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INVESTIGATION OF THE SEPTEMBER 1962 AND JUNE 1974 FLOODS THAT OCCURRED IN THE BIG SLOUGH CREEK BASIN AREA SOUTHEASTERN SARASOTA COUNTY

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This report was prepared with the basic objectives of:

1) Briefly describing the climate, topography, geology, and the general hydrology of the Big Slough Creek area.

2) Comparing and analyzing the available data, and the various conditions that affected, or could be expected to influence the hydrology of the two floods that occurred in the area. The first flood occurred in September of 1962, the other in June of 1974.

3) Discussing the application of the dimensionless unit hydrograph in this area.

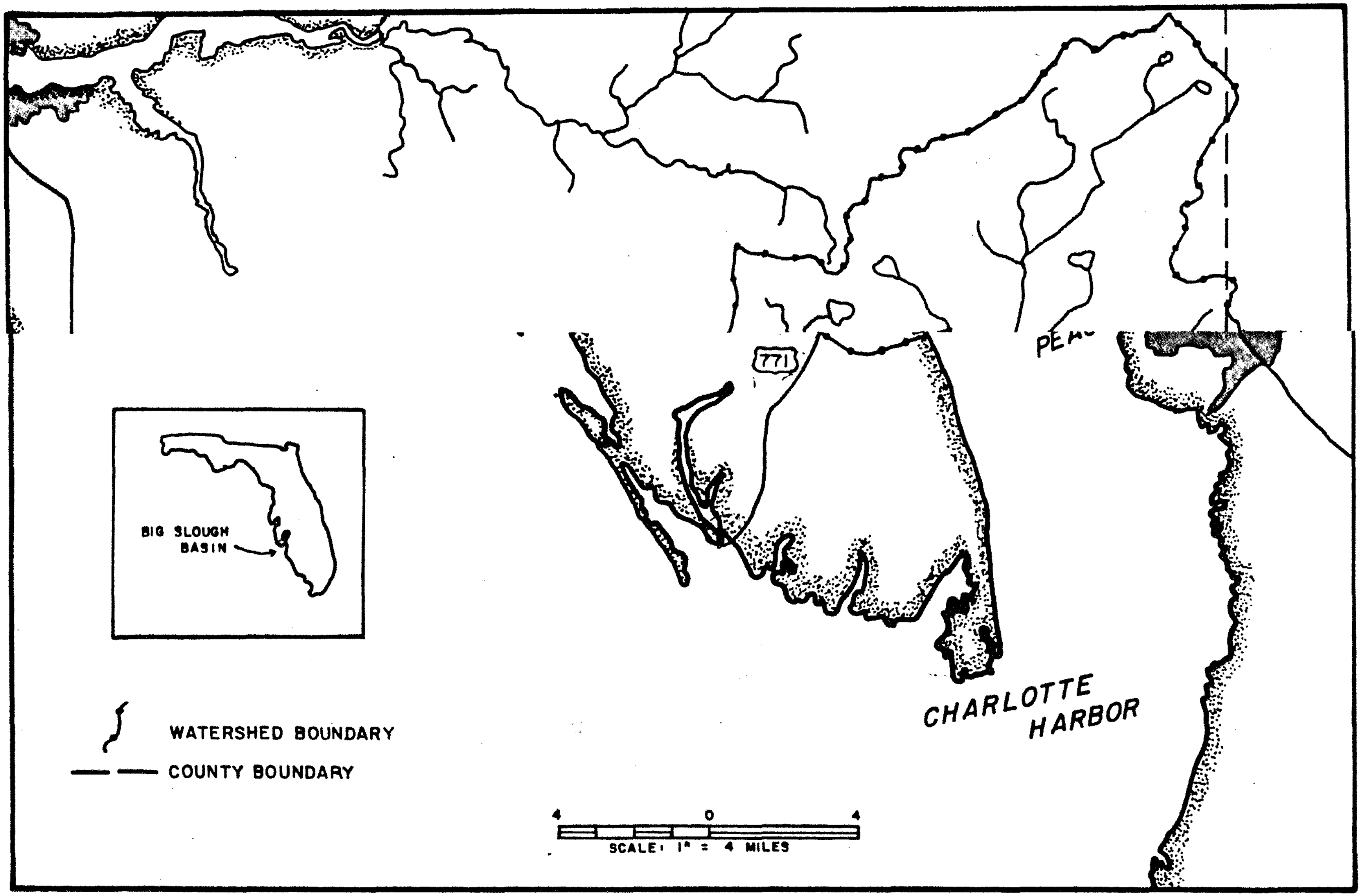

BIG SLOUGH BASIN
771
PEA
CHARLOTTE HARBOR
WATERSHED BOUNDARY
COUNTY BOUNDARY
4 0 4
SCALE: 1" = 4 MILES

FIGURE 1

DESCRIPTION OF THE AREA

Figure 1 is a location map of the study area, and will visually orient the following basin description.

Big Slough Creek is the principal tributary of the Myakka River; collectively the Myakka - Big Slough streams comprise the major portion of the Myakka River Basin, with a drainage area of about 550 square miles. Big Slough Creek separately has a drainage area of 97 square miles. Lying mainly in east - central Sarasota County, the upper boundaries of the basin extend into southeastern Manatee County and the extreme western portion of DeSoto County.

The major cities in proximity to the basin are Venice, located some 12 miles to the west, and Port Charlotte, some 10 miles to the southeast. U. S. Highway 41 traverses the lower reaches of the basin in connecting Venice and Port Charlotte. Associated more directly with the basin are the developments of Warm Mineral Springs, a Sarasota County subdivision located to the northwest of Big Slough Creek, and North Port Charlotte, a General Development Corporation project to the south and southeast of Big Slough.

