall per year, this loading was multiplied by 52. The estimated annual pollutant loadings are summarized in Table 4-5.

TABLE 4-5
POLLUTANT LOADING

Parameter	Volume of Runoff from 1-inch of Rain MG	Flow Weighted Average Concentration mg/l	Pollutant Loading From 1-inch of Rain lb/inch	Annual Pollutant Loading lb/year
Settleable Solids	3.7	0.22	6.8	354
Total Suspended Solids	3.7	26.4	817	42,484
Total Nitrogen	3.7	1.25	38.7	2,012
Total Phosphorous	3.7	0.44	13.6	707

The annual loading values were used to estimate the effectiveness of the nine alternative improvements studied on reducing the pollutant loadings into Little Sarasota Bay. A discussion of these alternatives and their effectiveness follows in Section 5.0 of this report.

SECTION 5.0
EVALUATION OF ALTERNATIVES

SECTION 5.0
EVALUATION OF ALTERNATIVES

5.10 Introduction

This section contains our evaluation of the alternative improvements studied for the Clower Creek area. The study incorporates a variety of approaches to reduce the quantity and improve the quality of stormwater runoff entering Little Sarasota Bay from the Clower Creek basin.

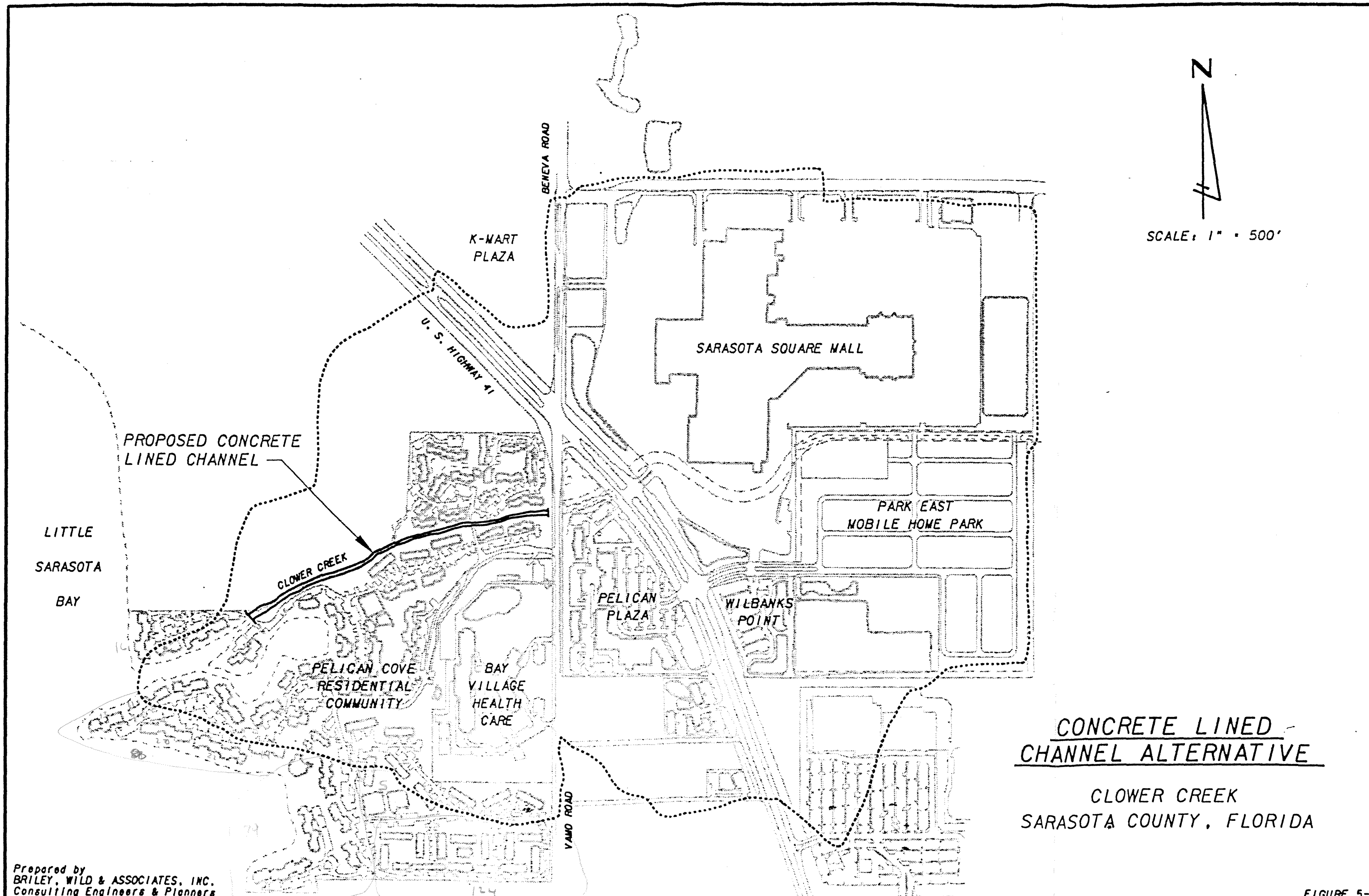
5.20 Alternatives Considered

Nine alternative improvements were evaluated and preliminary design and cost estimates were prepared for each. These alternatives were presented to representatives from the following agencies: Southwest Florida Water Management District, Department of Environmental Regulation, Department of Transportation, Sarasota County and the National Estuary Program Technical Advisory Committee. Modification of several of the alternatives and the addition of some sub-alternatives were made as a result of the technical discussions. The following subsections present a brief discussion of the alternatives considered and their effectiveness and cost.

5.21 Concrete Line Channel

The section of Clower Creek from Vamo Road to Clower Creek Drive experiences significant channel bank erosion and sediment bed load movement. This sediment transport is contributing to the increased siltation in the Pelican Cove Harbor entrance and Little Sarasota Bay. One of the alternatives considered was to line this section of channel with concrete while improving the cross-sectional area of a portion of the Creek. Figure 5-1 illustrates the location of the proposed improvement.

There are several advantages of this alternative. A concrete lined channel would provide increased stormwater conveyance capacity with a smoother roughness factor and an improved cross-sectional area. Lining the channel with concrete would eliminate the bank erosion and sediment bed load movement.



CONCRETE LINED
CHANNEL ALTERNATIVE

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

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FIGURE 5-1

The disadvantages of this alternative include a very high capital cost. Another disadvantage of this alternative is that it offers no reduction in sediment inflows from upstream areas. A concrete lined channel would require removal of all natural vegetation. The existing biological community would be permanently impacted. This impact is unacceptable from an environmental view point and therefore, would require significant mitigation to offset the impact.

The effectiveness in reducing settleable and suspended solids was determined using the field measurements taken at Vamo Road and at Brookhouse Drive. It was assumed the increase in solids concentration between the two locations was due to erosion and bed load movement. Therefore the reduction in solids which could be accomplished by lining the channel was estimated to be 39% for settleable solids and 10% for suspended solids. Lining the channel was estimated to offer no reduction in nitrogen, phosphorous or stormwater flow.

The reduction in annual pollutant loading is estimated by multiplying the percent reduction by the computed annual pollutant loading for each parameter. The resultant effectiveness of lining the channel from Vamo Road to Clower Creek Drive is shown in the table below.

TABLE 5-1
EFFECTIVENESS OF CONCRETE LINED CHANNEL

Parameter	% Reduction	Existing Annual Loading lb/yr.	Reduction in Annual Loading lb/yr.
Settleable Solids	39	354	138
Total Suspended Solids	10	42,484	4,250
Total Nitrogen	0	2,012	------
Total Phosphorous	0	707	------
Stormwater Flow	0	193 MG/yr.	------

The cost of lining approximately 1,750 feet of Clower Creek with six inches of concrete was estimated to be $337,000.00. A breakdown of the cost is given in Table 5-2.

TABLE 5-2
COST OF CONCRETE LINED CHANNEL

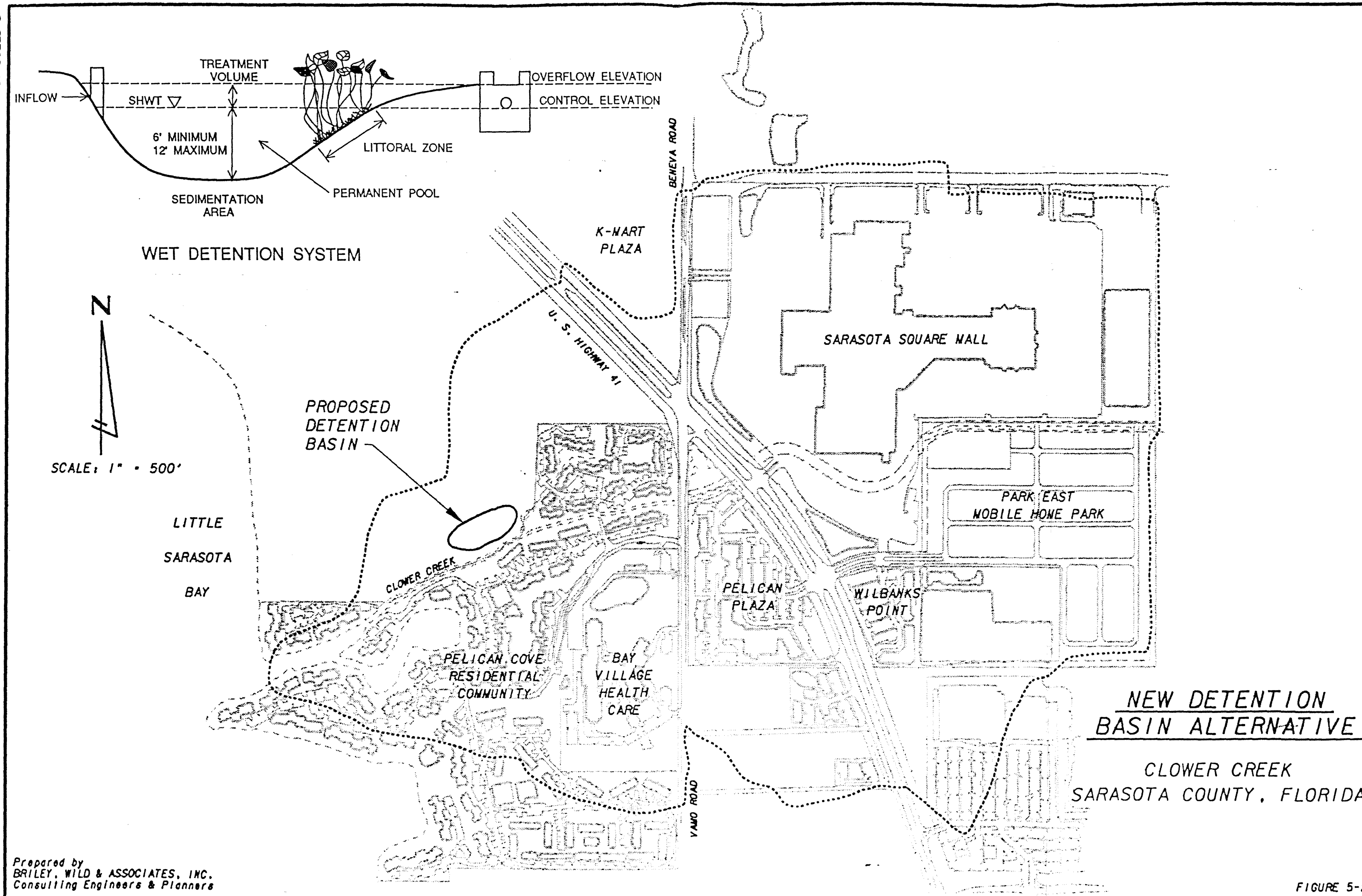
Item	Quantity	Unit Price	Construction Cost
Concrete Lining	1,300 yd^3	$210.00	$273,000.00
Channel Improvement	1,000 ft.	20.00	20,000.00
	Construction Cost		$293,000.00
	Contingencies Cost (15%)		43,950.00
	Total Cost		$337,000.00

5.22 New Detention Basin

A new wet detention basin was proposed north of Clower Creek in the location shown on Figure 5-2. Wet basins are detention systems which maintain a permanent pool of water. This type of pond is essentially a modification of the traditional flood attenuation pond and can maximize water quality treatment processes. These permanently wet ponds are designed to slowly release collected stormwater runoff through an outlet structure. A schematic of a typical wet detention system and associated discharge structure is also shown on Figure 5-2.

The advantages of this alternate are the high percentages of sediment removal and nutrient treatment. A flow diversion device in the channel would be required to divert runoff into the detention pond. This device would also serve to reduce the velocity in the channel at the area where bank erosion and sediment bed load movements are the greatest. The disadvantages are the high capital cost and the maintenance of removing sediment buildup. The diversion weir would also contribute some additional headloss which may result in upstream flooding under certain rainfall conditions.

The preliminary design and cost estimate prepared for this alternative were based on providing water quality treatment for one inch of runoff over the area of the basin not presently served by retention/detention facilities. This is approximately 140 acres. The depth of the treatment volume in a wet detention system is limited to a maximum of 18-inches in order to protect the planted area from drowning. Therefore to treat one inch of runoff for 140 acres requires a 6 acre pond. An additional acre is required for pond berm and buffer/maintenance area.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TREATMENT VOLUME
OVERFLOW ELEVATION
INFLOW
SHWT
CONTROL ELEVATION
6' MINIMUM
12' MAXIMUM
LITTORAL ZONE
SEDIMENTATION AREA
PERMANENT POOL
WET DETENTION SYSTEM
N
SCALE: 1" = 500'
BENEVA ROAD
K-MART PLAZA
U. S. HIGHWAY 41
SARASOTA SQUARE MALL
PROPOSED DETENTION BASIN
LITTLE SARASOTA BAY
CLOWER CREEK
PARK EAST MOBILE HOME PARK
PELICAN PLAZA
WILBANKS POINT
PELICAN COVE RESIDENTIAL COMMUNITY
BAY VILLAGE HEALTH CARE
VAMO ROAD
NEW DETENTION BASIN ALTERNATIVE
CLOWER CREEK
SARASOTA COUNTY, FLORIDA
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R-893
FIGURE 5-2

Wet detention basins have been shown by the Environmental Protection Agency Nationwide Urban Runoff Program (NURP) and other studies to be capable of highly effective performance in urban runoff applications. Particulate removal in excess of 90 percent for Total Suspended Solids can be obtained. A conservative estimate of 60 percent has been assumed for this study. No NURP data is available for Settleable Solids and a 60 percent removal has also been assumed for this parameter. Results indicate that biological processes which are operative in the permanent pool produces significant reductions (50 percent or more) in soluble nutrients, nitrate and soluble phosphorous. Reductions of pollutants with significant soluble factors were found to be on the order of approximately 50 percent for TKN and 65 percent for Total Phosphorous. The percentages used and the resultant effectiveness of this alternative are summarized in Table 5-3.

TABLE 5-3
EFFECTIVENESS OF DETENTION BASIN

Parameter	% Reduction	Existing Annual Loading lb/yr.	Reduction in Annual Loading lb/yr.
Settleable Solids	60	354	212
Total Suspended Solids	60	42,484	25,490
Total Nitrogen	50	2,012	1,006
Total Phosphorous	65	707	460
Stormwater Flow	0	193 MG/yr.	------.

The estimated cost of purchasing 7 acres of land at an assumed cost of $30,000/ac and constructing a new wet detention facility was determined to be approximately $476,000.00. The detailed cost estimate is summarized in Table 5-4.

TABLE 5-4
COST OF DETENTION BASIN

Item	Quantity	Unit Price	Construction Cost
Land Clearing	7 acres	$500.00	$3,500.00
Pond Excavation and Spreading	77,520 yd^3	2.50	193,800.00
Littoral Zone	445 yd^2	5.00	2,225.00
Sod	750 yd^2	1.75	1,313.00
Weir/Culverts/Outfall Structure		Lump Sum	30,000.00
	Construction Cost		$230,838.00
	Contingencies Cost (15%)		34,626.00
	Land Cost		210,000.00
	Total Cost		$476,000.00

5.23 Desiltation Basin

The third alternative evaluated was the construction of a desiltation basin at the same location as the proposed detention basin as shown on Figure 5-2. A desiltation basin is a concrete structure with interior baffles which acts as a settling basin for the removal of solids. The proposed desiltation basin would be generally rectangular in shape, 200-feet long, and 180-feet wide and 10-feet deep and constructed of precast concrete sheet pile wall elements with a central concrete sheet piling wall to assure the proper directional flow of runoff through the basin. A maintenance/buffer area around the basin would be required with a total land area to be purchased of one acre.

A desiltation basin is very efficient in sediment removal but provides no nutrient treatment processes. As with the detention basin, a flow diversion structure would be constructed reducing the velocity in the constricted area of the channel where the bank erosion and sediment bed load movement are the greatest. Careful design of the outfall structure would be required to reduce the headloss and potential upstream flooding in major rainfall events. The high capital cost and the required maintenance removal of sediment are disadvantages of this alternative.

