S0607.02

Conklin, Porter and Holmes
ENGINEERS, INC.
500 W. FULTON STREET
POST OFFICE BOX 1976
SANFORD, FLORIDA 32772-1976
TEL 407-322-6841 TEL 407-831-5717
FAX #407-330-0539

File
S0607.04

February 11, 1991

TO : Mr. William A. Simmons,
Interim City Manager

FROM : B. C. Conklin BCC

RE : Overall Storm Drainage Needs

Enclosed is data on the overall storm drainage needs in the City from our previous and ongoing studies.

Mill Creek / Cloud Branch

As you are aware, our current work is concentrated in the Mill Creek and Cloud Branch basins where we performed a study that was completed in 1988. We are currently doing preliminary engineering studies, preliminary plans, and R.O.W. studies on those same basins and have updated the 1988 cost data in the enclosed material.

It is noteworthy that the design storm utilized is a 25 year - 6 hour storm which will provide an adequate / cost effective level of protection and salvages more of the existing facilities at significantly reduced cost over a 25 year - 24 hour solution. In a few selected, developed areas where the open ditches are close to houses and pose a threat to human life or public health, and/or are aesthetically offensive, we have proposed to close up the drainage system. Detention facilities are planned at strategic locations in this retro-fit plan to modify and improve the existing open drainage system through a highly developed, minority area by mitigating the peak flows and providing some pollution abatement. However, neither the design storm nor the detention pollution abatement facilities will fully meet either the City's or the St. Johns River Water Management District requirements for new development.

As you know, our work on the R.O.W. (easement or acquisition problem) is a long ways from complete, so the numbers are very rough and based on the rough per square foot costs provided by the real estate consultant on the job.

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FAX #407-330-0639

Downtown Area

There is major flooding that occurs in the downtown First Street whenever there is a very heavy rainfall. This is caused by the fact that the lake tends to backwater the drainage system somewhat, and there is very little available fall or head from First Street onto the lake discharge. Also, a large upland area south of First Street drains northerly by pipes and overland into the First Street area, which is flatter and pocketed. Because of these conditions, very large pipes are required out to the lake, and the existing facilities are just not big enough and the streets flood periodically and water backs into some of the stores every few years.

A solution has been proposed that amounts to intercepting some of this water south of First Street and relieving the existing overloaded northerly discharge system by carrying a relief flow easterly to the existing Locust Avenue interceptor, thereby avoiding the need for another direct discharge pipe into the lake in the river front / marina area. The costs shown in the Downtown area do not include any facilities to store and mitigate flows or provide any pollution abatement of any kind. The solution is intended only to relieve flooding in the area.

Remaining Parts of the City (East Side, Lake Jessup, and the Locust Avenue Basin Beyond the Downtown Area)

We have used earlier previous study work and applied costs indices to bring the costs to the present time. The costs shown do not include pollution abatement facilities in these area.

If there are any questions, please let me know.

Summary of Construction Costs*
Sanford, Florida
February, 1991

	Mill Creek Basin	Cloud Branch Basin	Downtown Area	East Side Lake Jessup & Remainder of Locust Ave.Basins
Construction*	$4,492,183	$1,541,930	$1,221,050	$2,479,128
Land (Easements** and Fee Simple)	$1,330,954	$ 429,000		
	$5,823,137	$1,970,930	$1,221,050	$2,479,128

*The construction costs shown include a 15% construction contingency and a project allowance of 15% for engineering, surveying, soils, inspection, administrative and legal costs.

**Estimated cost to purchase land needed for detention. Assumes City exercises prescriptive rights on existing maintained ditches, obtains some additional easements by donation and some by acquisition.

MILL CREEK DRAINAGE BASIN

OPINION OF PROBABLE CONSTRUCTION COST

ITEM	COST
Channel Cleaning & Regrading (As environmentally allowed)	
Mill Creek Channel & Tributaries (33,000 L.F.)	$123,750
Stripping & Sodding (14,700 SY)	$ 8,250
Seeding & Mulching (73,300 SY)	$ 25,500
Subtotal	$171,250
Detention Pond Systems	
Opinions of Probable Costs do NOT include land and/or easement acquisition costs. Includes clearing and grubbing, demucking, excavation, filling, erosion control, sodding slopes, grassing & plantings, and fencing.	
18th Street (23 Acres)	$520,000
McCracken Road (6.1 Acres)	$130,000
8th Street (5.0 Acres)	$113,000
Subtotal	$763,000
13th Street Box Culvert Crossing	
Opinions of Probable Costs do NOT include land and/or easement acquisition costs.	
5' x 8' Box Culvert (150 L.F.) with Side Pipes, Connections, Miscellaneous Manholes, Inlets, Excavating, Sheeting, Dewatering, Wingwalls, Traffic & Drainage Control, Street and Culture Replacement.	$206,000
Subtotal	$206,000

Piping of Mill Creek - South of 13th Street to 18th Street.