Oriented on a generally northeast to southwest axis, water flows some 29.4 miles from the channelized northeast upper and middle portions of the stream, through natural meanders occurring in the lower middle reaches, and eventually through the channelized lower reaches where Big Slough enters the Myakka River, in the southwest portion of the basin. A low head dam some four miles from the mouth *of Big Slough, visible from U. S. Highway 41, impounds some flow, and is used for a municipal water supply by the city of North Port Charlotte.*

The climate of the Big Slough area can generally be described as humid subtropical, with summer temperatures ranging in the high seventies moderated by sea breezes, and mild winter temperatures ranging in the low sixties tempered by the warm waters of the Gulf of Mexico. Rainfall averages 54 inches a year, the majority of it occurring in the well-defined wet season of June through September. Most of this rainfall is characterized by high intensities and short durations, associated with very localized convectional thunderstorms. Winter rains are due to occasional frontal activities moving down in the area, and to the tropical depressions, disturbances, and hurricanes that pass through. Evapotranspiration (Et) rates average 35 - 40 inches a year; runoff probably averages 14 inches a year, based on the concept of the water budget, and on records of the Myakka River.

TOPOGRAPHY, GEOLOGY AND SOILS

Big Slough basin falls into a general topographic division of Florida commonly referred to as the Coastal Lowlands. This division consists of gradual changes in elevation called terraces, formed by different invasions of marine seas. Changes in elevations are, for the most part, barely susceptible and poorly defined. Elevations in the basin range from less than five feet above mean sea level near the entrance into the Myakka River, 15 - 20 feet above msl in the lower reaches of the basin, 25 - 35 feet in channelized reaches, and 50 - 75 feet in the extreme northeastern portion of the basin. Numerous sloughs and depressions, called wet weather ponds characterize the area, averaging 1 - 3 feet in depth during the wet season when the water table is high, and fluctuating with the water table relative to seasonal rainfalls. These ponds and sloughs vary in size usually averaging only a few acres, however, they constitute a significant total area, especially in the extreme upper portions of the basin, where they form the headwaters of Big Slough Creek. Many basin depressions are without natural outlets, however, in recent years canals have been excavated, forming outlets for these areas.

Pleistocene and Holocene deposits composed chiefly of fair to poorly permeable quartz sands and shells, cover most of the Myakka River and Big Slough Creek basins. The Caloosahatchee Marl, a zone of low permeability, underlies these thin surficial sands in *the area, restricting the downward percolation and recharge to lower aquifers.*

Soils which have developed on these recent materials are generally somewhat poor to very poorly drained. Predominant throughout the area are the somewhat poorly drained soils, occurring on the flat pinelands or palmetto prairies, or near depressions, sloughs, or streams (Reference 7, p. 9, 10). The poorly drained soils are most extensive in the depression and slough areas (Reference 7, p. 9, 10). The drainage characteristics of these soils and the near level relief of the area are conductive to long periods of inundation, especially during the wet season.

THE RUNOFF PROCESS

In order to better understand the conditions that produce flooding, a basic knowledge of the runoff process is necessary.

Overland flow occurs after the precipitation rate exceeds the infiltration rate for enough time to fulfill the demands of interception, infiltration, and depression storage, and establish an initial quantity of surface detention. Figure 2 is a graphical representation of this hydrologic sequence.