The preliminary design of the desiltation basin is for approximately 200 cfs of flow and a detention time of 15 minutes. This would result in an eighty percent removal of solids. As mentioned previously, no percent removal for nutrients has been assumed although some nutrients would be removed with the settling and removal of the solids. This alternative would not provide any reduction in stormwater flow. The effectiveness of the desiltation basin is summarized in Table 5-5.

TABLE 5-5
EFFECTIVENESS OF DESILTATION BASIN

Parameter	% Reduction	Existing Annual Loading lb/yr.	Reduction in Annual Loading lb/yr.
Settleable Solids	80	354	283
Total Suspended Solids	80	42,484	34,000
Total Nitrogen	0	2,012	------
Total Phosphorous	0	707	------
Stormwater Flow	0	193 MG/yr	------

The cost of purchasing the required acreage at an assumed $30,000/acre and constructing the desiltation basin was estimated to be approximately $856,500. A breakdown of the costs included follows in Table 5-6.

TABLE 5-6
COST OF DESILTATION BASIN

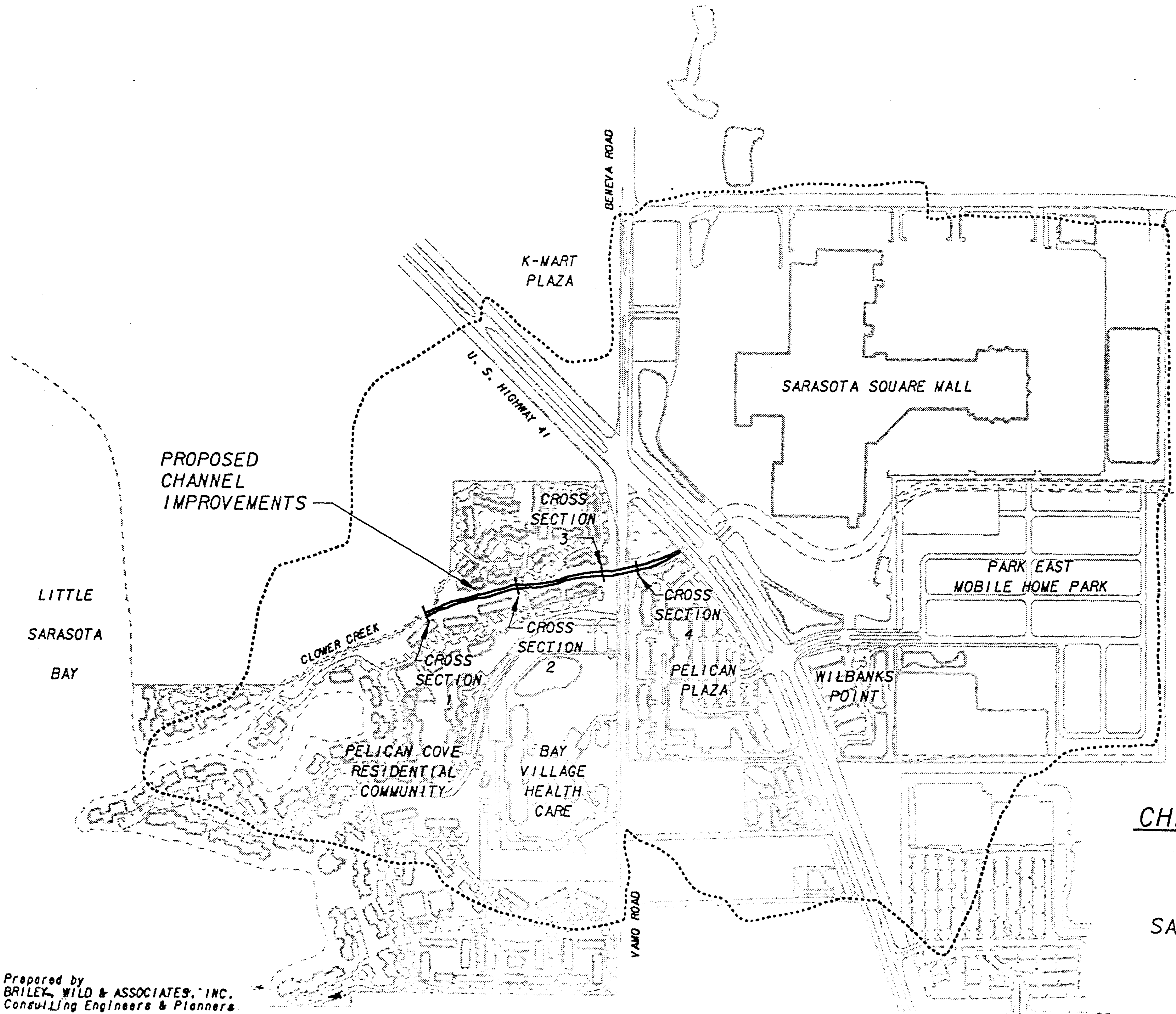
Item	Quantity	Unit Price	Construction Cost
Land Clearing	1 acre	$500.00	$ 500.00
Concrete Basin	3357 yd^3	205.00	688,185.00
Weir/Culverts/Outfall Structure		Lump Sum	30,000.00
	Construction Cost		$718,685.00
	Contingencies Cost (15%)		107,803.00
	Land Cost		30,000.00
	Total Cost		$856,500.00

5.24 Channel Improvement

A portion of Clower Creek downstream from Vamo Road has several areas with a reduced cross-section which has created severe erosion of the channel banks. The velocities in these areas are such that the sediment bed load movement is increased. Improvement of an approximately 1000-foot section of the Creek is proposed with a more uniform cross-section. The exotic vegetation on the channel banks, which is presently being undercut by erosion, would be removed and a littoral zone would be created along the improved section of the channel and also the 300-foot section of Creek between Vamo Road and U.S. 41. The location of the proposed improvements is shown on Figure 5-3.

The Pelican Cove development extends close to the channel banks. The top width of the channel in these areas is restricted requiring steeper side slopes than can be sodded. An erosion control fabric is proposed on the channel banks in these areas. The existing and proposed cross-sections are shown on Figure 5-4. A replanting program of the channel banks is proposed that will utilize environmentally acceptable vegetation.

Advantages of this alternative include elimination of the channel constriction and a reduction in the resultant channel bank erosion and sediment bed load movement. The improved cross-section would also provide greater stormwater transport capacity. The vegetation in the littoral zone would offer some pollutant uptake and provide an environmental habitat. Disadvantages of this alternate include a fairly high capital cost. Also, no reduction in upstream sediment inflow is provided with the proposed channel improvement. Maintenance of the proposed channel must also be considered a disadvantage. The proposed vegetation must be routinely maintained to maximize its efficiency in pollutant removal while minimizing the potential reduction in channel capacity.



N

SCALE: 1" = 500'

CHANNEL IMPROVEMENTS ALTERNATIVE

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

Prepared by
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FIGURE 5-3

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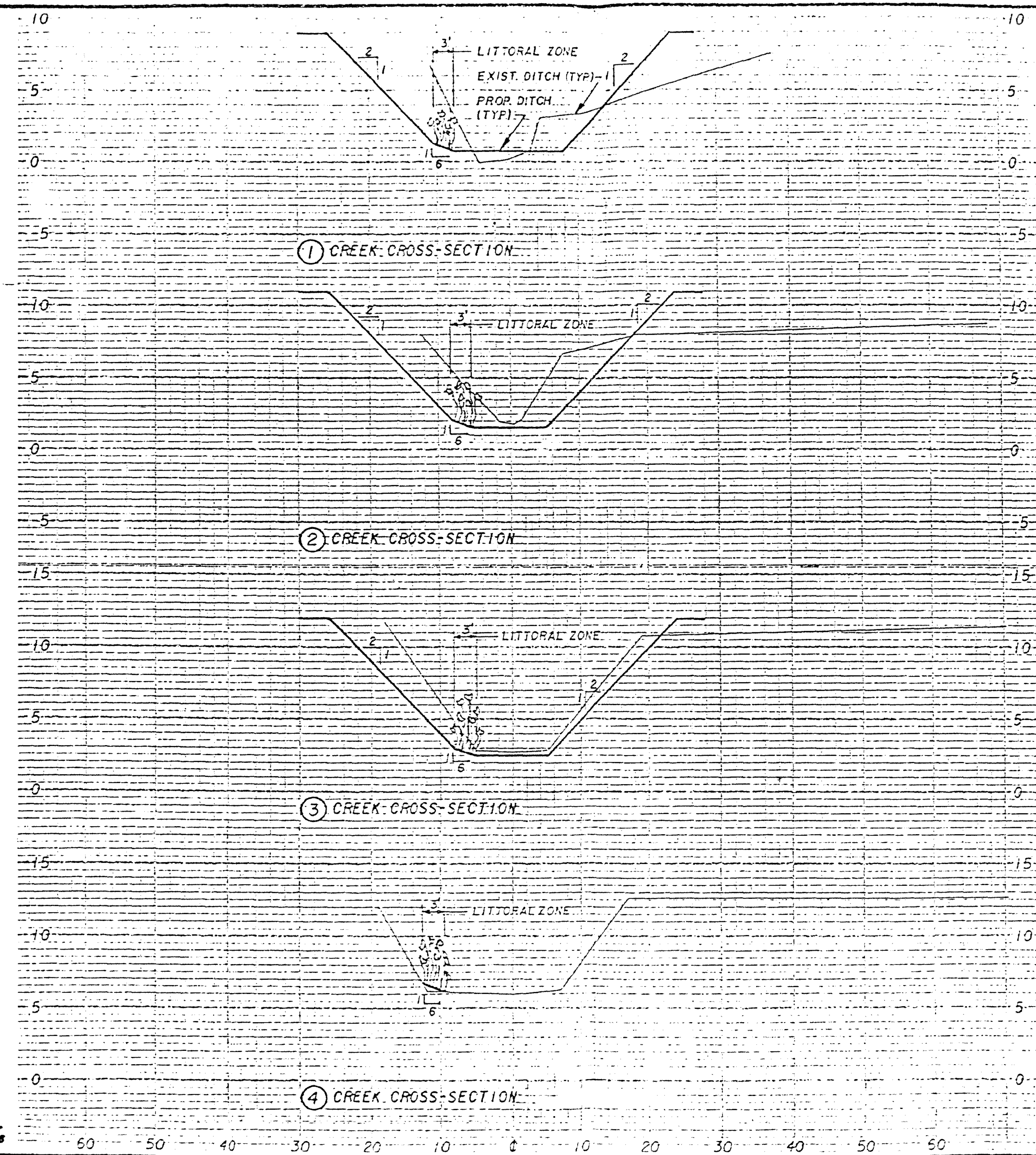

EXISTING & PROPOSED CHANNEL CROSS-SECTIONS

CLOWER CREEK

SARASOTA COUNTY, FLORIDA

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R-893

FIGURE 5-4

The effectiveness of this alternative in reducing solids was determined in a like manner as the concrete lined channel alternative. The field data collected upstream and downstream of these locations was used to determine the percent reduction in sediment that could be accomplished by significantly reducing the channel bank erosion and bed load movement. Although some nutrient removal will occur in the proposed littoral zone, no percent reduction was assumed. Table 5-7 summarizes the estimated pollutant reduction.

TABLE 5-7
EFFECTIVENESS OF CHANNEL IMPROVEMENT

Parameter	% Reduction	Existing Annual Loading lb/yr.	Reduction in Annual Loading lb/yr.
Settleable Solids	20	354	71
Total Suspended Solids	10	42,484	4,250
Total Nitrogen	0	2,012	------
Total Phosphorous	0	707	------
Stormwater Flow	0	193 MG/yr	------

Reshaping the channel, stabilizing the channel banks and creating a littoral zone is estimated to cost approximately $33,000. The basis for this estimate is shown on the following table.

TABLE 5-8
COST OF CHANNEL IMPROVEMENT

Item	Quantity	Unit Price	Construction Cost
Reshape Channel	1000-ft.	$20.00	$ 20,000.00
Sod/Plants	650 yd^2	3.00	1,950.00
Erosion Control Fabric	400 yd^2	10.00	4,000.00
Littoral Zone	433 yd^2	5.00	2,170.00
Maintenance Labor and Equipment		500/yr.	10,000.00
	Construction Cost		$38,120.00
	Contingencies Cost (15%)		5,718.00
	Total Cost		$44,000.00

5.25 Route Flow into Pelican Plaza Detention Basin

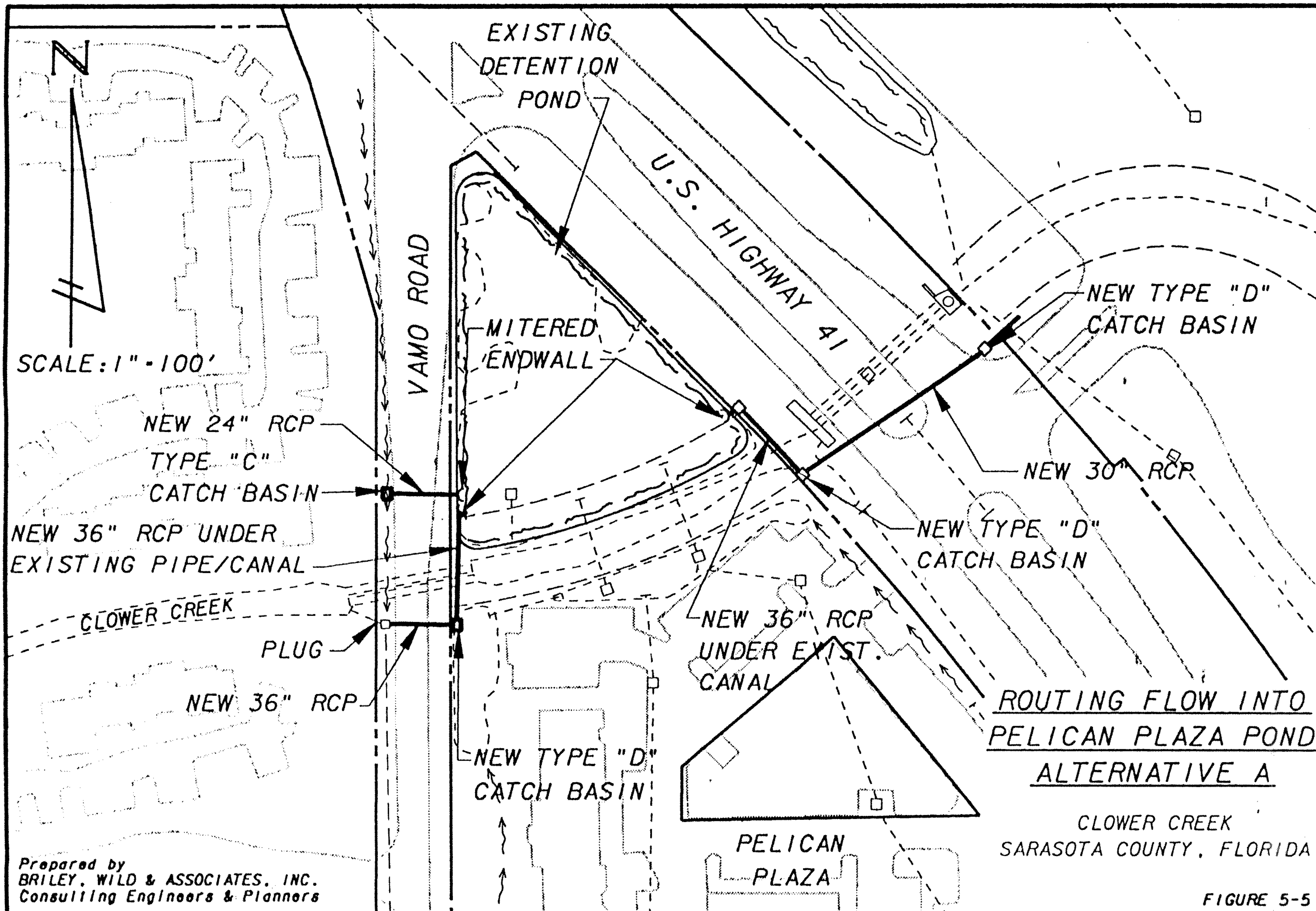
The runoff from U.S. 41, Vamo Road and the residential area of Marcia and Marbeth Streets is not routed through any retention/detention system prior to discharge to the Creek. An alternative was evaluated to route this flow into an existing detention pond at the intersection of U.S. 41 and Vamo Road just north of Clower Creek. This pond presently serves Pelican Plaza Shopping Center.

The advantage of this alternative would be to provide sediment removal and nutrient treatment and to provide flow attenuation for smaller storm events. The disadvantages include the cost of re-routing the stormwater conveyance system and the cost of reshaping the pond to meet wet detention basin design criteria in order to maximize the water quality treatment.

As discussed in Section 5.22, a properly designed wet detention basin is capable of removing 90 percent of the solids, 50 percent of the nitrogen and 65 percent of the phosphorous. A more conservative estimate of 60 percent for solids removal has been used in this study.