Opinions of Probable Cost do NOT include right-of-way or easement acquisition or utility relocation, should it become necessary.

Twin 48" R.C.P. (5,800 L.F.)	$1,160,000
Storm Inlets & Junction Boxes (12)	$ 60,000
Headwalls (2)	$ 20,000
Road Crossings (5)	$ 20,000
Seeding & Mulching (16,500 SY)	$ 5,775
Sheeting & Traffic Control	$150,000
Restoration	$ 20,000
Sub-Total	$1,430,775

New / Upgraded Culvert Crossings

Opinions of Probable Cost do NOT include right-of-way or easement acquisition costs.

Bradshaw Avenue

36" R.C.P. (60 L.F.)	$ 5,400
Road Crossing (1)	$ 4,000
Headwall, Normal (2)	$ 5,000
Sub-Total	$ 14,400

Chase Avenue

18" R.C.P. (60 L.F.)	$ 4,500
Road Crossing (1)	$ 4,000
Headwall, Normal (2)	$ 5,000
Sub-Total	$ 13,500

Marshall Avenue

29" x 45" E.R.C.P. (120 L.F.)	$ 15,000
Road Crossing (1)	$ 4,000
Headwall, Normal (2)	$ 5,000
Sub-Total	$ 24,000

25 Street

30" R.C.P. (40 L.F.)	$ 2,600
Sub-Total	$ 2,600

20th Street

Twin 54" R.C.P. (840 L.F.)	$190,000
Storm Inlets & Junction Boxes (4)	$ 20,000
Headwalls, Normal (2)	$ 20,000
Sodding (1000 SY)	$ 1,500
Road Crossings (3)	$ 12,000
Sub-Total	$243,500

18th Street Pond Diversion System

Twin 54" R.C.P. (640 L.F.)	$144,000
Headwalls, Normal (2)	$ 20,000
Sodding (800 SY)	$ 1,200
Broad Crested Weir Overflow/Drawdown Control STructure	$ 10,000
Sub-Total	$175,200

8th Street

Twin 48" R.C.P. (60 L.F.) & Existing 60" Diameter	$ 13,200
Road Crossing (1)	$ 4,000
Headwalls, Normal (2)	$ 15,000
Sub-Total	$ 32,200

8th Street (Tributary "E")

36" R.C.P. (60 L.F.)	$ 5,400
Road Crossing (1)	$ 4,000
Headwalls, Normal (2)	$ 5,000
Sub-Total	$ 14,400

Meisch Road

21" R.C.P. (60 L.F.)	$ 3,000
Road Crossing (1)	$ 4,000
Headwalls, Normal (2)	$ 5,000
Sub-Total	$ 12,000

Bevier Road

30" Equivalent R.C.P. (60 L.F.)	$ 5,700
Road Crossing (1)	$ 4,000
Headwalls, Normal (2)	$ 5,000
Sub-Total	$ 14,700

McCracken Road Pond Inlet / Outlet and Railroad Crossing

50" x 96" Corrugated Metal Arch (100 L.F.)	$ 32,500
Road Crossing (1)	$ 4,000
48" R.C.P. (60 L.F.)	$ 15,000
Headwalls, Normal (2)	$ 20,000
Sodding (300 SY)	$ 2,000
48" R.C.P. (60 L.F.)	$ 15,000
Railroad Crossing (Open Cut)	$ 15,000
Sodding (200 SY)	$ 1,500
Headwalls (2)	$ 10,000
Dixie Street Diversion	$ 5,000
Subtotal	$120,000

North of 8th Street Pond Inlet / Outlet System

Con Span Inlet & Outlet Structures	$120,000
4 Wingwalls	$ 40,000
Ditch Paving & Fabriform	$ 30,000
Overflow / Drawdown Weir Control Structure	$ 20,000
Sodding & Grassing	$ 8,000
Subtotal	$218,000