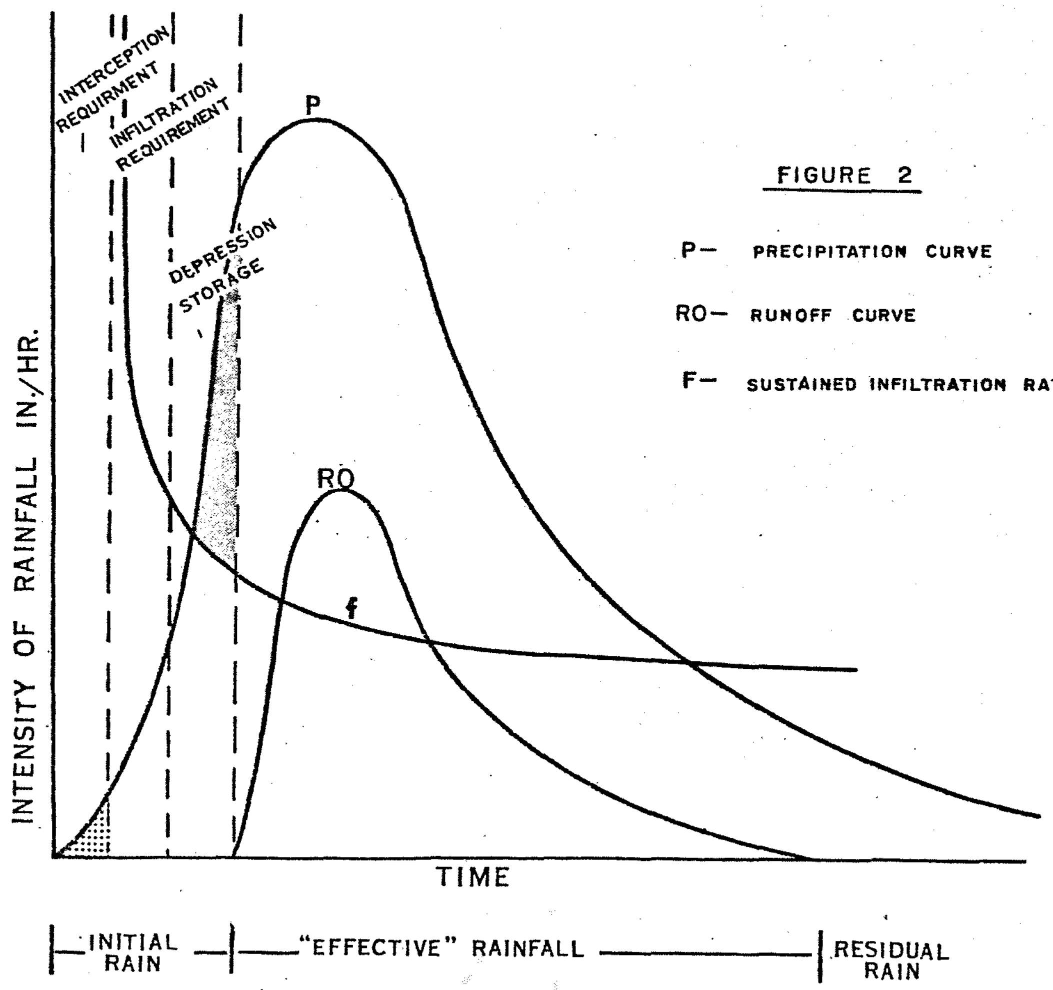


FIGURE 2

P— PRECIPITATION CURVE

RO— RUNOFF CURVE

F— SUSTAINED INFILTRATION RATE

In order for surface runoff to occur it is necessary that areas in which surface detention and overland flow exist be connected by coalescing micro-surface channels. Upon entering a defined stream channel, this surface runoff joins with other components of flow (subsurface flow and groundwater flow) to form total runoff, or stream flow. This streamflow represents the integrated result of all hydrometeorological factors operative in the drainage basin.

Runoff is an extremely variable quantity, not only from year to year, but season to season, day to day and even hour to hour. It is influenced by two major interrelated groups of factors: climatic and physiographic factors. Climatic factors such as the form of precipitation (rain, snow or hail), and the varying intensities, durations areal distributions, frequencies, directional movements and types (convectional, frontal and orographic) of precipitation all influence the quantities of runoff. Physiographic factors involving 1) basin characteristics which include the location, geometry, elevation, slope, efficeincy of drainage networks, degree of urbanization, soil types, and vegetation of the basin, and 2) channel characteristics, mainly the hydraulic properties that govern streamflow and storage, also have a pronounced effect on the runoff area.

It can readily be seen that floods are mainly a function of the same interrelated factors that influence runoff, and that the magnitudes of floods will vary with the quantities of runoff generated by a storm. When the streamflow represents a volume greater than the stream *channel can accomodate, and/or if incoming tides produce the phenomena known as backwater effect, the flow overtops its natural or artificial banks, spreads over its floodplain, and usually conflicts with man's activities.*

Figure 3 is a partial delineation of flood-prone areas in, and surrounding the Big Slough area, as designated by the United States Geological Survey. It is generally conceded that these flood-prone areas are the desirable areas for man's activities, however, this flooding nature of these areas, and of the wet weather ponds prevlaent in the area, should warrant the attention of developments located in them. An intensive floodplain management program would seem to be an economically and technically feasible solution to flood protection for these areas, supplementing flood control works that might exist.