This alternative was evaluated in two parts. Part A collects runoff from both sides of U.S. 41 and routes it into the pond. Part B eliminates the costly bore and jack crossing of U.S. 41 with the runoff from the east side of U.S. 41 continuing to discharge into Clower Creek untreated. The area of the Basin which Alternative A is designed to treat is 18 percent of the total Basin area. Part B is designed to treat 14 percent of the Basin. Figures 5-5 and 5-6 illustrate the flow re-routing for each part of this alternative.

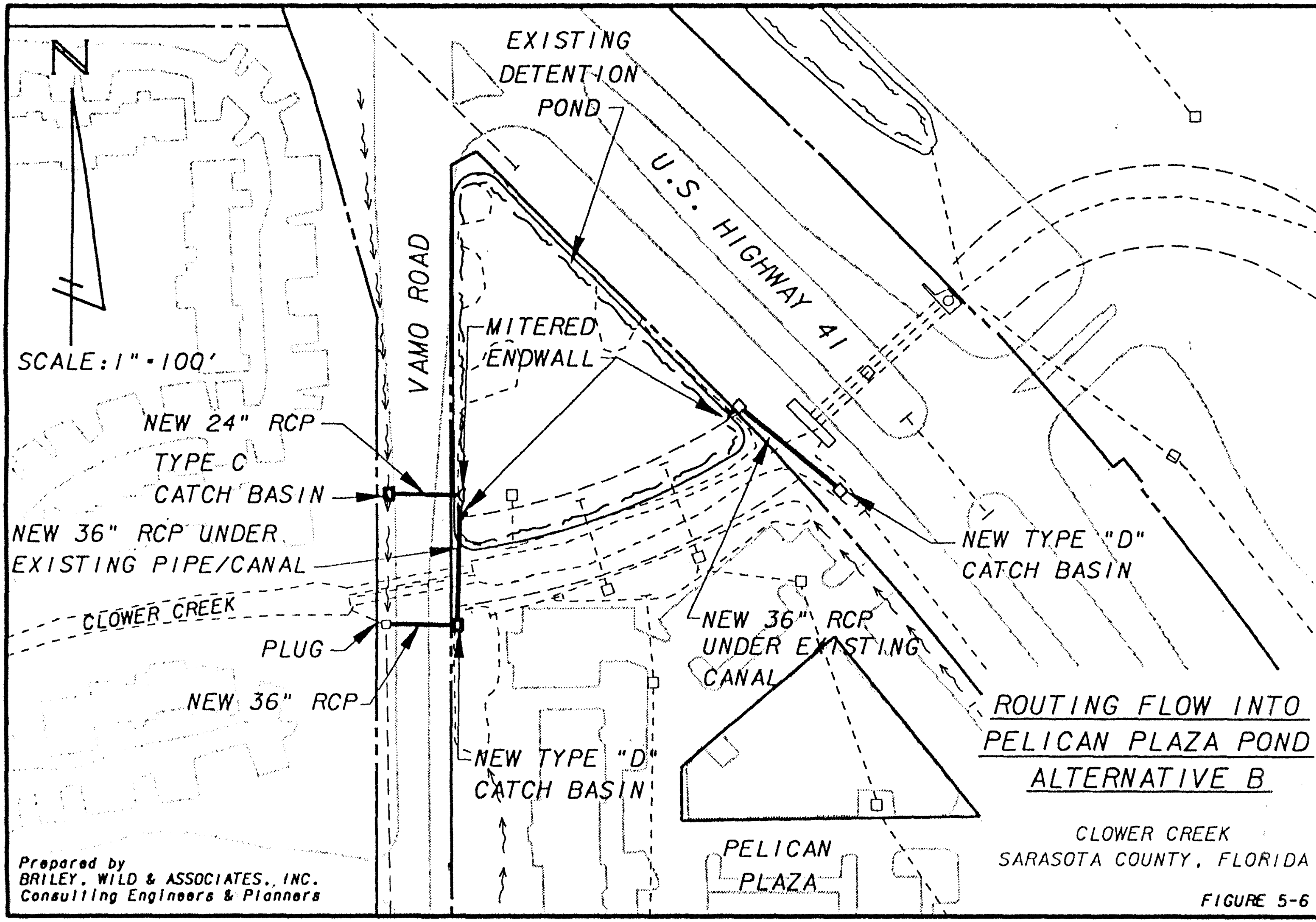
To evaluate the effectiveness of these alternatives, the percentage of the basin to be treated was multiplied by the percent removal expected to occur in a wet detention basin. This value was multiplied by the existing annual loading of each parameter to determine the reduction in loading each alternative could provide. Table 5-9 lists the computed effectiveness.



ROUTING FLOW INTO PELICAN PLAZA POND ALTERNATIVE A

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

FIGURE 5-5



ROUTING FLOW INTO PELICAN PLAZA POND ALTERNATIVE B

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

FIGURE 5-6

TABLE 5-9
EFFECTIVENESS OF ROUTING FLOW INTO PELICAN PLAZA POND

		ALTERNATIVE A		ALTERNATIVE B	
Parameter	Existing Annual Loading lb/yr.	% Reduction	Reduction in Annual Loading lb/yr.	% Reduction	Reduction in Annual Loading lb/yr.
Settleable Solids	354	(18) (60)	38	(14) (60)	30
Total Suspended Solids	42,484	(18) (60)	4,590	(14) (60)	3,570
Total Nitrogen	2,012	(18) (50)	181	(14) (50)	141
Total Phosphorous	707	(18) (65)	83	(14) (65)	65
Stormwater Flow	193 MG/yr	0	------	0	------

The cost of constructing Alternative A which includes the crossing of U.S. 41 was estimated to be approximately $170,000. Alternative B was estimated to cost approximately $56,000. The detailed cost estimates are shown in Table 5-10.

TABLE 5-10
COST OF ROUTING FLOW INTO PELICAN PLAZA POND
ALTERNATIVE A

Item	Quantity	Unit Price	Construction Cost
Bore and Jack U.S. 41 (175-ft. - 30-inch RCP)		Lump Sum	$ 100,000.00
24-inch RCP Crossing of Vamo Road	50 L.F.	100.00	5,000.00
36-inch RCP Crossing of Vamo Road	50 L.F.	150.00	7,500.00
2 - 36-inch RCP Crossing Under Clower Creek	153 L.F.	175.00	26,775.00
Catch Basin	5	1,500.00	7,500.00
Mitered Endwall	2	500.00	1,000.00
	Construction Cost		$147,775.00
	Contingencies Cost (15%)		22,166.00
	Total Cost		$170,000.00

TABLE 5-10 (Cont'd)
COST OF ROUTING FLOW INTO PELICAN PLAZA POND
ALTERNATIVE B

Item	Quantity	Unit Price	Construction Cost
24-inch RCP Crossing of Vamo Road	50 L.F.	100.00	$ 5,00.00
36-inch RCP Crossing of Vamo Road	50 L.F.	150.00	7,500.00
2 - 36-inch RCP Crossing Under Clower Creek	165 L.F.	175.00	26,775.00
Catch Basin	4	1,500.00	6,000.00
Mitered Endwall	2	500.00	1,000.00
	Construction Cost		$48,375.00
	Contingencies Cost (15%)		7,256.00
	Total Cost		$56,000.00

5.26 Ditch Checks

As discussed previously the runoff from the highway/roadway areas in the basin is presently not routed through any retention/detention facility. An alternate was investigated to install ditch checks in the roadside swales of U.S. 41 and Vamo Road. In order to accommodate combinations of alternates, the ditch check alternative was evaluated for the east side of U.S. 41 only as well. Two types of ditch checks were evaluated: sodded ditch checks and rigid ditch checks. Figure 5-7 illustrates the typical detail of each.

The purpose of a ditch check is to trap the first flush of runoff which contains the most concentrated pollutants and force this runoff to percolate into the swale. Careful design of the height and location of the ditch check assures limited reduction in stormwater conveyance capacity of the swale.

The advantage of this alternative is the reduction in sediment and stormwater flow and the increased percolation in the swales. The capital cost is minimal but the right-of-way maintenance costs may be increased.

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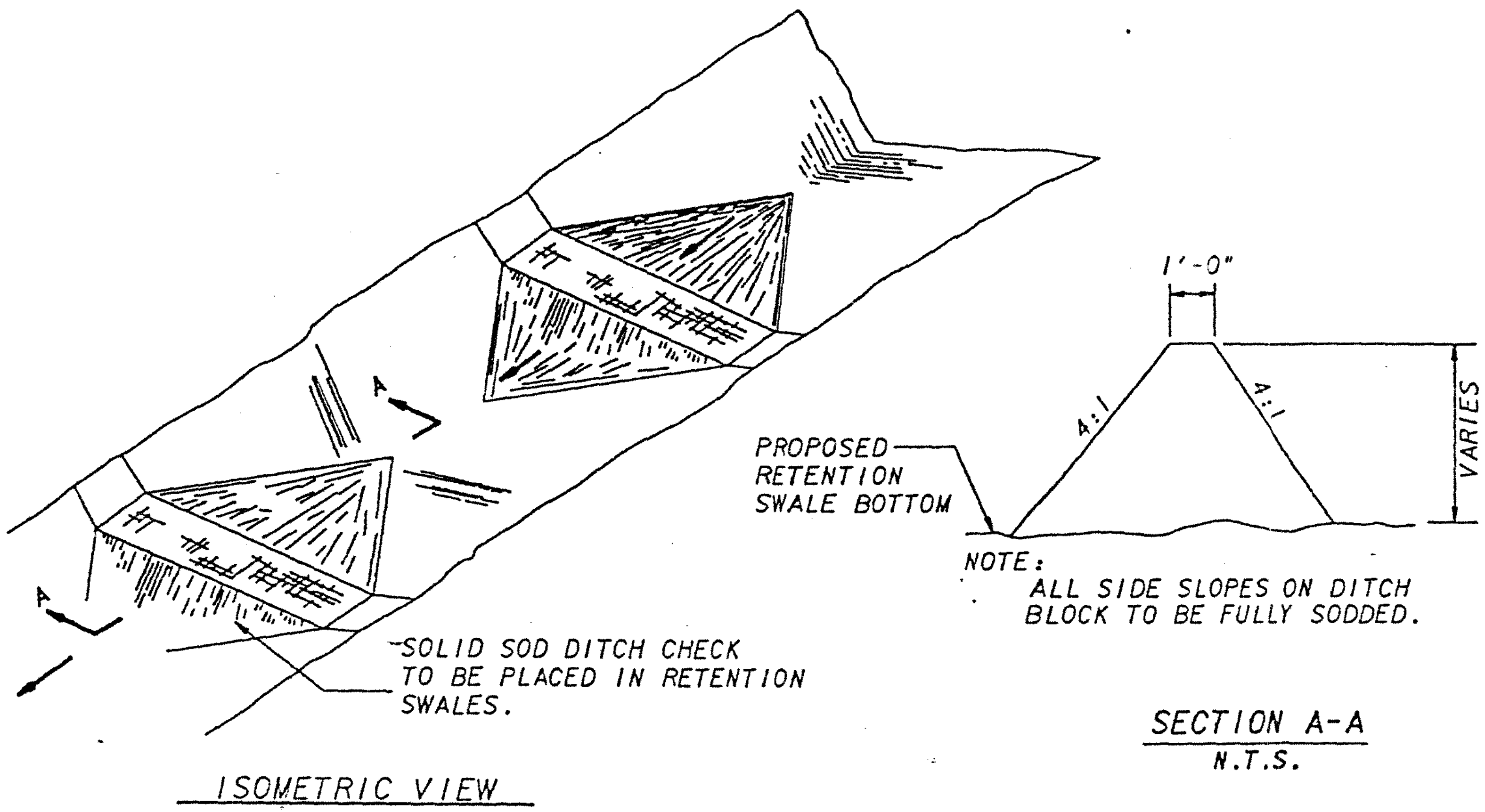
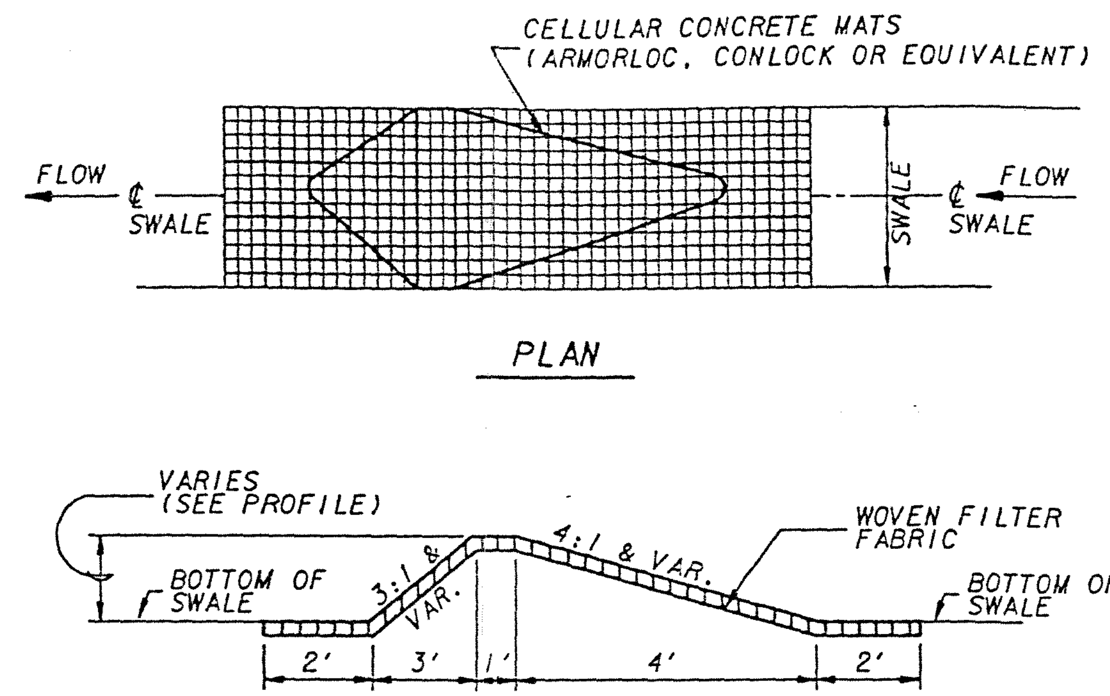


SOD DITCH CHECK



RIGID DITCH CHECK

DITCH CHECK ALTERNATIVE

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

R-893

PREPARED BY:
BRILEY, WILD & ASSOCIATES, INC.
CONSULTING ENGINEERS AND PLANNERS

FIGURE 5-7

The effectiveness of ditch checks was determined by computing the treatment volume that would be provided by the ditch checks and the percentage of total volume this equated to. This percentage was multiplied by the annual pollutant loading and flow to determine the reductions shown on Table 5-11. The effectiveness of each type of ditch check are the same.

TABLE 5-11
EFFECTIVENESS OF DITCH CHECKS

Parameter	% Reduction	Existing Annual Loading lb/yr.	Reduction in Annual Loading lb/yr.
Settleable Solids	6.8	354	24
Total Suspended Solids	6.8	42,484	2,883
Total Nitrogen	6.8	2,012	136
Total Phosphorous	6.8	707	48
Stormwater Flow	6.8	193 MG/yr	13 MG/yr

EFFECTIVENESS OF DITCH CHECKS ON EAST SIDE OF U.S. 41 ONLY

Parameter	% Reduction	Existing Annual Loading lb/yr.	Reduction in Annual Loading lb/yr.
Settleable Solids	2.3	354	8.2
Total Suspended Solids	2.3	42,484	988
Total Nitrogen	2.3	2,012	47
Total Phosphorous	2.3	707	16
Stormwater Flow	2.3	193 MG/yr	4.5 MG/yr

The estimated cost of sodded ditch checks is approximately $3,600 for both sides of U.S. 41 and Vamo Road and approximately $1,400 for the east side of U.S. 41 only. For rigid ditch checks the cost is $9,300 for the entire proposed area and $3,700 for the east side of U.S. 41 only. The costs are summarized below in Table 5-12.