TOTAL - MILL CREEK OPINION OF OF PROBABLE CONSTRUCTION COST	$3,455,525
15% Construction Contingency	518,329
15% Project Costs (Surveying, Soils, Engineering, Legal, Administrative, Inspection)	$518,329
TOTAL - MILL CREEK	$4,492,183

CLOUD BRANCH DRAINAGE BASIN

OPINION OF PROBABLE CONSTRUCTION COST

ITEM	COST
Channel Cleaning & Regrading (As environmentally allowed)	
Cloud Branch Channel & Tributaries (10,500 L.F.)	$39,500
Sodding (5500 SY)	$ 8,250
Seeding & Mulching (27,000 SY)	$ 9,450
Regrading & excavate new bottom profile (13th St. to Coastline Park), sheeting & shoring as necessary for culvert installation (1500 LF)	$ 9,000
Sub-Total	$66,200
Detention Pond Systems	
Opinions of Probable Costs do NOT include land and/or easement acquisition costs. Includes clearing and grubbing, demucking, excavation, filling, erosion control, sodding slopes, grassing & plantings, and fencing.	
Coastline Park (12.6 Ac.)	$285,000
14th-16 Street (4.0 Ac.)	$ 90,000
Sub-Total	$375,000
Piping of Cloud Branch - South of 13th Street to Coastline Park	
Opinions of Probable Cost do NOT include right-of-way or easement acquisition or utility relocation, should it become necessary.	
Twin 48" Box Culvert (1000 L.F.)	$200,000
Storm Inlets & Junction Boxes (9)	$ 45,000
Headwalls (2)	$ 20,000
Road Crossings (3)	$ 12,000
Seeding & Mulching (2860 SY)	$ 1,000
Sheeting & Traffic Control	$100,000
Restoration	$ 10,000
Sub-Total	$388,000

New Upgraded Culvert Crossings

Opinion of Probable Cost does NOT include right-of-way and/or easement acquisition costs

19 Street

48" R.C.P. (60 L.F.)		$ 7,200
Road Crossing (1)		$ 4,000
Headwalls, Normal (2)		$ 10,000
	Sub-Total	$ 21,200

16th Street

32 S.F. Box Culvert (60 L.F.)		$ 15,000
Road Crossing (1)		$ 4,000
Headwalls, Normal (2)		$ 5,000
	Sub-Total	$ 24,000

14th Street

32 S.F. Box Culvert (60 L.F.)		$ 15,000
Road Crossing (1)		$ 4,000
Headwalls, Normal (2)		$ 5,000
	Sub-Total	$ 24,000

8th Street

48" R.C.P. (60 L.F.)		$ 7,200
Road Crossing (1)		$ 4,000
Headwalls, Normal (2)		$ 10,000
	Sub-Total	$ 21,200

Railroad Crossing

Twin 48" R.C.P. (300 L.F.)		$ 90,000
Railroad Crossing (Open Cut)		$ 30,000
Headwalls (4)		$ 30,000
Erosion Protection		$ 30,000
R.R. Traffic Control & Supervision		$ 20,000
	Subtotal	$200,000

14th - 16th Street Pond Inlet/Outlet System

Inlet & Outlet Piping Through Berms	$ 20,000
4 Wingwalls & Headwalls	$ 10,000
Ditch Paving, Fabriform	$ 5,000
Overflow Drawdown Control Structure	$ 8,000
Sodding and Grassing	$ 1,500
Subtotal	$ 44,500

Coastline Park Ponds Inlet/Outlet System

Slope Paving, Fabriform at Inlet, Around Inlet Control Structure & Pond Crossing	$ 10,000
Outlet Overflow / Drawdown Control Structure	$ 10,000
Sodding	$ 2,000
Subtotal	$ 22,000

TOTAL - CLOUD BRANCH OPINION OF OF PROBABLE CONSTRUCTION COST	$1,186,100
15% Construction Contingency	$ 177,915
15% Project Costs (Surveying, Soils, Engineering, Legal, Administrative, Inspection)	$ 177,915
TOTAL - CLOUD BRANCH	$1,541,930

DOWNTOWN RELIEVER

Estimate of Probable Construction Cost for Alternate No. 1 (From Myrtle Avenue to Large Junction Box Between Pine and Hickory Avenue, via 1st or 2nd Street)