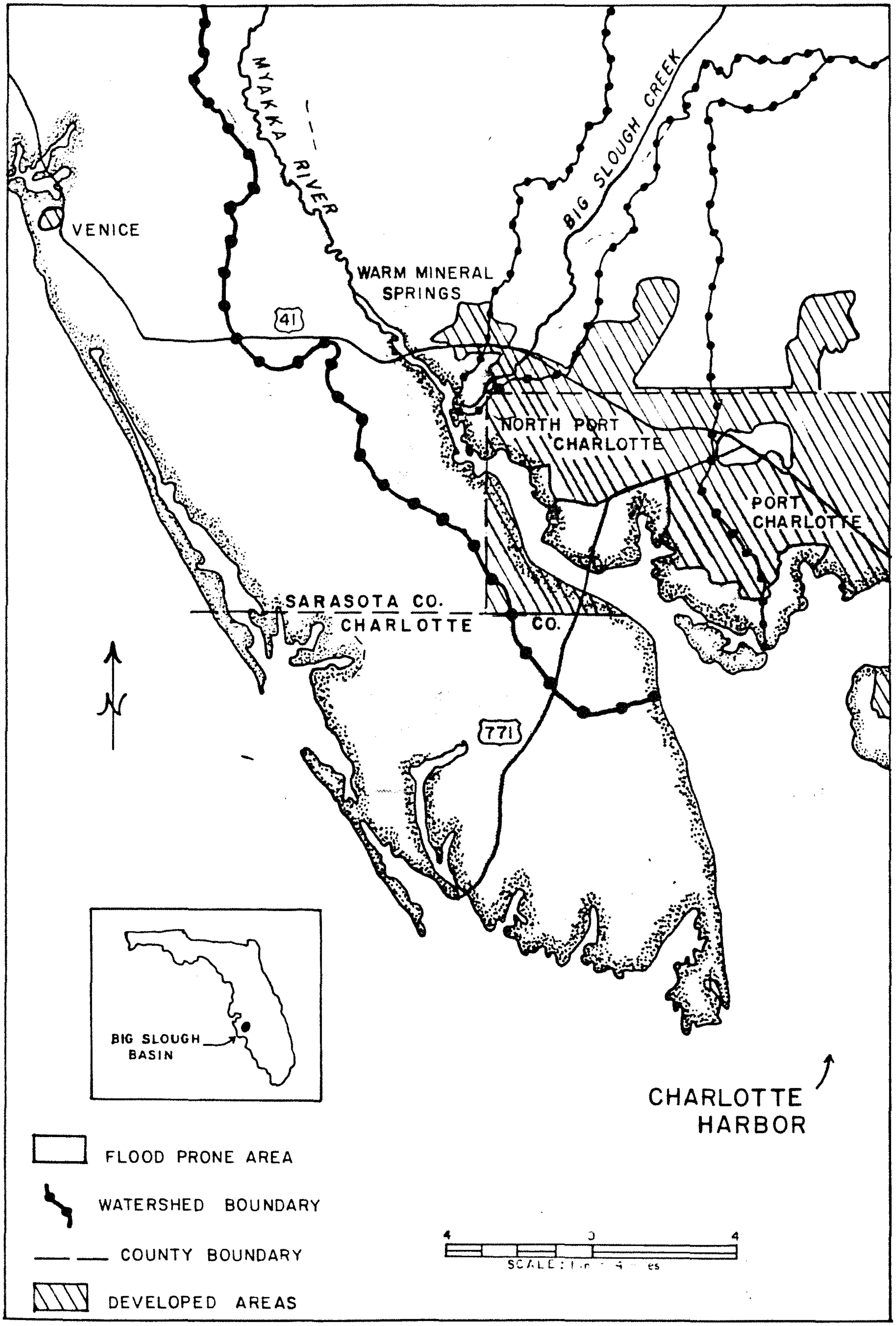

MYAKKA RIVER
BIG SLOUGH CREEK
VENICE
WARM MINERAL SPRINGS
41
NORTH PORT CHARLOTTE
PORT CHARLOTTE
SARASOTA CO.
CHARLOTTE CO.
N
771
BIG SLOUGH BASIN
CHARLOTTE HARBOR
FLOOD PRONE AREA
WATERSHED BOUNDARY
COUNTY BOUNDARY
DEVELOPED AREAS
4
0
4

FIGURE 3

A thorough comparison of the magnitudes and conditions that produced the September 1962 flood, and the June 1974 flood in the Big Slough area, would require:

1) *More accurate rainfall data including actual depths, durations, intensities, areal distributions, paths and wind velocity durations for each flood-producing storm.*
2) *Stream stage - discharge data including peak rates, peak stages and hydrographs for both floods. The flood of 1962 occurred before the continous stage recorder was established on Big Slough Creek in 1963. The flood of 1974 occurred after the elimination of the site in 1973.*
3) *Actual soil and groundwater conditions existing before each flood.*
4) *Actual tidal levels, ranges and durations.*

However, it is possible to analyze and to interpret available data, and evaluate the conditions that could be expected to exist for each flood so as to develop a general comparison of both events. Such a comparison will involve briefly discussing the meteorlogical differences, the effects of seasonal factors, the changes in drainage patterns and effeciencies, and the differences in tidal levels and durations, relative to each flood.

THE FLOOD OF 1962

The flood that occurred in September 1962, was produced by an extremely high intensity - two day rainfall, associated with a shallow tropical depression that moved out of the Gulf of Mexico and through the Big Slough area on the twentieth and twenty-first of the month. This storm conformed to the Corps of Engineers definition of a flood-producing storm for this area; heaviest storm rainfalls concentrated within a two day period or less, producing the maximum flood depths upon the land (Reference 2, p. 22 & 26). The forty-eight hour rainfall totaled in excess of fifteen inches in the Sarasota - Bradenton area, and ranged between ten and fifteen inches in the coastal areas of the southwest coast. Inland sections averaged between five and ten inches. Table 1 summarizes area rainfall for this storm:

Table 1
Rainfall data for the flood of 1962 - Big Slough Basin

	September 1962					Storm Totals
	18	19	20	21	22	
Arcadia*	-	.50	1.65	7.35	T	9.00"
Punta Gorda*	-	1.00	1.54	9.00	.09	10.54"
Venice*	-	.47	4.21	3.32	-	7.53"
Venetia**	T	1.90	3.51	6.20	-	9.71"
Big Slough Basin						9.02"

* N.O.A.A. Official Data

** Florida Division of Forestry Data (not averaged)

Figure 4 is the constructed hydrograph, the graphical representation of the change in stream discharge with respect to time, of Big Slough Creek for this storm. Measurements of stages on Big Slough Creek during this flood indicated an attained water level of 16.35 feet above mean sea level (gauge datum - 1.37 feet above msl). Calculating to a discharge of 3,010 cfs, this was the highest recorded stage peak and flow for Big Slough Creek. Average discharge for the same period, based on 1963 - 1970 data, calculated to be 148 cfs.

Occurring toward the end of the defined rainy season, it is valid to assume that upon the initial rainfall of this storm, the ground was near saturation, or fully saturated. As a result, rainfall quantities became surface runoff, and eventually constituted a major portion of the streamflow. The hydrograph for this event is based on this criteria, and reflects the conditions that promoted runoff during this storm. With these conditions, the average depth of flooding would roughly equal the depth of rainfall for the area.