TABLE 5-12
COST OF DITCH CHECKS

Item	Quantity	Unit Price	Construction Cost
U.S. 41 Ditch Check			
Sodded	17	135.00	$ 2,295.00
Rigid	17	350.00	5,950.00
Vamo Road Ditch Check			
Sodded	8	100.00	800.00
Rigid	8	260.00	2,080.00
East Side of U.S. 41 Only Ditch Check			
Sodded	9	135.00	1,215.00
Rigid	9	350.00	3,150.00

Construction Cost - Sodded Ditch Checks	$3,095.00
Contingencies Cost (15%)	464.00
Total Cost - Sodded Ditch Checks	$3,600.00
Construction Cost - Rigid Ditch Checks	$8,030.00
Contingencies Cost (15%)	1,205.00
Total Cost - Rigid Ditch Checks	$9,300.00
Construction Cost - Rigid Ditch Checks on East Side of U.S. 41	$1,215.00
Contingencies Cost (15%)	182.00
Total Cost - Sodded Ditch Checks on East Side of U.S. 41	$1,400.00
Construction Cost - Rigid Ditch Checks on East Side of U.S. 41	$3,1505.00
Contingencies Cost (15%)	472.00
Total Cost - Rigid Ditch Checks on East Side of U.S. 41	$3,700.00

5.27 Route Flow From Park East into Detention Basin

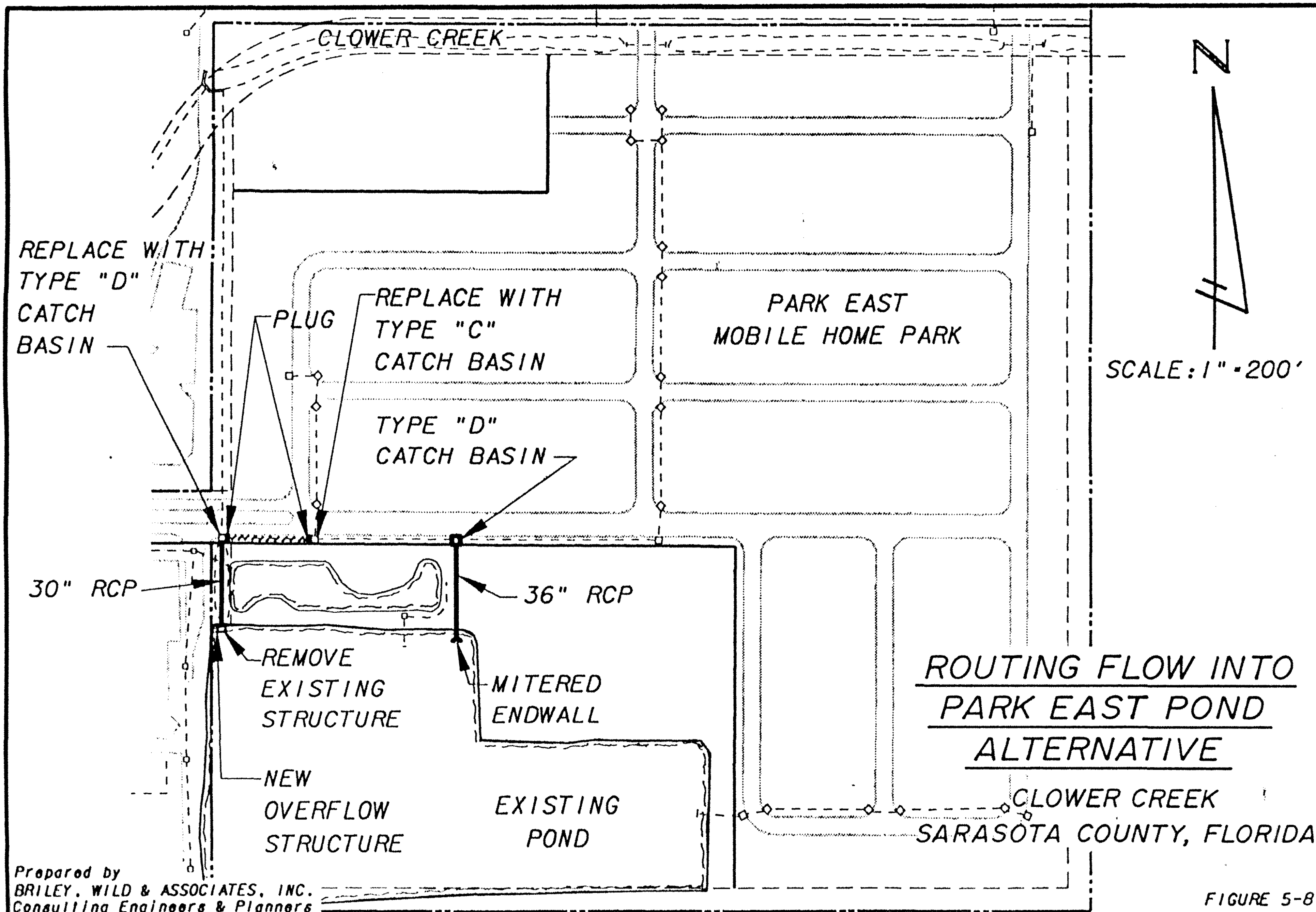
Park East Mobile Home Park is an approximately 35 acre site in the southeastern portion of the Clower Creek basin. Runoff from approximately 10 acres of the development presently discharges into an existing 5 acre pond. Runoff from the rest of the development currently is collected in a stormwater system and piped directly to Clower Creek. It is proposed in this alternative to route the flow from the remaining 25 acres through the existing pond and reshape the pond into a wet detention basin with a littoral shelf. Figure 5-8 illustrates the proposed re-routing.

As discussed previously, a wet detention system offers significant reduction in pollutant concentration. In addition to the sediment and nutrient removal, a reduction in localized flooding would occur as a result of the routing into the pond. The disadvantages are the cost of re-routing the storm sewers and the cost of reconstructing the pond to meet wet detention criteria.

The estimate of the effectiveness of this alternative was computed in a like manner as the re-routing into the Pelican Plaza pond. The additional area of Park East which would be treated under this alternate is approximately 8.33 percent of the total Basin area. This percentage was multiplied by the estimated percent removal that can be accomplished with a wet detention system. This value multiplied by the annual loading leaving the basin provides the pollutant reduction of this alternative. The effectiveness is summarized below in Table 5-13.

TABLE 5-13
EFFECTIVENESS OF ROUTING FLOW INTO PARK EAST POND

Parameter	% Reduction	Existing Annual Loading lb/yr.	Reduction in Annual Loading lb/yr.
Settleable Solids	(8.33) (60)	354	18
Total Suspended Solids	(8.33) (60)	42,484	2,123
Total Nitrogen	(8.33) (50)	2,012	84
Total Phosphorous	(8.33) (65)	707	38
Stormwater Flow	0	193 MG/yr	0



ROUTING FLOW INTO PARK EAST POND ALTERNATIVE

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

Prepared by
BRILEY, WILD & ASSOCIATES, INC.
Consulting Engineers & Planners

FIGURE 5-8

The re-routing of the storm sewers and the reconstruction of the pond with a littoral zone and a new overflow structure and discharge pipe is estimated to cost approximately $30,000. Table 5-14 summarizes the costs incurred in this alternate.

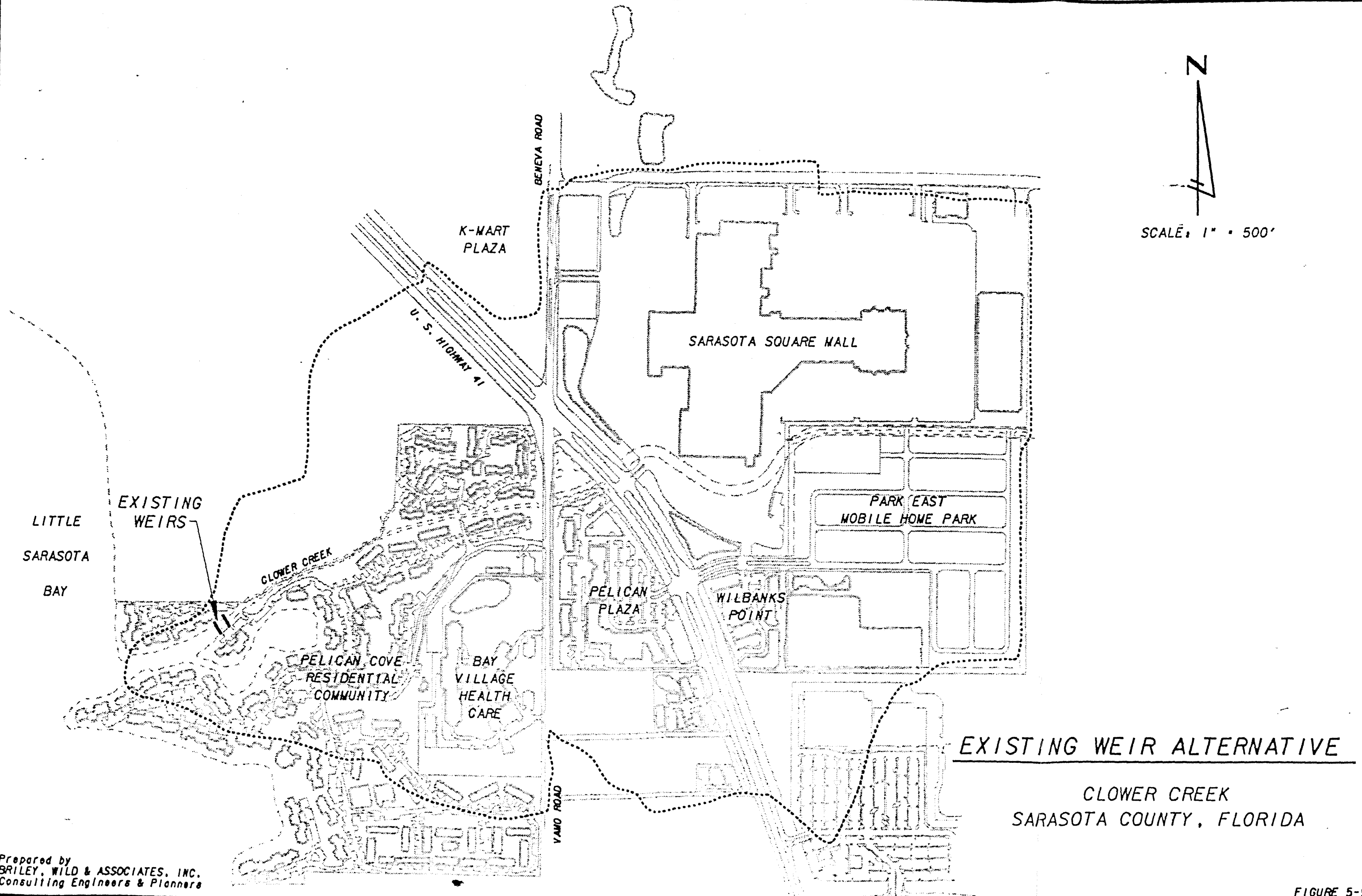
TABLE 5-14
COST OF ROUTING FLOW INTO PARK EAST POND

Item	Quantity	Unit Price	Construction Cost
Pond Reconstruction		Lump Sum	$ 5,000.00
Catch Basin	3	1,500.00	4,500.00
Overflow Structure	1	2,500.00	2,500.00
30-inch RCP	140 L.F.	43.00	6,020.00
36-inch RCP	150 L.F.	51.00	7,650.00
Mitered Endwall	1	500.00	500.00
	Construction Cost		$26,170.00
	Contingencies Cost (15%)		3,925.00
	Total Cost		$30,000.00

5.28 Utilize Existing Creek Bed Weirs

There are two existing weir structures near the mouth of Clower Creek just upstream of the Pelican Cove harbor entrance. The location of the weirs is illustrated on Figure 5-9. These weirs have been periodically dredged at the same time the harbor entrance was dredged. This alternative recommends that these weirs be maintained properly to reduce the sediment passing through into Little Sarasota Bay. The difficulty of physically removing the sediment build-up with minimal disturbance of vegetation and the cost of this periodic activity is the disadvantage of the alternative. The advantage is a reduction in siltation of the harbor entrance and Little Sarasota Bay for a fairly low cost.

Assuming the creek bed weirs would act in a similar manner as swales checks in removing solids, a reduction of 50 percent of settleable solids and 20 percent of suspended solids has been assumed to evaluate the effectiveness. A 20 percent reduction in nitrogen and phosphorous was also assumed. Table 5-15 summarizes the anticipated values for this alternative.



EXISTING WEIR ALTERNATIVE

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

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FIGURE 5-9

TABLE 5-15
EFFECTIVENESS OF UTILIZING CREEK BED WEIRS

Parameter	% Reduction	Existing Annual Loading lb/yr.	Reduction in Annual Loading lb/yr.
Settleable Solids	50	354	177
Total Suspended Solids	20	42,484	8,500
Total Nitrogen	20	2,012	402
Total Phosphorous	20	707	142
Stormwater Flow	0	193 MG/yr	------

The cost associated with this alternative is the periodic dredging cost. Assuming the dredging would be required every five years for a twenty year period the cost would be $75,000. The 20 year period was chosen for alternative comparison purposes. Table 5-16 provides the computed quantity and unit price data.

TABLE 5-16
COST OF UTILIZING CREEK BED WEIRS

Item	Quantity	Unit Price	Construction Cost
Dredge Channel	370 yd^3	25.00	$ 9,260.00
	Construction Cost		$9,260.00
	Contingencies Cost (15%)		1,389.00
	Total Cost		$10,650.00/ every 5 years
	For a 20 year period:		
	Total Cost		$53,250.00
	Cost Increase (40%)		21,300.00
	Total Cost for a 20 year period		$75,000.00

5.29 Convert Asphalt Parking

An alternative was evaluated to convert some of the existing asphalt parking in the Sarasota Square Mall to grass parking. The potential areas where grass parking would be used to accommodate overflow parking during peak shopping periods is shown on Figure 5-10.

There are several advantages of grass parking in lieu of asphalt. By reducing the impervious area, the runoff and sediment contribution are reduced. Local recharge is increased. The disadvantages are the cost of converting the parking and the higher maintenance cost.

The NURP data was used to determine the percent reduction in pollutant loading that could be expected from the change in land use from asphalt to grass parking. The stormwater runoff reduction was based on the difference in the computed runoff from the two surfaces using the Rational Method.

The area proposed for conversion amounts to 2.2 percent of the basin area. This value was multiplied by the reduction percentages to determine the reduction in pollutant loadings from the Clower Creek basin. Table 5-17 illustrates the expected effectiveness of this alternative.

TABLE 5-17
EFFECTIVENESS OF PARKING CONVERSION

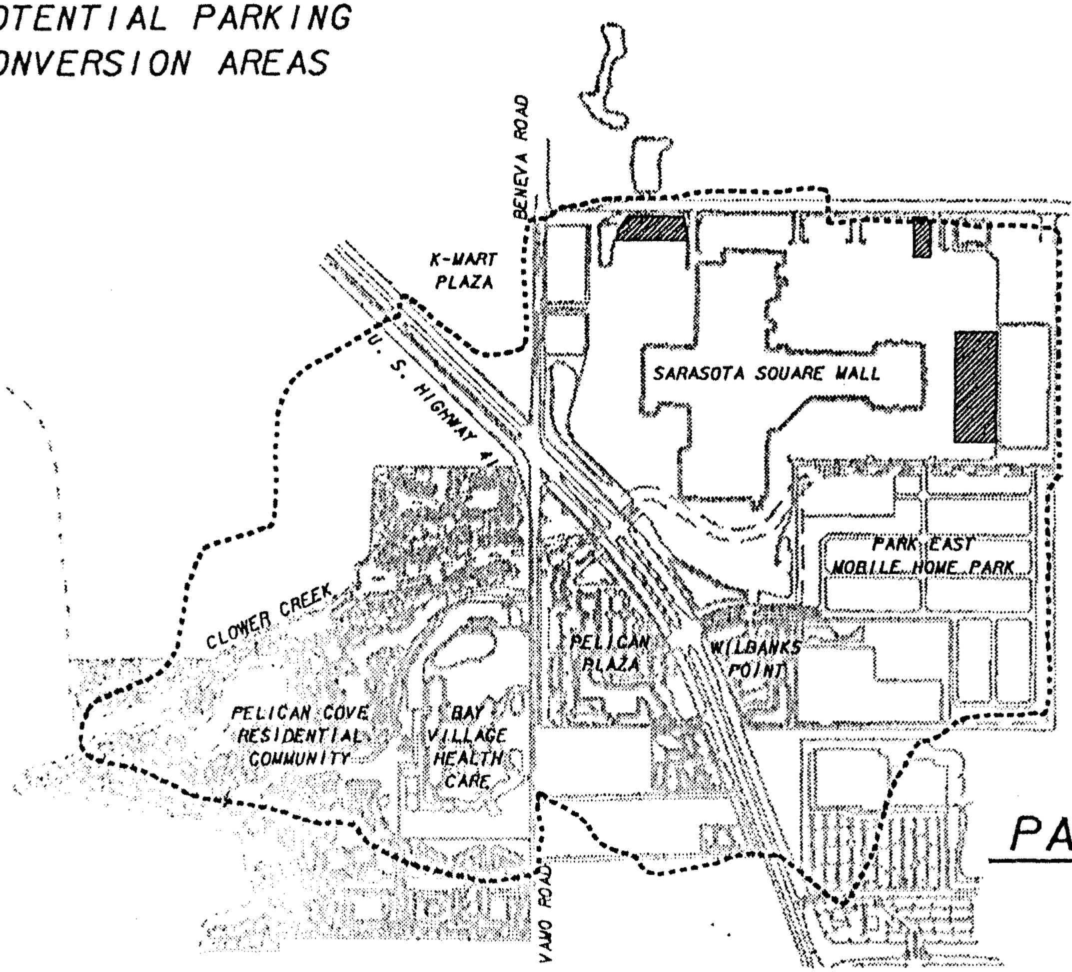
Parameter	% Reduction	Existing Annual Loading lb/yr.	Reduction in Annual Loading lb/yr.
Settleable Solids	(2.2) (88)	354	71
Total Suspended Solids	(2.2) (88)	42,484	830
Total Nitrogen	(2.2) (56)	2,012	25
Total Phosphorous	(2.2) (88)	707	14
Stormwater Flow	(2.2) (78)	193 MG/yr	3.3 MG/yr

As mentioned above, the cost of converting asphalt parking to grass parking is quite high. The ideal approach would be to include grass for overflow parking in the original design. However, this alternative investigated the cost of conversion which was estimated to be approximately $630,000. Table 5-18 summarizes the costs involved.