Description	Quantity	Unit	Unit Cost	Total
Storm Manhole, 6'-8' Deep; 6-8' Diameter	2	Ea.	$ 6,000	$ 12,000
Storm Manhole, 8'-10' Deep; 8'-10' Diameter	5	Ea.	$ 10,000	$ 50,000
Concrete Pipe (Including Dewatering, Exvacation, Backfill & Compaction)				
a. 36" Diameter	430	L.F.	$ 100	$ 43,000
b. 42" Diameter	345	L.F.	$ 120	$ 41,400
c. 60" Diameter	325	L.F.	$ 160	$ 52,000
d. 72" Diameter	1,425	L.F.	$ 200	$285,000
Roadway Removal and Restoration (Including Base, Sub-base, & curbing)				
a. Brick Roadway Replacement				
1) 35' Wide	870	L.F.	$ 285	$247,950
2) 30' Wide	330	L.F.	$ 245	$ 80,850
b. Asphalt Roadway Replacement				
1) 38' Wide	150	L.F.	$ 60	$ 9,000
2) 35' Wide (Intersection, no curb.)	60	L.F.	$ 47	$ 2,820
3) 28' Wide	1,000	L.F.	$ 48	$ 48,000
4) 20' Wide	250	L.F.	$ 37	$ 9,250
Connect Existing Inlets to New Pipe	15	Ea.	$ 1,000	$ 15,000
Reconstruct Sidewalks	4,800	L.F.	$ 5	$ 24,000
Utility Conflicts, Repairs, Relocation*	38	Ea.	$ 500	$ 19,000

*Based on similar billings during Sanford Sewer Rehabilitation)

Alternate No. 1 Subtotal	$939,270
+15% Construction Contingency	140,890
+15% Engineering, Surveying, Legal, Administrative, Etc.	140,890
	$1,221,050

MILL CREEK/CLOUD BRANCH

DRAINAGE STUDY

CITY OF SANFORD, FLORIDA

S0607.00

APRIL 1988

CONKLIN, PORTER & HOLMES-ENGINEERS, INC.
P. O. Box 1976
SANFORD, FLORIDA 32772-1976

CPH PROJECT NO. S0607.00

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1.0 SUMMARY AND CONCLUSIONS

This report presents the results of a drainage study done for the City of Sanford by Conklin, Porter & Holmes - Engineers, Inc. on the drainage systems in the north-central and northwestern portions of the City of Sanford. These two major systems are known as the Mill Creek and Cloud Branch Drainage Basins and form the conduits providing stormwater drainage from those areas of the City of Sanford into Lake Monroe. The report includes discussions of the site specific drainage basin parameters used in the analysis, the hydrologic and hydraulic analysis techniques used, the results of the hydrologic/ hydraulic analysis, identification and prioritization of some general and some specific improvements needed, opinion of probable cost of those improvements, and lastly supporting maps and calculations.

The study used hydrologic design techniques for determination of the runoff from areas within each basin by use of the Soil Conservation Service hydrograph methods. Site specific data including areas, existing soil and cover complex determinations, site slope and time of concentration determinations, and unit hydrograph shape factors were determined on an individual subbasin by subbasin basis. A design rainfall frequency of 25 years and a rainfall duration of 6 hours were used for the analysis. The rainfall distribution pattern used in the analysis was that distribution published by Seminole County in its Land Development Code as a Seminole County specific distribution for a 25-year, 6-hour storm event.

A ten to fifteen (10-15) percent increase in runoff due to future development was incorporated into the analysis. This increase assumes the future requirement of stormwater retention

systems for individual developments to be built in the basins; but predicts, to be conservative, that these systems will not be 100% effective, and that there will be other small development and individual home building that will not provide any stormwater retention.

The hydraulic analysis methods used for this study were interconnected pond routing methods with determination of existing and proposed on-line storage areas, existing and proposed control structures (culverts, etc.), and existing and proposed channel geometry used to determine routed runoff peak rates and stages within the existing and proposed drainage systems. The modeling technique used takes into account backwater stage for each of the control structures.

The major conclusions of this report are:

- That the existing Mill Creek and Cloud Branch drainage system contains existing channel and culvert restrictions that constitute major blockage and flow hindrance problems to the overall basin drainage resulting in localized flooding, bank erosion, and culvert plugging problems;

- That certain of the culverts and channel systems need to be repaired and replaced in order to make the drainage systems capable of passing a 25-year 6-hour design storm event without substantive flooding; and

- That prioritization of the repairs/replacements can be made so as to most effectively direct any available resources towards improvement of the Mill Creek and Cloud Branch drainage basins.