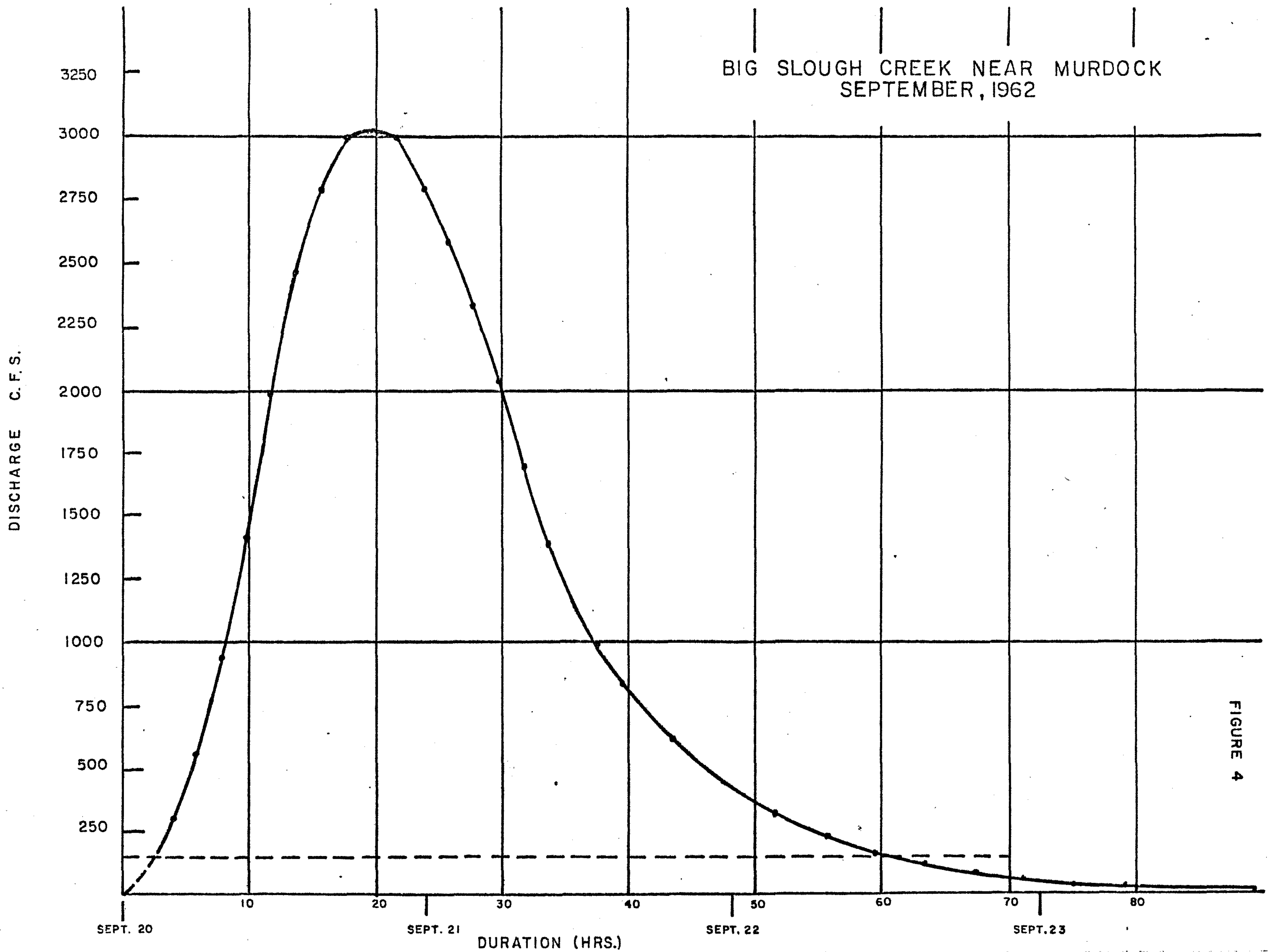

BIG SLOUGH CREEK NEAR MURDOCK
SEPTEMBER, 1962
DISCHARGE C.F.S.
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
10
20
30
40
50
60
70
80
SEPT. 20
SEPT. 21
SEPT. 22
SEPT. 23
DURATION (HRS.)

FIGURE 4

The Flood of 1974

The flood occurring in June of 1974 was a unique event characterized by heavy rainfall and high southwesterly winds averaging 40 to 50 knots. It was actually produced by two successive storms, the first being a subtropical storm which moved rapidly through the area on the twenty-forth and twenty-fifth, and the second, being a tropical depression that passed through the area on the twenty-seventh and twenty-eighth of the month. These successive flood-producing storms were characterized by a high to moderate intensity rainfall, lasting some five days, with sustained winds. The five-day rainfall total averaged ten inches over most of the west-central and southwest Florida, with some twenty inches falling in parts of the Tampa Bay region. Table 2 summarizes area rainfall for this storm.