TABLE 5-18
COST OF PARKING CONVERSION

Item	Quantity	Unit Price	Construction Cost
Asphalt Removal	32,225 yd^2	10.00	$ 322,250.00
Sod	32,225 yd^2	7.00	225,575.00
	Construction Cost		$547,825.00
	Contingencies Cost (15%)		82,174.00
	Total Cost		$630,000.00

POTENTIAL PARKING CONVERSION AREAS



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SCALE: 1" = 1000'

PARKING CONVERSION ALTERNATIVE

CLOWER CREEK
SARASOTA COUNTY, FLORIDA

Prepared by
BRILEY, WILD & ASSOCIATES, INC.
Consulting Engineers & Planners

FIGURE 5-10

SECTION 6.0
SELECTED ALTERNATIVES

SECTION 6.0
SELECTED ALTERNATIVES

6.10 General

A comparative analysis of the nine alternatives and their sub-alternatives was performed to determine which are the most effective improvements. A ranking was developed based on the cost per pound of pollutants removal and on the total pounds of pollutant removed for each of the evaluated alternatives.

The selected alternatives were incorporated into the AdICPR computer model and the proposed system analyzed for the design storm of a 10 year frequency - 24 hour duration.

6.20 Alternative Comparative Analysis

In order to form a basis of comparison for each of the nine alternatives considered and their sub-alternatives the cost per pound of pollutant removed was computed. These costs are summarized in Table 6-1. Each of the alternatives was then ranked by its cost effectiveness in removing each of the pollutants and in reducing the quantity of stormwater runoff.

As shown in Table 6-1, only two of the alternatives are successful in reducing all four pollutants and the flow. Several of the alternatives have very high removal rates of one or more of the constituents but are ineffective in reducing other parameters. However, all of the alternatives were able to reduce Settleable and Total Suspended Solids. As this study was initiated because of increased siltation, the lack of nutrient removal capabilities of some of the alternatives was not considered in the averaging. In order to compare the total effectiveness of each of the nine alternatives and the four sub-alternatives, the individual rankings resulting from the cost effectiveness of reducing each of the constituents was averaged. For example, the cost effectiveness of lining the channel with concrete ranks 11 in Settleable Solids and 12 in Total Suspended Solids. Therefore, the average cost effectiveness for this alternative is 11.5. A summary of the averaged ranking is in Table 6-2. The averages were then ranked in order from one to fourteen with one being the most cost effective.

TABLE 6-1

COST EFFECTIVENESS

ALTERNATIVE	COST, $	SS REDUCTION LB./YR.	COST/LB. SS REMOVED	TSS REDUCTION LB./YR.	COST/LB. TSS REMOVED	TN REDUCTION LB./YR.	COST/LB. TN LB./YR.	TP REDUCTION LB./YR.	COST/LB. TP LB./YR.	FLOW REDUCTION M GAL./YR.	COST/MG FLOW REMOVED
1. Concrete Channel	337,000.	138	2,445	4,250	80	0	-	0	-	0	-
2. Detention Basin	476,000.	212	2,245	25,490	19	1,006	475	460	1,035	0	-
3. Desiltation Basin	856,500.	283	3,025	34,000	25	402	2,130	141	6,075	0	-
4. Channel Improvements	44,000.00	71	620	4,250	10	0	-	0	-	0	-
5. Route Flow into Pelican Plaza Pond											
With U.S. 41 Crossing	170,000.	38	4,475	4,590	37	181	940	83	2,050	0	-
Without U.S. 41 Crossing	56,000.	30	1,870	3,570	16	141	400	65	860	0	-
6. Ditch Checks											
U.S. 41/Vamo Road											
Sodded	3,600.	24	150	2,883	1	136	26	48	75	13	435
Rigid	9,300.	24	390	2,883	3	136	68	48	195	13	715
East Side of U.S. 41 Only											
Sodded	1,400.	8.2	170	988	1	47	30	16	88	4.5	315
Rigid	3,700.	8.2	450	988	4	47	79	16	230	4.5	825
7. Route Park East MHP into Detention Pond	30,000.	18	1,670	2,123	14	84	360	38	780	0	-
8. Use Existing Weirs	75,000.*	177	425	8,500	9	402	190	142	530	0	-
9. Replace Asphalt Paving	630,000.	71	8,875	7,830	760	25	25,200	14	45,000	3.3	190,900

* Dredging every 5 years for 20 years

TABLE 6-2

EFFECTIVENESS RANKING

ALTERNATIVE	RANKING BY COST/LB. REMOVED Average	RANKING BY COST/LB. REMOVED Overall	RANKING BY TOTAL LB. REMOVED Average	RANKING BY TOTAL LB. REMOVED Overall	COMBINED RANKING Average	COMBINED RANKING Overall	EVALUATED EFFECTIVENESS RANKING
1. Concrete Channel	11.6	13	2.0	3	8.0	9	8
2. Detention Basin	8.8	9	1.5	1	5.0	4	4
3. Desiltation Basin	10.5	10	1.8	2	6.0	5	7
4. Channel Improvements	3.5	3	2.2	4	3.5	1	1
5. Route Flow into Pelican Plaza Pond							
With U.S. 41 Crossing	10.5	10	5.0	7	8.5	11	6
Without U.S. 41 Crossing	15.7	14	6.8	10	12.0	14	
6. Ditch Checks							
U.S. 41/Vamo Road							
Sodded	1.2	1	6.4	8	4.5	2	2
Rigid	6.5	7	6.4	8	7.5	8	
East Side of U.S. 41 Only							
Sodded	1.6	2	9.2	12	7.0	7	
Rigid	4.4	4	9.2	12	8.0	9	
7. Route Park East MHP into Detention Pond	6.8	8	9.8	14	11.0	12	5
8. Use Existing Weirs *	5.5	6	2.5	6	6.0	5	3
9. Replace Asphalt Paving	10.8	12	9.0	11	11.5	13	9

* Dredging every 5 years for 20 years

The total pounds of pollutant reduction varied significantly among the alternatives. A comparison was also made of each of the nine alternatives and the four sub-alternatives to rank their effectiveness by total pounds or million gallons removed. As with the cost per pound ranking, the total pound ranking was performed for each constituent and the average ranking computed. Table 6-2 includes a summary of this average ranking and the ranking from one to fourteen with one removing the highest poundage.

To provide an overall comparison, the average ranking by cost per pound and the average ranking by total pounds were averaged and the average ranked from one to fourteen with one being the most effective. After further evaluation, an overall ranking of the alternatives was provided. The resultant ranking was as follows:

1. Channel Improvements.
2. Sodded Ditch Checks for U.S. 41/Vamo Road.
3. Use Existing Weirs.
4. New Detention Basin.
5. Route Park East into Detention Pond.
6. Route Flow into Pelican Plaza Pond.
7. Desiltation Basin.
8. Concrete Channel.
9. Replace Asphalt Parking.

6.30 Recommended Alternatives

As mentioned previously, three presentations of the results of this study were given to representatives of Sarasota County, South Florida Water Management District, Florida Department of Transportation, Department of Environmental Regulation and the National Estuary Program's Technical Advisory Committee. These meetings provided input regarding the permitability of the alternatives as well as an in-depth discussion of which alternatives were most preferable from both an environmental and practical standpoint. Several of the alternatives were modified as a result of the suggestions made at these meetings, such as the adding of a littoral zone to the channel improvement alternate.

After all suggestions and comments had been taken into account, Briley Wild and Sarasota County personnel developed the following list of recommended alternatives:

1. Channel improvement of 1300-ft of Clower Creek.
2. Install sodded ditch checks in the swales along U.S. 41 and Vamo Road.
3. Route the flow from the Park East Mobile Home Park into the existing detention pond.
4. Effectively utilize the existing Creek bed weirs.

Table 6-3 provides a summary of the cost and effectiveness of the four recommended alternatives. A brief synopsis of each follows.

As discussed previously, a portion of the Clower Creek channel downstream from Vamo Road contains several constricted areas which cause high velocities. The velocities are such that severe channel bank erosion and sediment bed load movement are contributing to the increased siltation in the Pelican Cove Harbor entrance and Little Sarasota Bay. An improved cross-section in these areas is recommended with stabilized channel banks and a proposed littoral zone. Please refer to Section 5.24 for a more detailed discussion and to Figures 5-5 and 5-6 for an illustration of the proposed improvements.

Sodded ditch checks are proposed in the swales along U.S. 41 and Vamo Road. The runoff from these highway areas and the residential area of Marcia and Marbeth Streets which discharges to these swales is presently untreated. The ditch checks are designed to trap the first flush of runoff which contains the most concentrated pollutants and force this flow to percolate. Section 5.26 contains a more detailed discussion and Figure 5-7 illustrates the typical design of a ditch check.

Runoff from approximately 25 acres of the 35 acre Park East Mobile Home Park presently discharges directly into Clower Creek with no water quality treatment. It is proposed in this recommended alternative to route this runoff through the existing detention pond and reconstruct the pond to meet wet detention criteria. The proposed re-routing is illustrated on Figure 5-8 and further discussed in Section 5.27.

As described in Section 5.28, there are two existing weir structures near the mouth of Clower Creek just upstream of the Pelican Cove Harbor entrance. It is recommended that these weirs be periodically dredged to remove the trapped sediment. This periodic maintenance offers a significant reduction in siltation of the harbor entrance and Little Sarasota Bay for a fairly low cost.

TABLE 6-3
SUMMARY OF RECOMMENDED ALTERNATIVES

Alternatives	lb. SS Removal/yr.	lb. TSS Removal/yr.	lb. TN Removal/yr.	lb. TP Removal/yr.	MG Flow Removal/yr.	Cost
Channel Improvement	71	4,250	------	------	------	$33,000.00
Ditch Checks	24	2,883	136	48	13	3,600.00
Route Park East Flow	18	2,123	84	38	------	30,000.00
Utilize Existing Weirs	177	8,500	402	142	------	75,000.00 *
TOTAL	296	17,756	622	228	13	$141,600.00
% Reduction from Existing Loading	84	42	31	32	6.7	

* Cost for dredging every 5 years for 20 years.

6.40 Other Recommendations

In addition to the above improvements, it is also recommended that an improved maintenance program and best management practices be implemented.

6.41 Maintenance Program

It is a recommendation of this report that County forces be reinforced to provide for routine maintenance of storm sewer systems, channels and culverts. The owners of the private stormwater management facilities provide the routine maintenance of their storm sewer systems and retention/detention basins. It is recommended that their maintenance programs be improved.

Maintenance is extremely important in assuring the designed hydraulic capacities of these systems are not reduced due to accumulated rubbish or debris or from overgrown vegetation. Floating debris has a tendency to clog culverts and is many times the primary reason for flooding. Maintenance also provides the related benefits of an aesthetically pleasing environment and minor improvements to water quality.

Frequency of a maintenance program will vary depending upon the function. Vegetation and sedimentation should be removed from channels on semi-annual to annual basis. Inspection for debris or rubbish should be at a minimum on a monthly basis or following a major storm occurrence.

6.42 Best Management Practices

With the improvements recommended by this report in place, the majority of the runoff from the Clower Creek basin will pass through some kind of retention/detention system where water quality treatment will occur. One area of significance that the proposed system does not provide treatment for is the Pelican Cove residential area. Runoff from this area discharges directly into the Creek. The density of the development and the proximity of the existing buildings to the Creek does not allow for construction of structural stormwater controls.

It is recommended that non-structural controls for reducing stormwater pollutants, i.e. best management practices, be implemented in this area. Non-structural source controls, as defined in the Florida Development Manual produced by the Department of Environmental Regulation, are practices that are intended to improve runoff quality by reducing the generation and accumulation of potential stormwater runoff contaminants at or near their sources. Following is a summary of stormwater management practices recommended in the Florida Development Manual for use in Florida.

Fertilizer Application Control. This practice involves managing the use of fertilizer so as to keep it on the land and out of our waterways. Implementation will result in maximum effectiveness of the nutrients on vegetation and reduced nutrient loads in our waterways. The practice covers concepts such as public education, the need for soil testing, and the proper timing of fertilizer applications.

Pesticide Use Control. This practice involves eliminating excessive pesticide use by proper application procedures and the use of alternatives to chemical pest control. The goal is to reduce the load of pesticide-related contaminants in stormwater runoff. The practice covers legal requirements for pesticide application, methods of application, equipment cleaning, disposal of unused chemicals and empty containers, pesticide storage, alternative pest control methodologies, and public education.

Solid Waste Collection and Disposal. This practice involves the routine management and handling of urban refuse, litter and fallen leaves in ways that will prevent their becoming water pollutants. Recommendations range from improved municipal trash and leaf collection and disposal operations to public education concerning collection procedures and concepts such as recycling wastes.

Street Cleaning. This practice involves sweeping, vacuuming, flushing, or otherwise cleaning streets, parking lots and other paved vehicular traffic areas. The objective is to remove dry-weather accumulations of pollutants, especially fine particulate matter, before wash-off can occur, thus reducing the potential for pollution impacts on receiving waters. In the past, street cleaning operations were conducted primarily for aesthetic purposes; however, they are now known to be an effective method for improving the quality of runoff.

6.50 Proposed Stormwater Management System

The existing stormwater management system was analyzed for a 10 year frequency - 24 hour duration storm event. These results may be found in Section 3.0. The improvements recommended in this Section were incorporated into the AdICPR model and a simulation of the 10 year - 24 hour event performed.

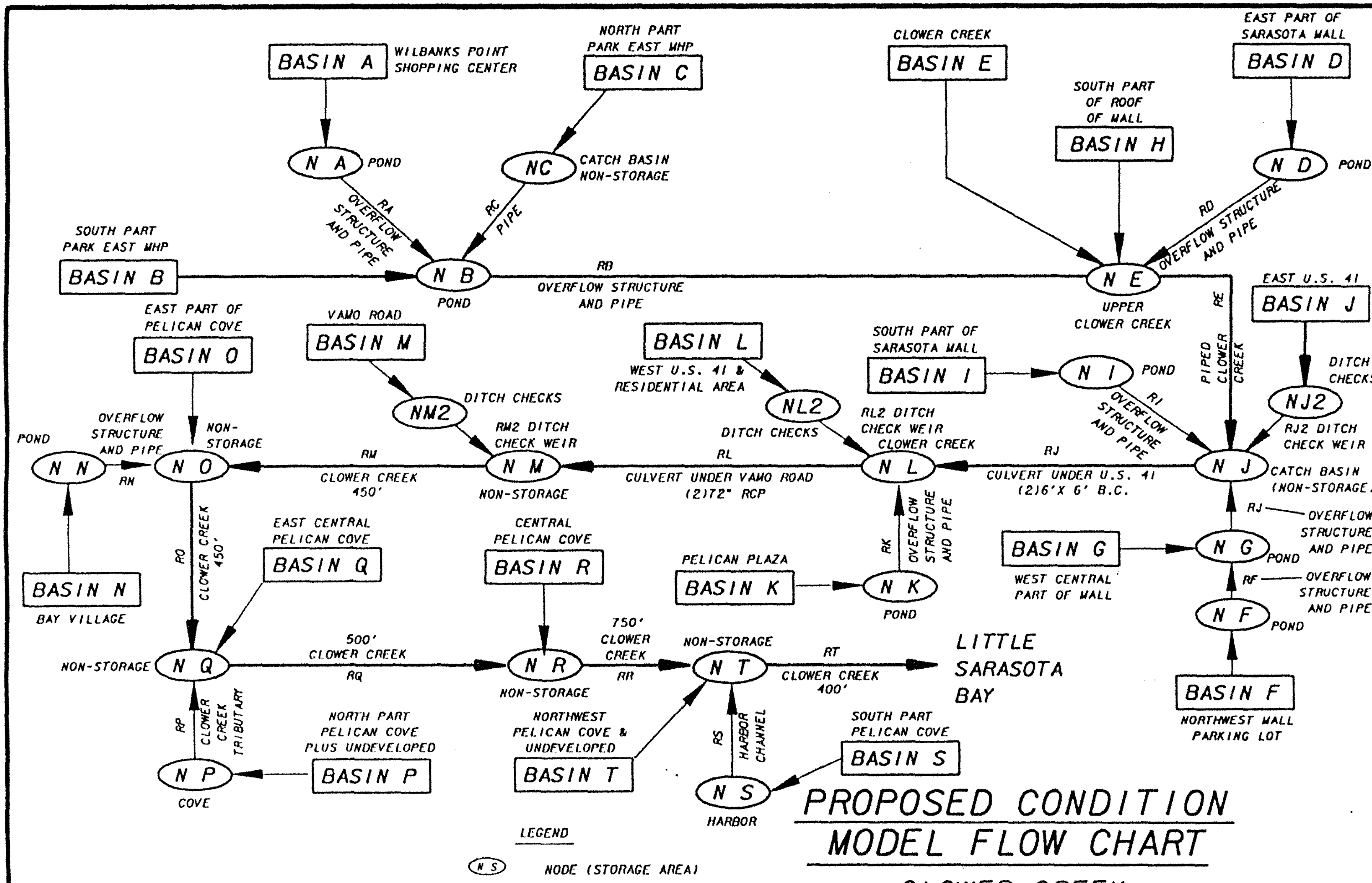
The channel improvement significantly reduced the flood elevations in these areas, while maintaining approximately the same flow. The velocities were such that the bank erosion and bed load movement should essentially be eliminated.

The ditch check alternative raised the stage elevations in the swales but did not create any upstream flooding. The slightly higher elevations are not considered to have any adverse impact on the drainage system of the Clower Creek basins.

The Park East Mobile Home Park alternative raised the elevation in the existing pond. While this did not create any additional upstream flooding, a reduction in the existing flooding did not occur as intended. During the design phases of the project, the overflow structure and piping will be modified to improve the existing drainage in addition to the water quality treatment offered by this alternative.

A layout of the AdICPR node and reach diagram revised for the proposed condition is shown on Figure 6-1. Appendix 2 contains a printout of the input data for the nodes and reaches for the proposed improvements. Table 6-4 lists the nodal maximums resulting from the 10 year - 24 hour storm event in the proposed condition. The maximum stage, peak inflow and outflow are shown for each node. The proposed reach maximum flows and stages resulting from the design storm event are listed in Table 6-5.

R-893 ST 90223-3



PROPOSED CONDITION MODEL FLOW CHART

CLOWER CREEK

SARASOTA COUNTY, FLORIDA

FIGURE 6-1

Prepared by
BRILEY, WILD & ASSOCIATES, INC.
Consulting Engineers & Planners

TABLE 6-4
PROPOSED NODAL MAXIMUMS

Node Designation	Stage (ft)	Inflow (cfs)	Outflow (cfs)
NA	14.37	29.2	10.3
NB	13.36	124	13.1
NC	15.05	70.1	69.8
ND	15.13	199	61.1
NE	11.33	107	77.5
NF	15.88	47.5	4.3
NG	14.98	99.0	25.9
NI	14.05	42.2	8.6
NJ	9.13	124	116
NJ2	13.27	13.0	12.9
NK	11.49	61.8	11.1
NL	9.06	154	154
NL2	14.27	38.2	30.8
NM	6.24	165	165
NM2	13.21	18.4	11.9
NN	14.73	37.9	9.2
NO	5.68	188	179
NP	5.54	46.0	42.4
NQ	5.23	228	220
NR	4.70	239	229
NS	3.70	68.1	62.1
NT	3.67	301	293
NU	3.50	293	------

TABLE 6-5
PROPOSED REACH MAXIMUMS

Reach Designation	Time (hrs)	Flow (cfs)	From Node Designation	Stage (ft)	To Node Designation	Stage (ft)
RA	12.58	10.3	NA	14.4	NB	12.6
RB	14.83	13.1	NB	13.4	NE	10.6
RC	12.33	69.8	NC	15.0	NB	12.2
RD	12.75	61.1	ND	15.1	NE	11.3
RE	12.75	77.2	NE	11.3	NJ	9.0
RF	25.50	4.3	NF	14.6	NG	11.9
RG	13.58	25.9	NG	14.6	NJ	9.0
RI	12.58	8.6	NI	14.0	NJ	9.0
RJ	12.83	114.	NJ	9.1	NL	9.0
RJ2	14.75	12.9	NJ2	13.3	NJ	8.6
RK	15.75	11.1	NK	11.2	NL	8.2
RL	13.17	152.	NL	9.0	NM	6.2
RL2	13.17	30.8	NL2	14.3	NL	9.0
RM	13.17	164.	NM	6.2	NO	5.6
RM2	12.92	11.9	NM2	13.2	NM	6.2
RN	13.92	9.2	NN	14.6	NO	5.4
RO	13.08	177.	NO	5.6	NQ	5.2
RP	12.67	42.4	NP	5.5	NQ	5.2
RQ	12.92	218.	NQ	5.2	NR	4.7
RR	12.92	228.	NR	4.7	NT	3.7
RS	12.50	62.2	NS	3.7	NT	3.7
RT	12.67	292.	NT	3.7	NU	3.5

SECTION 7.0
SUMMARY AND RECOMMENDATIONS

SECTION 7.0
SUMMARY AND RECOMMENDATIONS

7.10 Introduction

The purpose of the Clower Creek Stormwater Study was to develop improvements that would improve the quality and reduce the quantity of stormwater runoff entering Little Sarasota Bay. Early on in the study it was realized that significant reduction in quantity would be very difficult considering lack of available undeveloped land and the presence of a high water table. However, a significant improvement of water quality could be accomplished with several cost-effective alternatives.

Our recommendations include physical improvements, such as channel improvement, routing through water quality treatment systems, system maintenance and best management practices. Each of these matters are important elements to improve the quality of stormwater discharging into Little Sarasota Bay.

7.20 Findings and Conclusions

A number of pertinent findings and conclusions were made during the course of this study. Briefly those are:

1. Limited water quality data indicates existing stormwater detention/treatment facilities are having a positive effect.

2. Limited settleable solids and suspended solids data indicates that the siltation problem may have been largely due to construction activities.

3. The stormwater runoff reaching the Clower Creek basin from Pelican Cove, Park East Mobile Home Park and from the U.S. Highway 41 and Vamo Road areas receives no detention/treatment.

4. Significant improvements in stormwater quality and limited reductions in stormwater runoff can be effected by programmed maintenance of existing facilities and by construction of new facilities.

Development of the proposed stormwater management system is the first step toward solving the existing and future siltation problem in the Clower Creek basin. This Basin is typical in Sarasota County and elsewhere with a natural waterway conveying poor quality runoff from a highly urbanized area to a protected water body. Many of the improvements recommended for this Basin can be used in similar areas.

7.30 Recommended Improvements

We recommend that the County proceed with construction of the following improvements:

Recommended Improvement	Total Cost
1. Improve 1300-ft. of Clower Creek stabilizing the channel banks and providing a littoral zone	$33,000.00
2. Install sodded ditch checks in the swales along U.S. 41 and Vamo Road	3,600.00
3. Route the runoff from Park East Mobile Home Park into the existing detention pond	30,000.00
4. Utilize the existing Creek bed weirs	75,000.00 *

* Dredging every 5 years for 20 years.

Recommended Program Cost	$141,600.00

7.40 Other Recommendations

We further recommend that Sarasota County undertake the following:

1. Allocate additional resources to stormwater management system maintenance.

2. Implement a Best Management Practices program.

7.50 Summary

This plan develops a program which will provide for the removal of settleable solids from the stormwater entering and transversing Clower Creek. The result is that siltation in the Creek Basin will be reduced, and the quality of water entering Little Sarasota Bay will be improved. The recommendations are cost effective and the benefits of protecting the Bay warrant the expenditure.

APPENDIX 1

Advanced Interconnected Channel & Pond Routing (adICPR Ver 1.30)
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CLOWER CREEK 10 YR 24 HR EXISTING
9/11/91

NODE NAME	NODE TYPE	INI STAGE (ft)	X-COOR (ft)	Y-COOR (ft)	LENGTH (ft)	STAGE (ft)	AREA/TIME (ac)/(hr)
NA	AREA	11.000	.000	.000	.000	11.000	.420
						12.000	.520
						13.000	.620
						14.000	.730
						15.000	.880
						16.000	.880
NB	AREA	11.000	.000	.000	.000	11.000	5.150
						12.000	5.300
						13.000	5.460
						14.000	5.620
						15.000	5.770
						16.000	5.770
NC1	AREA	10.000	.000	.000	.000	10.000	.000
						11.000	.050
						12.000	.050
						13.000	.050
						14.000	.050
						15.000	5.000
NC2	AREA	9.000	.000	.000	.000	9.000	.050
						15.000	.050
ND	AREA	11.000	.000	.000	.000	11.000	3.260
						12.000	3.370
						13.000	3.490
						14.000	3.610
						15.000	3.730
						16.000	3.850
						17.000	3.850
NE	AREA	8.000	.000	.000	.000	8.000	.010
						9.000	.080
						10.000	.190
						11.000	.290
						12.000	.370
						13.000	.440
						14.000	.510
						15.000	.580
						15.500	.620
						16.500	.620

CLOWER CREEK 10 YR 24 HR EXISTING
9/11/91

NODE NAME	NODE TYPE	INI STAGE (ft)	X-COOR (ft)	Y-COOR (ft)	LENGTH (ft)	STAGE (ft)	AREA/TIME (ac)/(hr)
NF	AREA	12.000	.000	.000	.000	12.000	.310
						13.000	.350
						14.000	.390
						15.000	.430
						16.000	5.000
NG	AREA	10.000	.000	.000	.000	10.000	.970
						11.000	1.080
						12.000	1.180
						13.000	1.290
						14.000	1.420
						15.000	1.560
						16.000	1.720
						17.000	5.000
NI	AREA	11.500	.000	.000	.000	11.500	.800
						12.000	.830
						13.000	.900
						14.000	.980
						15.000	1.050
						16.000	1.140
						17.000	5.000
NJ	AREA	6.000	.000	.000	.000	6.000	.050
						14.000	.050
NK	AREA	5.500	.000	.000	.000	5.500	.410
						6.000	.440
						7.000	.500
						8.000	.560
						9.000	.620
						10.000	.690
						11.000	.760
						12.000	5.000
NL	AREA	5.000	.000	.000	.000	5.000	.005
						6.000	.010
						7.000	.050
						8.000	.080
						9.000	.100
						10.000	.110
						11.000	.120
						12.000	.120

Advanced Interconnected Channel & Pond Routing (adICPR Ver 1.30)

CLOWER CREEK 10 YR 24 HR EXISTING
9/11/91

NODE NAME	NODE TYPE	INI STAGE (ft)	X-COOR (ft)	Y-COOR (ft)	LENGTH (ft)	STAGE (ft)	AREA/TIME (ac)/(hr)
NM	AREA	3.000	.000	.000	.000	12.000	.050
						17.000	.050
NN	AREA	12.000	.000	.000	.000	12.000	.790
						13.000	.880
						14.000	.970
						15.000	.970
NO	AREA	2.000	.000	.000	.000	12.000	.050
						17.000	.050
NP	AREA	.000	.000	.000	.000	.000	.050
						1.000	.100
						2.000	.130
						3.000	.160
						4.000	.210
						5.000	.260
						6.000	.320
						7.000	.320
NQ	AREA	1.000	.000	.000	.000	10.000	.050
						15.000	.050
NR	AREA	.500	.000	.000	.000	8.000	.050
						13.000	.050
NS	AREA	.000	.000	.000	.000	.000	.050
						1.000	1.000
						2.000	1.300
						3.000	1.600
						4.000	2.000
						5.000	2.500
						6.000	3.100
						7.000	3.100
NT	AREA	.100	.000	.000	.000	5.000	.050
						10.000	.050
NU	TIME	3.500	.000	.000	.000	3.500	.000
						3.500	30.000

CLOWER CREEK 10 YR 24 HR EXISTING
9/11/91

```
>>REACH NAME       : RC1
  FROM NODE        : NC1
  TO NODE          : NC2
  REACH TYPE       : CIRCULAR CULVERT
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF

  CULVERT DATA     :
         SPAN (in):  24.000        RISE (in):  24.000     LENGTH (ft): 525.000
   U/S INVERT (ft):  10.000 D/S INVERT (ft):    9.210       MANNING N:     .024
       ENTRNC LOSS:    .500   # OF CULVERTS:    1.000

  POSITION A       : NOT USED

  POSITION B       : NOT USED

              NOTE:

>>REACH NAME       : RC2
  FROM NODE        : NC2
  TO NODE          : NE
  REACH TYPE       : ARCH CULVERT
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF

  CULVERT DATA     :
         SPAN (in):  43.000        RISE (in):  27.000     LENGTH (ft): 700.000
   U/S INVERT (ft):   8.980 D/S INVERT (ft):    7.820       MANNING N:     .024
       ENTRNC LOSS:    .500   # OF CULVERTS:    1.000

  POSITION A       : NOT USED

  POSITION B       : NOT USED

              NOTE:
```

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CLOWER CREEK 10 YR 24 HR EXISTING
9/11/91

```
>>REACH NAME        : RC1
  FROM NODE         : NC1
  TO NODE           : NC2
  REACH TYPE        : CIRCULAR CULVERT
  FLOW DIRECTION    : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH      : OFF

  CULVERT DATA      :
         SPAN (in):   24.000       RISE (in):   24.000     LENGTH (ft): 525.000
   U/S INVERT (ft):   10.000 D/S INVERT (ft):    9.210       MANNING N:     .024
       ENTRNC LOSS:     .500   # OF CULVERTS:    1.000

  POSITION A        : NOT USED

  POSITION B        : NOT USED

              NOTE:

>>REACH NAME        : RC2
  FROM NODE         : NC2
  TO NODE           : NE
  REACH TYPE        : ARCH CULVERT
  FLOW DIRECTION    : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH      : OFF

  CULVERT DATA      :
         SPAN (in):   43.000       RISE (in):   27.000     LENGTH (ft): 700.000
   U/S INVERT (ft):    8.980 D/S INVERT (ft):    7.820       MANNING N:     .024
       ENTRNC LOSS:     .500   # OF CULVERTS:    1.000

  POSITION A        : NOT USED

  POSITION B        : NOT USED

              NOTE:
```

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```
>>REACH NAME       : RE
  FROM NODE        : NE
  TO NODE          : NJ
  REACH TYPE       : CIRCULAR CULVERT
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF

  CULVERT DATA     :
         SPAN (in):  78.000        RISE (in):  78.000     LENGTH (ft): 962.000
   U/S INVERT (ft):   7.820 D/S INVERT (ft):    6.080       MANNING N:     .013
       ENTRNC LOSS:    .500   # OF CULVERTS:    1.000

  POSITION A       : NOT USED

  POSITION B       : NOT USED

            NOTE:

>>REACH NAME       : RJ
  FROM NODE        : NJ
  TO NODE          : NL
  REACH TYPE       : RECTANGULAR CULVERT
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF

  CULVERT DATA     :
         SPAN (in):  72.000        RISE (in):  72.000     LENGTH (ft): 118.000
   U/S INVERT (ft):   6.000 D/S INVERT (ft):    5.400       MANNING N:     .013
       ENTRNC LOSS:    .500   # OF CULVERTS:    2.000

  POSITION A       : NOT USED

  POSITION B       : NOT USED

            NOTE:
```

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9/11/91

```
>>REACH NAME       : RL
  FROM NODE        : NL
  TO NODE          : NM
  REACH TYPE       : CIRCULAR CULVERT
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF

  CULVERT DATA     :
         SPAN (in):  72.000       RISE (in):  72.000     LENGTH (ft):  98.200
   U/S INVERT (ft):   5.400 D/S INVERT (ft):   3.420       MANNING N:    .013
       ENTRNC LOSS:    .500   # OF CULVERTS:   2.000

  POSITION A       : NOT USED

  POSITION B       : NOT USED

             NOTE:
```

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CLOWER CREEK 10 YR 24 HR EXISTING
9/11/91

```
>>REACH NAME       : RA
  FROM NODE        : NA
  TO NODE          : NB
  REACH TYPE       : CIRCULAR CULVERT
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF

  CULVERT DATA     :
         SPAN (in):  24.000       RISE (in):  24.000     LENGTH (ft):  45.000
   U/S INVERT (ft):   9.250 D/S INVERT (ft):   8.980       MANNING N:    .013
       ENTRNC LOSS:    .500   # OF CULVERTS:   1.000

  POSITION A       : RECTANGULAR RISER SLOT
    CREST EL. (ft):  13.000  CREST LN. (ft):   2.000    OPENING (ft): 999.000
        WEIR COEF.:   3.200       GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

  POSITION B       : NOT USED

              NOTE:

>>REACH NAME       : RB
  FROM NODE        : NB
  TO NODE          : NC2
  REACH TYPE       : CIRCULAR CULVERT
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF

  CULVERT DATA     :
         SPAN (in):  30.000       RISE (in):  30.000     LENGTH (ft): 140.000
   U/S INVERT (ft):   9.300 D/S INVERT (ft):   9.040       MANNING N:    .013
       ENTRNC LOSS:    .500   # OF CULVERTS:   1.000

  POSITION A       : RECTANGULAR RISER SLOT
    CREST EL. (ft):  11.500  CREST LN. (ft):  25.000    OPENING (ft): 999.000
        WEIR COEF.:   3.200       GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

  POSITION B       : NOT USED

              NOTE:
```

```
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CLOWER CREEK 10 YR 24 HR EXISTING
9/11/91

>>REACH NAME       : RD
  FROM NODE        : ND
  TO NODE          : NE
  REACH TYPE       : CIRCULAR CULVERT
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF