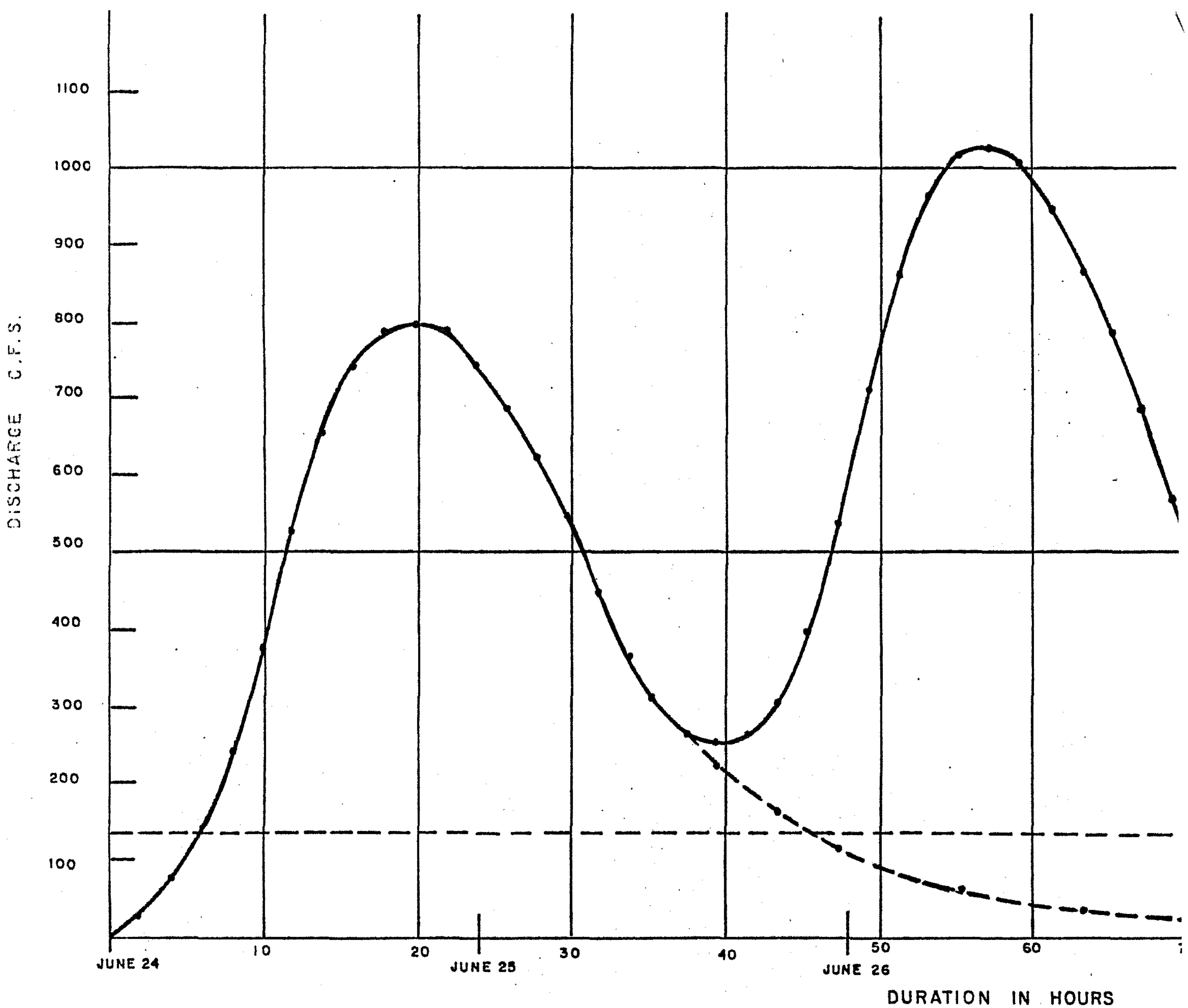
Table 2

Rainfall Data for the Flood of 1974 - Big Slough Basin

	June 1974					Storm Totals
	24	25	26	27	28	
Arcadia*	2.59	1.67	.20	2.60	1.09	8.15"
Punta Gorda*	3.08	3.16	1.40	2.50	2.30	12.44"
Venice*	.50	3.45	.30	2.10	1.93	8.28"
Venetia**	3.20	.70	5.00	1.50	1.20	11.60"
Big Slough Basin						9.6"

Figure 5 is the composite hydrograph of Big Slough Creek for this storm. It graphically displays the nature of the rainfall, as it relates to streamflow. Peak flows of 799 cfs and 1022 cfs, respective to each storm, occurred in Big Slough Creek. Average discharge for this period based on 1963 - 1970 records was 135 cfs.

This event, totally unlike the previous flood of 1962, occurred at the initial portion of the defined wet season for the area. It can be assumed that the droughts occurring nearly every year during the spring months (reference 3, p.16), the increasing evapotranspiration (Et) rates, and the high infiltration and storage demands, would substantially reduce the initial amounts of runoff generated, as probably was the case in this storm.


DISCHARGE C.F.S.
1100
1000
900
800
700
600
500
400
300
200
100
JUNE 24
10
20
JUNE 25
30
40
JUNE 26
50
60
DURATION IN HOURS

Applying the Dimensionless Unit Hydrograph in the Big Slough Basin

Quite often it is necessary to predict the flow regime of a stream on which limited flow records are available. Fortunately, techniques exist for synthesizing streamflow records, or hydrographs, from meteorlogical data. It should be understood however, that these techniques sometimes employ values and assumptions that do not normally apply, or occur, in a specific study area. Therefore, several methods should be reviewed before applying any particular technique to an area.

The hydrographs used in this report were derived through the methodology of the dimensionless unit hydrograph, as developed by Victor Mockus, Hydraulic Engineer of the U. S. Soil Conservation Service (reference 1 & 6). Derived from a large variety of watersheds throughout the U. S., the dimensionless unit hydrograph graphically expresses discharge as the ratio of discharge to peak discharge, and time by the ratio of time to lag time (the elapsed time between the occurrence of rainfall and the occurrence of peak flow).

The hydrographs in the report were developed from the basic equation for the peak rate of a hydrograph:

$$qp = \frac{KAQ}{Tp}$$

where qp is the peak rate of flow in cfs, A is the drainage area in square miles, Q is the volume of runoff in inches, Tp is the time to peak flow, and K is a constant, whose value of 484 was obtained through the development of a triangular unit hydrograph (ref. 1).

Initially, the peak-rate equation was rearranged to solve for Tp, because other factors in the equation were known for the flood of 1962. Assuming $K = 484$, and solving the equation, resulted in a time to peak value of 140 hours, obviously unacceptable for this area.

The National Engineering Handbook (Reference 6) states that K values could vary from 600 in steep terrain to 300 in flat swampy areas. However, when solving for Tp with $K = 300$, another unacceptable figure of 87 hours was obtained. Through further investigation and conversation with the Soil Conservation Service (SCS) in Gainesville, and other hydrologists, it was found that K had been shown to vary considerably less than 300. Application in Texas obtained a K value of 161 (personal communication with Mr. Jim Woodfin, SCS).

It was decided that the best approach to the problem in order to arrive at a reasonable K value for the study area was to determine the time of concentration, Tc, for this basin, use it to solve another equation for Tp, then solve the peak rate equation for K. Using the criteria and methodology suggested by Ogrosky and Mockus (Reference 1), Tc was found through the equation:

$$Tc = \frac{L^{1.15}}{7,700H^{.38}}$$

where L is the length of the watershed along the main channel from the basin outlet to the highest ridge, in feet; and H is the difference in elevation between the basin outlet and the most distant ridge, to equal 29.8 hours.

From this Tc value, L(.6Tc) the lag time of the basin, and D(.133Tc) the duration of unit excess rainfall were calculated to be 17.88 hours and 3.87 hours respectively. Substituting these values into the time to peak formula

$$Tp = \frac{D}{2} + L$$

resulted in a final Tp value of 19.74 hours.

Knowing this Tp value, the peak rate equation was transformed into

$$K = \frac{Tp\ qp}{AQ}$$

with Tp = 19.74 hours, qp = 3010 cfs, A = 97 square miles, and Q = 9 inches; K was found to equal 68.06 for the Big Slough Basin.

Multiplying Tp and qp by the time ratios and discharge ratios derived from the dimensionless unit hydrograph obtained the values necessary to plot Figure 4, the hydrograph for Big Slough Creek for the flood of September 1962.

For the flood of June 1974, a somewhat different approach was necessary. Due to the seasonal drought factor influence during this storm, it was necessary to determine the actual runoff resulting from each days' rainfall. This was done by determining the hydrologic soil group, the land use and treatment class, and the resultant runoff curve number (CN), through the methodology suggested by the National Engineering Handbook (Reference 6). These values and conditions were determined for each day for the June 24 - 28 period, and as a result daily and total runoff values were obtained for the same period.

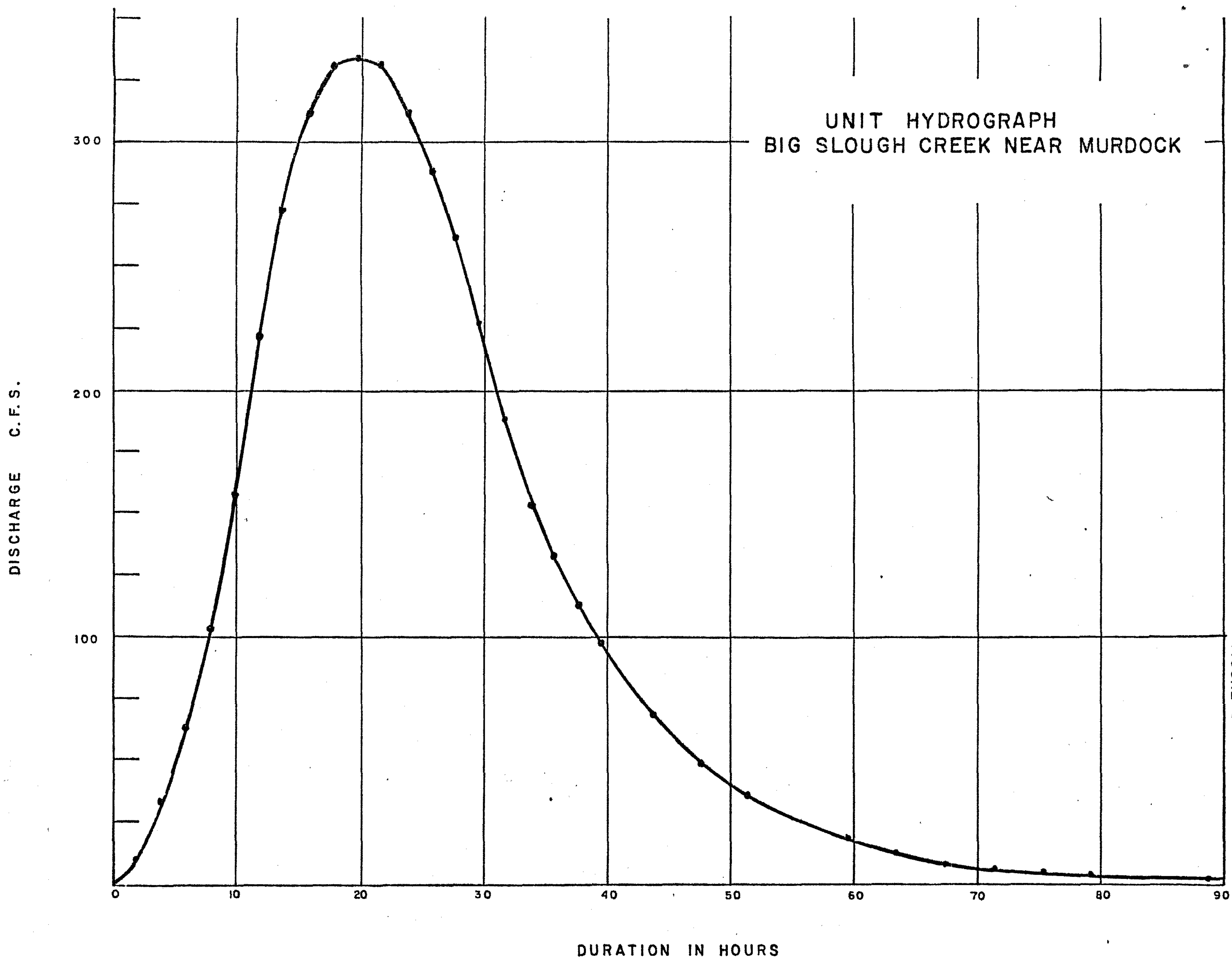
As previously mentioned, this flood was produced by two successive storms. Not knowing the times of initial rainfalls, or rainfall durations for each event, June 26 was designated as the lull of the first storm and the beginning of the second storm. Rainfall and runoff amounts for this day were considered to contribute to both storm totals; that is total rainfall and runoff for the first storm would equal values from June 24, 25, 26; the second storm would equal values from June 26, 27, and 28.