  CULVERT DATA     :
         SPAN (in):   60.000        RISE (in):   60.000     LENGTH (ft): 125.000
   U/S INVERT (ft):    9.050 D/S INVERT (ft):    8.090        MANNING N:    .013
       ENTRNC LOSS:     .500    # OF CULVERTS:    1.000

  POSITION A       : RECTANGULAR RISER SLOT
    CREST EL. (ft):   12.280  CREST LN. (ft):    4.000     OPENING (ft):   2.750
        WEIR COEF.:    3.200      GATE COEF.:     .600 NUMBER OF ELEM.:   1.000

  POSITION B       : RECTANGULAR RISER SLOT
    CREST EL. (ft):   15.030  CREST LN. (ft):   16.000     OPENING (ft): 999.000
        WEIR COEF.:    3.200      GATE COEF.:     .600 NUMBER OF ELEM.:   1.000

             NOTE:

>>REACH NAME       : RF
  FROM NODE        : NF
  TO NODE          : NG
  REACH TYPE       : CIRCULAR CULVERT
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF

  CULVERT DATA     :
         SPAN (in):   15.000        RISE (in):   15.000     LENGTH (ft): 600.000
   U/S INVERT (ft):   12.000 D/S INVERT (ft):    9.600        MANNING N:    .013
       ENTRNC LOSS:     .500    # OF CULVERTS:    1.000

  POSITION A       : RECTANGULAR RISER SLOT
    CREST EL. (ft):   13.500  CREST LN. (ft):    2.500     OPENING (ft):    .600
        WEIR COEF.:    3.200      GATE COEF.:     .600 NUMBER OF ELEM.:   1.000

  POSITION B       : NOT USED

             NOTE:
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CLOWER CREEK 10 YR 24 HR EXISTING
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```
>>REACH NAME       : RG
  FROM NODE        : NG
  TO NODE          : NJ
  REACH TYPE       : CIRCULAR CULVERT
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF

  CULVERT DATA     :
         SPAN (in):  24.000        RISE (in):  24.000     LENGTH (ft): 110.000
   U/S INVERT (ft):  10.070 D/S INVERT (ft):   9.400        MANNING N:    .013
       ENTRNC LOSS:    .500    # OF CULVERTS:   1.000

  POSITION A       : RECTANGULAR RISER SLOT
    CREST EL. (ft):  10.070  CREST LN. (ft):   1.000     OPENING (ft):   3.600
        WEIR COEF.:   3.200       GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

  POSITION B       : RECTANGULAR RISER SLOT
    CREST EL. (ft):  13.670  CREST LN. (ft):  10.000     OPENING (ft): 999.000
        WEIR COEF.:   3.200       GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

             NOTE:

>>REACH NAME       : RI
  FROM NODE        : NI
  TO NODE          : NJ
  REACH TYPE       : CIRCULAR CULVERT
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF

  CULVERT DATA     :
         SPAN (in):  18.000        RISE (in):  18.000     LENGTH (ft): 400.000
   U/S INVERT (ft):  11.150 D/S INVERT (ft):   9.400        MANNING N:    .013
       ENTRNC LOSS:    .500    # OF CULVERTS:   1.000

  POSITION A       : RECTANGULAR RISER SLOT
    CREST EL. (ft):  11.150  CREST LN. (ft):   1.000     OPENING (ft):   1.500
        WEIR COEF.:   3.200       GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

  POSITION B       : RECTANGULAR RISER SLOT
    CREST EL. (ft):  12.650  CREST LN. (ft):   4.000     OPENING (ft): 999.000
        WEIR COEF.:   3.200       GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

             NOTE:
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```
>>REACH NAME        : RK
  FROM NODE         : NK
  TO NODE           : NL
  REACH TYPE        : CIRCULAR CULVERT
  FLOW DIRECTION    : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH      : OFF

  CULVERT DATA      :
         SPAN (in):  15.000        RISE (in):  15.000     LENGTH (ft):  32.000
   U/S INVERT (ft):   5.500 D/S INVERT (ft):   5.440       MANNING N:     .013
       ENTRNC LOSS:    .500    # OF CULVERTS:   1.000

  POSITION A        : RECTANGULAR RISER SLOT
    CREST EL. (ft):   9.000  CREST LN. (ft):   4.250    OPENING (ft): 999.000
        WEIR COEF.:   3.200       GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

  POSITION B        : NOT USED

             NOTE:

>>REACH NAME        : RN
  FROM NODE         : NN
  TO NODE           : NO
  REACH TYPE        : CIRCULAR CULVERT
  FLOW DIRECTION    : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH      : OFF

  CULVERT DATA      :
         SPAN (in):  15.000        RISE (in):  15.000     LENGTH (ft): 390.000
   U/S INVERT (ft):   8.020 D/S INVERT (ft):   3.880       MANNING N:     .013
       ENTRNC LOSS:    .500    # OF CULVERTS:   1.000

  POSITION A        : RECTANGULAR RISER SLOT
    CREST EL. (ft):  12.700  CREST LN. (ft):   3.000    OPENING (ft):    .700
        WEIR COEF.:   3.200       GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

  POSITION B        : RECTANGULAR RISER SLOT
    CREST EL. (ft):  13.400  CREST LN. (ft):  16.000    OPENING (ft): 999.000
        WEIR COEF.:   3.200       GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

             NOTE:
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>>REACH NAME        : RM
  FROM NODE         : NM
  TO NODE           : NO
  REACH TYPE        : TRAPEZOIDAL CHANNEL, ENERGY EQ.
  FLOW DIRECTION    : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH      : OFF
   BOT. WIDTH (ft):   10.000   LEFT SS (h/v):    1.400   RGHT SS (h/v):    1.800
       LENGTH (ft): 450.000 U/S INVERT (ft):    2.800 D/S INVERT (ft):    1.900
          MANNING N:     .070    ENTRNC COEF.:     .100 MAX. DEPTH (ft):  99.000

             NOTE:

>>REACH NAME        : RO
  FROM NODE         : NO
  TO NODE           : NQ
  REACH TYPE        : TRAPEZOIDAL CHANNEL, ENERGY EQ.
  FLOW DIRECTION    : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH      : OFF
   BOT. WIDTH (ft):    4.000   LEFT SS (h/v):    1.400   RGHT SS (h/v):    1.100
       LENGTH (ft): 450.000 U/S INVERT (ft):    1.900 D/S INVERT (ft):    1.000
          MANNING N:     .070    ENTRNC COEF.:     .100 MAX. DEPTH (ft):  99.000

             NOTE:

>>REACH NAME        : RP
  FROM NODE         : NP
  TO NODE           : NQ
  REACH TYPE        : TRAPEZOIDAL CHANNEL, ENERGY EQ.
  FLOW DIRECTION    : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH      : OFF
   BOT. WIDTH (ft):    4.000   LEFT SS (h/v):    1.400   RGHT SS (h/v):    1.100
       LENGTH (ft): 400.000 U/S INVERT (ft):    1.100 D/S INVERT (ft):    1.000
          MANNING N:     .070    ENTRNC COEF.:     .100 MAX. DEPTH (ft):  99.000

             NOTE:

>>REACH NAME        : RQ
  FROM NODE         : NQ
  TO NODE           : NR
  REACH TYPE        : TRAPEZOIDAL CHANNEL, ENERGY EQ.
  FLOW DIRECTION    : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH      : OFF
   BOT. WIDTH (ft):    4.000   LEFT SS (h/v):    1.100   RGHT SS (h/v):    4.600
       LENGTH (ft): 550.000 U/S INVERT (ft):    1.000 D/S INVERT (ft):     .500
          MANNING N:     .070    ENTRNC COEF.:     .100 MAX. DEPTH (ft):  99.000

             NOTE:
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```
>>REACH NAME       : RR
  FROM NODE        : NR
  TO NODE          : NT
  REACH TYPE       : TRAPEZOIDAL CHANNEL, ENERGY EQ.
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF
   BOT. WIDTH (ft):  18.000   LEFT SS (h/v):    1.500   RGHT SS (h/v):    6.000
       LENGTH (ft): 650.000 U/S INVERT (ft):     .500 D/S INVERT (ft):     .100
         MANNING N:    .060    ENTRNC COEF.:     .100 MAX. DEPTH (ft):   99.000

            NOTE:

>>REACH NAME       : RS
  FROM NODE        : NS
  TO NODE          : NT
  REACH TYPE       : TRAPEZOIDAL CHANNEL, ENERGY EQ.
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF
   BOT. WIDTH (ft):  20.000   LEFT SS (h/v):    1.600   RGHT SS (h/v):    1.600
       LENGTH (ft): 110.000 U/S INVERT (ft):     .500 D/S INVERT (ft):     .100
         MANNING N:    .060    ENTRNC COEF.:     .100 MAX. DEPTH (ft):   99.000

            NOTE:

>>REACH NAME       : RT
  FROM NODE        : NT
  TO NODE          : NU
  REACH TYPE       : TRAPEZOIDAL CHANNEL, ENERGY EQ.
  FLOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
  TURBO SWITCH     : OFF
   BOT. WIDTH (ft):  50.000   LEFT SS (h/v):   12.000   RGHT SS (h/v):   12.000
       LENGTH (ft): 400.000 U/S INVERT (ft):     .100 D/S INVERT (ft):     .000
         MANNING N:    .060    ENTRNC COEF.:     .100 MAX. DEPTH (ft):   99.000

            NOTE:
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CLOWER CREEK 10 YR 24 HR EXISTING
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REACH SUMMARY

INDEX	RCHNAME	FRMNODE	TONODE	REACH TYPE
1	RC1	NC1	NC2	CIRCULAR CULVERT
2	RC2	NC2	NE	ARCH CULVERT
3	RE	NE	NJ	CIRCULAR CULVERT
4	RJ	NJ	NL	RECTANGULAR CULVERT
5	RL	NL	NM	CIRCULAR CULVERT
6	RA	NA	NB	CIRCULAR CULVERT
7	RB	NB	NC2	CIRCULAR CULVERT
8	RD	ND	NE	CIRCULAR CULVERT
9	RF	NF	NG	CIRCULAR CULVERT
10	RG	NG	NJ	CIRCULAR CULVERT
11	RI	NI	NJ	CIRCULAR CULVERT
12	RK	NK	NL	CIRCULAR CULVERT
13	RN	NN	NO	CIRCULAR CULVERT
14	RM	NM	NO	TRAPEZOIDAL CHANNEL, ENERGY EQ.
15	RO	NO	NQ	TRAPEZOIDAL CHANNEL, ENERGY EQ.
16	RP	NP	NQ	TRAPEZOIDAL CHANNEL, ENERGY EQ.
17	RQ	NQ	NR	TRAPEZOIDAL CHANNEL, ENERGY EQ.
18	RR	NR	NT	TRAPEZOIDAL CHANNEL, ENERGY EQ.
19	RS	NS	NT	TRAPEZOIDAL CHANNEL, ENERGY EQ.
20	RT	NT	NU	TRAPEZOIDAL CHANNEL, ENERGY EQ.

APPENDIX 2

CLOWER CREEK 10 YR 24 HR PROPOSED
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NODE NAME	NODE TYPE	INI STAGE (ft)	X-COOR (ft)	Y-COOR (ft)	LENGTH (ft)	STAGE (ft)	AREA/TIME (ac)/(hr)
NA	AREA	11.000	.000	.000	.000	11.000	.420
						12.000	.520
						13.000	.620
						14.000	.730
						15.000	.880
						16.000	.880
NB	AREA	11.000	.000	.000	.000	11.000	5.150
						12.000	5.300
						13.000	5.460
						14.000	5.620
						15.000	5.770
						16.000	5.770
NC	AREA	9.000	.000	.000	.000	9.000	.050
						15.000	.050
ND	AREA	11.000	.000	.000	.000	11.000	3.260
						12.000	3.370
						13.000	3.490
						14.000	3.610
						15.000	3.730
						16.000	3.850
						17.000	3.850
NE	AREA	8.000	.000	.000	.000	8.000	.010
						9.000	.080
						10.000	.190
						11.000	.290
						12.000	.370
						13.000	.440
						14.000	.510
						15.000	.580
						15.500	.620
						16.500	.620
NF	AREA	12.000	.000	.000	.000	12.000	.310
						13.000	.350
						14.000	.390
						15.000	.430
						16.000	5.000

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NODE NAME	NODE TYPE	INI STAGE (ft)	X-COOR (ft)	Y-COOR (ft)	LENGTH (ft)	STAGE (ft)	AREA/TIME (ac)/(hr)
NG	AREA	10.000	.000	.000	.000	10.000	.970
						11.000	1.080
						12.000	1.180
						13.000	1.290
						14.000	1.420
						15.000	1.560
						16.000	1.720
						17.000	5.000
NI	AREA	11.500	.000	.000	.000	11.500	.800
						12.000	.830
						13.000	.900
						14.000	.980
						15.000	1.050
						16.000	1.140
						17.000	5.000
NJ	AREA	6.000	.000	.000	.000	14.000	.050
						19.000	.050
NK	AREA	5.500	.000	.000	.000	5.500	.410
						6.000	.440
						7.000	.500
						8.000	.560
						9.000	.620
						10.000	.690
						11.000	.760
						12.000	5.000
NL	AREA	4.500	.000	.000	.000	4.500	.005
						6.000	.010
						7.000	.050
						8.000	.080
						9.000	.100
						10.000	.110
						11.000	.120
						12.000	.120
NM	AREA	3.000	.000	.000	.000	12.000	.050
						17.000	.050

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NODE NAME	NODE TYPE	INI STAGE (ft)	X-COOR (ft)	Y-COOR (ft)	LENGTH (ft)	STAGE (ft)	AREA/TIME (ac)/(hr)
NN	AREA	12.000	.000	.000	.000	12.000	.790
						13.000	.880
						14.000	.970
						15.000	.970
NO	AREA	2.000	.000	.000	.000	12.000	.050
						17.000	.050
NP	AREA	.000	.000	.000	.000	.000	.050
						1.000	.100
						2.000	.130
						3.000	.160
						4.000	.210
						5.000	.260
						6.000	.320
						7.000	.320
NQ	AREA	1.000	.000	.000	.000	10.000	.050
						15.000	.050
NR	AREA	.500	.000	.000	.000	8.000	.050
						13.000	.050
NS	AREA	.000	.000	.000	.000	.000	.050
						1.000	1.000
						2.000	1.300
						3.000	1.600
						4.000	2.000
						5.000	2.500
						6.000	3.100
						7.000	3.100
NT	AREA	.100	.000	.000	.000	5.000	.050
						10.000	.050
NU	TIME	3.500	.000	.000	.000	3.500	.000
						3.500	30.000
NL2	AREA	11.000	.000	.000	.000	11.000	.000
						11.500	.350
						12.000	.700
						13.000	.700

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NODE NAME	NODE TYPE	INI STAGE (ft)	X-COOR (ft)	Y-COOR (ft)	LENGTH (ft)	STAGE (ft)	AREA/TIME (ac)/(hr)
NM2	AREA	11.000	.000	.000	.000	11.000	.000
						11.500	.300
						12.000	.600
						13.000	.600
NJ2	AREA	11.000	.000	.000	.000	11.000	.000
						11.500	.150
						12.000	.300
						13.000	.300

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NODE NAME	NODE TYPE	INI STAGE (ft)	X-COOR (ft)	Y-COOR (ft)	LENGTH (ft)	STAGE (ft)	AREA/TIME (ac)/(hr)
NM2	AREA	11.000	.000	.000	.000	11.000	.000
						11.500	.300
						12.000	.600
						13.000	.600
NJ2	AREA	11.000	.000	.000	.000	11.000	.000
						11.500	.150
						12.000	.300
						13.000	.300

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```
:ACH NAME       : RL2
:OM NODE        : NL2
) NODE          : NL
:ACH TYPE       : RECTANGULAR WEIR/GATE/ORIFICE, VILLEMONTE EQ.
.OW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
 CREST EL. (ft):  12.000  CREST LN. (ft):   3.000    OPENING (ft): 999.000
     WEIR COEF.:   3.000      GATE COEF.:    .600 NUMBER OF ELEM.:   1.000
           NOTE:

:ACH NAME       : RM2
:OM NODE        : NM2
) NODE          : NM
:ACH TYPE       : RECTANGULAR WEIR/GATE/ORIFICE, VILLEMONTE EQ.
.OW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
 CREST EL. (ft):  12.000  CREST LN. (ft):   3.000    OPENING (ft): 999.000
     WEIR COEF.:   3.000      GATE COEF.:    .600 NUMBER OF ELEM.:   1.000
           NOTE:

:ACH NAME       : RJ2
:OM NODE        : NJ2
) NODE          : NJ
:ACH TYPE       : RECTANGULAR WEIR/GATE/ORIFICE, VILLEMONTE EQ.
.OW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
 CREST EL. (ft):  12.000  CREST LN. (ft):   3.000    OPENING (ft): 999.000
     WEIR COEF.:   3.000      GATE COEF.:    .600 NUMBER OF ELEM.:   1.000
           NOTE:
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```
ACH NAME        : RJ
OM NODE         : NJ
 NODE           : NL
ACH TYPE        : RECTANGULAR CULVERT
OW DIRECTION    : POSITIVE AND NEGATIVE FLOWS ALLOWED
RBO SWITCH      : OFF