With these figures the calculated Q values (the runoff volumes resulting from each storm) were plugged into the peak rate equation, with K, A, and Tp constants equaling the values calculated for the September 1962 flood. Qp values of 799 cfs and 1022 cfs, were determined as the peak rates of flow, respective to each storm rainfall, during the flood.

Again, Tp and qp values were multiplied by the appropriate ratio figures, to obtain the values for Figure 5, the composite hydrograph for the flood of June 1974.

Figure 6 is the unit hydrograph, Big Slough Creek; that is the hydrograph of direct runoff resulting from 1 inch of excess rainfall (the total rainfall minus interception, infiltration, and storage demands, see Figure 2), distributed evenly over a basin in a specific unit of time. The theory of the unit hydrograph also assumes that discharge at any time is proportional to the volume of runoff, and that time factors effecting the hydrograph remain constant. The principles of the unit hydrograph make it a very useful tool in flood estimation and

FIGURE 6


UNIT HYDROGRAPH
BIG SLOUGH CREEK NEAR MURDOCK
DISCHARGE C.F.S.
300
200
100
0
10
20
30
40
50
60
70
80
90
DURATION IN HOURS

production, making full use of precipitation data in areas which streamflow records are not available/ or do not reflect major amounts of storm runoff.

Figure 6 is actually a unit hydrograph developed by applying unit hydrograph principles to the previous hydrographs constructed for the floods of 1962 and 1974. To clarify, the peak rate of flow for the flood of 1962, 3010 cfs, was produced from a Q value of 9 inches. The peak rate for the unit hydrograph, resulting from one inch of excess rainfall, would equal 3010/9 or 334 cfs. The values for the unit hydrograph were then derived by multiplying the previous Tp value and the new qp value of 334 cfs by the appropriate time or discharge ratio.

Conclusions and Recommendations

Floods are basically due to excess amounts of surface runoff occurring in a defined stream channel that is incapable of handling these amounts. Factors that affect runoff will also affect floods and are categorized into two basic groups: climatic factors, which are meteorological in nature, and physiographic factors which involve the various physical characteristics of the basin.

As previously stated the magnitudes and extents of the two floods investigated in this report could only be empirically derived. The use of synthetic analysis techniques, resulting from a lack of necessary data, lends for much discussion on the actual hydrology of these floods. However, interpretation of the analyzed data and the inferences drawn from the probable existing conditions relative to each storm indicate that the following conclusions can be made.

The flood of September, 1962 was produced by a high intensity, short duration storm; enhanced by conditions that lended to increased surface runoff. Rainfall totaling 9 inches fell over a two day period, resulting in a peak discharge of 3010 cfs in Big Slough Creek. In direct contrast to the hydrologic conditions during the September, 1962 flood, the flood of June, 1974 was produced by two successive storms of moderate intensity, lasting over a five day period, with sustained high winds. These storms produced a rainfall total of 9.6 inches over the five day period, and two peak discharges of 799 cfs and 1022 cfs respective to each storm occurring in Big

Slough Creek.

Even though an initial review might conclude otherwise, the flood of June, 1974 was of greater effect on local residents in, and adjacent to, Big Slough Creek basin area for the following reasons:

1) The storms of 1974 were associated with higher sustained winds than was the previous flood producing storm of September, 1962. In essence, prevailing southwesterly winds experienced for several days probably increased tidal levels and durations, producing a backwater effect influencing upstream flow characteristics apparently for great distances.

2) The flooding was enhanced during the storms by canal systems, removing available water at a rapid rate, and being affected by this backwater.

3) Due to areas natural function of increasing the time of concentration factor, floodwaters during the storm of September, 1962 were retained for longer periods then gradually released for a relatively unobstructed flow through the stream channel to the outlet.

To reiterate local residents were flooded in June of 1974 due to both natural and artificial conditions; natural in the sense that enduring winds and tides were a major influence of the flooding, and artificial in the sense that canals offered an additional "floodplain" closer to the affected residents.

It is hoped that besides fulfilling it's initial objectives, this report would give residents in the area a basic understanding of the conditions that produced each flood and why each had a different *effect; and that it might serve as some technical background for more detailed investigations in the area. It is also hoped that a need for such further investigations of flood problems are realized and will offer the following recommendations to assist in future studies and planning:*

1) Relocation and establishment of a permanent gauging site on Big Slough Creek.

2) Properly locating, establishing and maintaining a series of tidal gauging stations on the Myakka River, and Big Slough Creek, and at determined sites of upstream reaches.

3) Continued planning and implementation of flood plain management and land use techniques.

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