LVERT DATA      :
     SPAN (in):  72.000       RISE (in):  72.000     LENGTH (ft): 118.000
J/S INVERT (ft):   6.000 D/S INVERT (ft):   5.400      MANNING N:    .013
   ENTRNC LOSS:    .500   # OF CULVERTS:   2.000

SITION A        : NOT USED

SITION B        : NOT USED

          NOTE:

EACH NAME       : RL
ROM NODE        : NL
) NODE          : NM
EACH TYPE       : CIRCULAR CULVERT
LOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
JRBO SWITCH     : OFF

JLVERT DATA     :
     SPAN (in):  72.000       RISE (in):  72.000     LENGTH (ft):  98.200
J/S INVERT (ft):   5.400 D/S INVERT (ft):   3.420      MANNING N:    .013
   ENTRNC LOSS:    .500   # OF CULVERTS:   2.000

OSITION A       : NOT USED

OSITION B       : NOT USED

          NOTE:
```

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```
ACH NAME         : RA
OM NODE          : NA
 NODE            : NB
ACH TYPE         : CIRCULAR CULVERT
OW DIRECTION     : POSITIVE AND NEGATIVE FLOWS ALLOWED
RBO SWITCH       : OFF

LVERT DATA       :
     SPAN (in):   24.000      RISE (in):   24.000     LENGTH (ft):  45.000
 /S INVERT (ft):   9.250 D/S INVERT (ft):   8.980       MANNING N:    .013
    ENTRNC LOSS:    .500  # OF CULVERTS:   1.000

SITION A         : RECTANGULAR RISER SLOT
CREST EL. (ft):  13.000  CREST LN. (ft):   2.000    OPENING (ft): 999.000
    WEIR COEF.:   3.200      GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

SITION B         : NOT USED

         NOTE:

ACH NAME         : RB
OM NODE          : NB
 NODE            : NE
ACH TYPE         : CIRCULAR CULVERT
OW DIRECTION     : POSITIVE AND NEGATIVE FLOWS ALLOWED
RBO SWITCH       : OFF

LVERT DATA       :
     SPAN (in):   30.000      RISE (in):   30.000     LENGTH (ft): 600.000
 /S INVERT (ft):   9.300 D/S INVERT (ft):   7.500       MANNING N:    .013
    ENTRNC LOSS:    .500  # OF CULVERTS:   1.000

SITION A         : CIRCULAR RISER SLOT
NVERT EL. (ft):  11.000      SPAN (in):   2.500        RISE (in):   2.500
    WEIR COEF.:   3.200      GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

SITION B         : RECTANGULAR RISER SLOT
CREST EL. (ft):  12.500  CREST LN. (ft):   5.000    OPENING (ft): 999.000
    WEIR COEF.:   3.200      GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

         NOTE:
```

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```
ACH NAME       : RD
OM NODE        : ND
 NODE          : NE
ACH TYPE       : CIRCULAR CULVERT
OW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
RBO SWITCH     : OFF

LVERT DATA     :
     SPAN (in):   60.000       RISE (in):   60.000     LENGTH (ft): 125.000
J/S INVERT (ft):   9.050 D/S INVERT (ft):    8.090       MANNING N:     .013
   ENTRNC LOSS:     .500  # OF CULVERTS:    1.000

SITION A       : RECTANGULAR RISER SLOT
CREST EL. (ft):  12.280  CREST LN. (ft):    4.000    OPENING (ft):    2.750
    WEIR COEF.:   3.200       GATE COEF.:     .600 NUMBER OF ELEM.:   1.000

SITION B       : RECTANGULAR RISER SLOT
CREST EL. (ft):  15.030  CREST LN. (ft):   16.000    OPENING (ft): 999.000
    WEIR COEF.:   3.200       GATE COEF.:     .600 NUMBER OF ELEM.:   1.000

          NOTE:

EACH NAME      : RF
ROM NODE       : NF
) NODE         : NG
EACH TYPE      : CIRCULAR CULVERT
LOW DIRECTION  : POSITIVE AND NEGATIVE FLOWS ALLOWED
JRBO SWITCH    : OFF

JLVERT DATA    :
     SPAN (in):   15.000       RISE (in):   15.000     LENGTH (ft): 600.000
J/S INVERT (ft):  12.000 D/S INVERT (ft):    9.600       MANNING N:     .013
   ENTRNC LOSS:     .500  # OF CULVERTS:    1.000

OSITION A      : RECTANGULAR RISER SLOT
CREST EL. (ft):  13.500  CREST LN. (ft):    2.500    OPENING (ft):     .600
    WEIR COEF.:   3.200       GATE COEF.:     .600 NUMBER OF ELEM.:   1.000

OSITION B      : NOT USED

          NOTE:
```

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```
ACH NAME        : RG
OM NODE         : NG
 NODE           : NJ
ACH TYPE        : CIRCULAR CULVERT
OW DIRECTION    : POSITIVE AND NEGATIVE FLOWS ALLOWED
RBO SWITCH      : OFF

LVERT DATA      :
     SPAN (in):  24.000       RISE (in):  24.000     LENGTH (ft): 110.000
 /S INVERT (ft): 10.070 D/S INVERT (ft):   9.400       MANNING N:    .013
    ENTRNC LOSS:    .500   # OF CULVERTS:   1.000

SITION A        : RECTANGULAR RISER SLOT
CREST EL. (ft):  10.070  CREST LN. (ft):   1.000    OPENING (ft):   3.600
    WEIR COEF.:   3.200      GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

SITION B        : RECTANGULAR RISER SLOT
CREST EL. (ft):  13.670  CREST LN. (ft):  10.000    OPENING (ft): 999.000
    WEIR COEF.:   3.200      GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

          NOTE:

EACH NAME       : RI
ROM NODE        : NI
) NODE          : NJ
EACH TYPE       : CIRCULAR CULVERT
LOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
URBO SWITCH     : OFF

ULVERT DATA     :
     SPAN (in):  18.000       RISE (in):  18.000     LENGTH (ft): 400.000
U/S INVERT (ft): 11.150 D/S INVERT (ft):   9.400       MANNING N:    .013
    ENTRNC LOSS:    .500   # OF CULVERTS:   1.000

OSITION A       : RECTANGULAR RISER SLOT
CREST EL. (ft):  11.150  CREST LN. (ft):   1.000    OPENING (ft):   1.500
    WEIR COEF.:   3.200      GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

OSITION B       : RECTANGULAR RISER SLOT
CREST EL. (ft):  12.650  CREST LN. (ft):   4.000    OPENING (ft): 999.000
    WEIR COEF.:   3.200      GATE COEF.:    .600 NUMBER OF ELEM.:   1.000

          NOTE:
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```
ACH NAME       : RK
OM NODE        : NK
 NODE          : NL
ACH TYPE       : CIRCULAR CULVERT
OW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
RBO SWITCH     : OFF

LVERT DATA     :
     SPAN (in):  15.000      RISE (in):  15.000    LENGTH (ft):  32.000
/S INVERT (ft):   5.500 D/S INVERT (ft):  5.440      MANNING N:    .013
   ENTRNC LOSS:    .500  # OF CULVERTS:   1.000

SITION A       : RECTANGULAR RISER SLOT
CREST EL. (ft):   9.000 CREST LN. (ft):   4.250   OPENING (ft): 999.000
    WEIR COEF.:   3.200     GATE COEF.:    .600 NUMBER OF ELEM.:  1.000

SITION B       : NOT USED

          NOTE:

EACH NAME      : RN
ROM NODE       : NN
) NODE         : NO
EACH TYPE      : CIRCULAR CULVERT
LOW DIRECTION  : POSITIVE AND NEGATIVE FLOWS ALLOWED
JRBO SWITCH    : OFF

JLVERT DATA    :
     SPAN (in):  15.000      RISE (in):  15.000    LENGTH (ft): 390.000
J/S INVERT (ft):  8.020 D/S INVERT (ft):  3.880      MANNING N:    .013
   ENTRNC LOSS:    .500  # OF CULVERTS:   1.000

OSITION A      : RECTANGULAR RISER SLOT
CREST EL. (ft):  12.700 CREST LN. (ft):   3.000   OPENING (ft):    .700
    WEIR COEF.:   3.200     GATE COEF.:    .600 NUMBER OF ELEM.:  1.000

OSITION B      : RECTANGULAR RISER SLOT
CREST EL. (ft):  13.400 CREST LN. (ft):  16.000   OPENING (ft): 999.000
    WEIR COEF.:   3.200     GATE COEF.:    .600 NUMBER OF ELEM.:  1.000

          NOTE:
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EACH NAME       : RP
ROM NODE        : NP
O NODE          : NQ
EACH TYPE       : TRAPEZOIDAL CHANNEL, ENERGY EQ.
LOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
URBO SWITCH     : OFF
BOT. WIDTH (ft):   4.000   LEFT SS (h/v):   1.400   RGHT SS (h/v):   1.100
    LENGTH (ft): 400.000 U/S INVERT (ft):   1.100 D/S INVERT (ft):   1.000
      MANNING N:    .070    ENTRNC COEF.:    .100 MAX. DEPTH (ft):  99.000

          NOTE:

EACH NAME       : RR
ROM NODE        : NR
O NODE          : NT
EACH TYPE       : TRAPEZOIDAL CHANNEL, ENERGY EQ.
LOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
URBO SWITCH     : OFF
BOT. WIDTH (ft):  18.000   LEFT SS (h/v):   1.500   RGHT SS (h/v):   6.000
    LENGTH (ft): 650.000 U/S INVERT (ft):    .500 D/S INVERT (ft):    .100
      MANNING N:    .060    ENTRNC COEF.:    .100 MAX. DEPTH (ft):  99.000

          NOTE:

EACH NAME       : RS
ROM NODE        : NS
O NODE          : NT
EACH TYPE       : TRAPEZOIDAL CHANNEL, ENERGY EQ.
LOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
URBO SWITCH     : OFF
BOT. WIDTH (ft):  20.000   LEFT SS (h/v):   1.600   RGHT SS (h/v):   1.600
    LENGTH (ft): 110.000 U/S INVERT (ft):    .500 D/S INVERT (ft):    .100
      MANNING N:    .060    ENTRNC COEF.:    .100 MAX. DEPTH (ft):  99.000

          NOTE:

EACH NAME       : RT
ROM NODE        : NT
O NODE          : NU
EACH TYPE       : TRAPEZOIDAL CHANNEL, ENERGY EQ.
LOW DIRECTION   : POSITIVE AND NEGATIVE FLOWS ALLOWED
URBO SWITCH     : OFF
BOT. WIDTH (ft):  50.000   LEFT SS (h/v):  12.000   RGHT SS (h/v):  12.000
    LENGTH (ft): 400.000 U/S INVERT (ft):    .100 D/S INVERT (ft):    .000
      MANNING N:    .060    ENTRNC COEF.:    .100 MAX. DEPTH (ft):  99.000

          NOTE:
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ACH NAME : RM
OM NODE : NM
NODE : NO
ACH TYPE : IRREGULAR SECTION CHANNEL, ENERGY EQ.
OW DIRECTION : POSITIVE AND NEGATIVE FLOWS ALLOWED
RBO SWITCH : OFF
LENGTH (ft): 450.000 U/S INVERT (ft): 2.800 D/S INVERT (ft): 1.900
ENTRNC COEF.: .100 MAX. DEPTH (ft): 10.500

X-VAL (ft)	Y-VAL (ft)	N-VAL
.000	12.000	.050
50.000	11.999	.050
68.000	3.000	.050
71.000	2.500	.050
81.000	2.499	.050
100.000	12.000	.050
150.000	11.999	.050

DEPTH (ft)	AREA (sf)	PERIM (ft)	TOPWD (ft)	CONVEYANCE
.000	.00	.00	.00	.0
.001	.01	10.00	10.00	.0
.501	6.01	14.16	14.00	100.8
9.500	293.97	54.41	50.00	26902.4
9.501	294.07	154.41	150.00	13428.4
10.500	443.92	154.41	150.00	26675.5
15.500	1193.92	154.41	150.00	138748.0

NOTE:

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CLOWER CREEK 10 YR 24 HR PROPOSED
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ACH NAME : RO
OM NODE : NO
NODE : NQ
ACH TYPE : IRREGULAR SECTION CHANNEL, ENERGY EQ.
OW DIRECTION : POSITIVE AND NEGATIVE FLOWS ALLOWED
RBO SWITCH : OFF
LENGTH (ft): 450.000 U/S INVERT (ft): 1.900 D/S INVERT (ft): 1.000
ENTRNC COEF.: .100 MAX. DEPTH (ft): 10.500

X-VAL (ft)	Y-VAL (ft)	N-VAL
.000	11.000	.050
50.000	10.999	.050
68.000	2.000	.050
71.000	1.500	.050
81.000	1.499	.050
100.000	11.000	.050
150.000	10.999	.050

DEPTH (ft)	AREA (sf)	PERIM (ft)	TOPWD (ft)	CONVEYANCE
.000	.00	.00	.00	.0
.001	.01	10.00	10.00	.0
.501	6.01	14.16	14.00	100.8
9.500	293.97	54.41	50.00	26902.4
9.501	294.07	154.41	150.00	13428.4
10.500	443.92	154.41	150.00	26675.5
15.500	1193.92	154.41	150.00	138748.0

NOTE:

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CLOWER CREEK 10 YR 24 HR PROPOSED
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ACH NAME : RQ
OM NODE : NQ
NODE : NR
ACH TYPE : IRREGULAR SECTION CHANNEL, ENERGY EQ.
OW DIRECTION : POSITIVE AND NEGATIVE FLOWS ALLOWED
RBO SWITCH : OFF
LENGTH (ft): 550.000 U/S INVERT (ft): 1.000 D/S INVERT (ft): .500
ENTRNC COEF.: .100 MAX. DEPTH (ft): 9.250

X-VAL (ft)	Y-VAL (ft)	N-VAL
.000	9.000	.050
50.000	8.999	.050
65.500	1.250	.050
68.500	.750	.050
83.500	.749	.050
100.000	9.000	.050
150.000	8.999	.050

DEPTH (ft)	AREA (sf)	PERIM (ft)	TOPWD (ft)	CONVEYANCE
.000	.00	.00	.00	.0
.001	.01	15.00	15.00	.0
.501	8.51	19.16	19.00	147.2
8.250	275.85	53.82	50.00	24371.7
8.251	275.95	153.82	150.00	12108.4
9.250	425.80	153.82	150.00	24948.7
14.250	1175.80	153.82	150.00	135601.0

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REACH SUMMARY

RCHNAME	FRMNODE	TONODE	REACH TYPE
RL2	NL2	NL	RECTANGULAR WEIR/GATE/ORIFICE, VILLEMONTE EQ
RM2	NM2	NM	RECTANGULAR WEIR/GATE/ORIFICE, VILLEMONTE EQ
RJ2	NJ2	NJ	RECTANGULAR WEIR/GATE/ORIFICE, VILLEMONTE EQ
RC	NC	NB	CIRCULAR CULVERT
RE	NE	NJ	CIRCULAR CULVERT
RJ	NJ	NL	RECTANGULAR CULVERT
RL	NL	NM	CIRCULAR CULVERT
RA	NA	NB	CIRCULAR CULVERT
RB	NB	NE	CIRCULAR CULVERT
RD	ND	NE	CIRCULAR CULVERT
RF	NF	NG	CIRCULAR CULVERT
RG	NG	NJ	CIRCULAR CULVERT
RI	NI	NJ	CIRCULAR CULVERT
RK	NK	NL	CIRCULAR CULVERT
RN	NN	NO	CIRCULAR CULVERT
RP	NP	NQ	TRAPEZOIDAL CHANNEL, ENERGY EQ.
RR	NR	NT	TRAPEZOIDAL CHANNEL, ENERGY EQ.
RS	NS	NT	TRAPEZOIDAL CHANNEL, ENERGY EQ.
RT	NT	NU	TRAPEZOIDAL CHANNEL, ENERGY EQ.
RM	NM	NO	IRREGULAR SECTION CHANNEL, ENERGY EQ.
RO	NO	NQ	IRREGULAR SECTION CHANNEL, ENERGY EQ.
RQ	NQ	NR	IRREGULAR SECTION CHANNEL, ENERGY EQ.

BASIN		NODES	
BMP	BWA	BMP	BWA
5600	T	5600	NT
5610	S	5610	NS
5620	R	5620	NR
5640	Q	5640	NQ
5650	P	5650	NP
5660	O	5660	NO
5670	N	5670	NN
5690	M	5680	NM
5705	K	5690	NM2
5710	L	5700	NL
5722	G	5705	NK
5725	F	5710	NL2
5730	I	5720	NJ
5735	J	5722	NG
5740	H	5725	NF
5742	E	5730	NI
5750	D	5735	NJ2
5760	B	5740	NE
5765	C	5750	ND
5770	A	5760	NB
		5765	NC
		5770	NA