Specific recommendations of priority for system repairs/replacements may be found in Sections 5.3 and 5.4 on pages 86 through 97 of this report. Generally the

recommendations for repairs/replacement include removal of existing debris and vegetation growth within each of the channels, closing existing creeks/ditches where there is insufficient land area between existing homes to construct the necessary channel section and as such constitutes a safety hazard, and lastly construction of culvert and retention pond facilities as needed to reduce the peak flows through on-line flow buffering.

Section 6.0 contained on pages 98 through 107 presents opinions of probable construction cost for the individual prioritized system repair/replacements as well as totalization of those opinions of probable construction cost for each of the two creeks. As noted in that section, a total of $1,266,672 was presented as an opinion of a probable construction cost for improvements to the Cloud Branch system and a total of $3,397,350 was presented as the opinion of probable construction cost of improvements to the Mill Creek system. These costs include an allowance for final engineering, surveying, and design as well as a twenty-five percent contingency. These probable construction costs do not include any allowance for land acquisition for retention pond or pipe systems, purchase of right-of-way or easements as necessary for the construction, or other related land purchase or legal items.

2.0 INTRODUCTION

The north central and northwestern portions of the City of Sanford contain stormwater drainage systems generally tributary to two existing natural drainage channels. These two channels are Mill Creek and Cloud Branch. Specific delineation of the basin boundaries and site specific data for each of the basins is presented in subsequent portions of this report, but generally the Mill Creek system drains the northwestern portion of the City of Sanford roughly bounded by Lake Monroe on the north, 25th Street on the south, Airport Blvd. and Bevier Road on the west and Olive Street on the east. The Cloud Branch system is generally bounded by Lake Monroe on the north, 25th Street on the south, Park Ave. and Sanford Ave. on the east and Olive Ave. on the west. Both of these basins drain from south to north and are natural drainage channels which have been substantially modified by the inclusions of culverts, regrading, basin diversions, rechannelization, and other activities throughout the development of the City of Sanford. Observation by the City of Sanford personnel as well as by the residents in each of these basins indicate that the basins and their draining creek systems experience high water flows, localized flooding, erosion problems, and safety problems due to proximity of structures to the creek at many locations.

The purpose of this report is to present specific analyses and results of studying these two creek systems and proposing and analyzing measures to improve their capability to handle adequately a design storm of 25 year frequency 6 hour duration. A further purpose of this report is to prioritize and estimate a probable construction cost for the proposed channel, culvert,

and system improvements for each of the two drainage systems so as to assist in better determining the application of available resources towards remedying the existing drainage problems in these two areas.

Extensive field investigations, aerial photograph, and map reviews, discussion with City of Sanford, St. Johns River Water Management District, and other regulatory agencies were done during the preparation of this report and the authors would like to convey their appreciate for the assistance provided by the City of Sanford and the regulatory agencies.

3.0 MILL CREEK AND CLOUD BRANCH DRAINAGE BASIN PARAMETERS

3.1 SITE LOCATION

Sanford, county seat of Seminole County, is situated in north central Seminole County about twenty miles north of Orlando. It spreads along the southern shore of Lake Monroe, part of the St. Johns River system and is just west of Interstate 4, as shown in Figure 3-1. The city of Sanford encompasses approximately 8100 acres and has a population in excess of 29,000 residents.

The Mill Creek and Cloud Branch drainage basins, approximately 1392 and 664 acres in size respectively, above their existing outlet to Lake Monroe, are located in and generally drain the western portion of the City of Sanford. The Mill Creek drainage basin is roughly bounded geographically by Meisch Road on the west, Olive Avenue on the east, Santa Barbara Drive on the south, and Highway 46 (First Street) on the north. Figure 3-2 shows the exact extent of the drainage basin while Figure A-1 (Map Pocket A) shows the individual subbasins within the drainage basin.

The Cloud Branch drainage basin is roughly bounded geographically by Olive Avenue on the west, Park Avenue on the east, 25th Street on the south, and Highway 46 (First St.) on the north. Figure 3-3 shows the exact extent of the drainage basin while Figure B-1 (Map Pocket B) shows the individual subbasins or subareas within the drainage basin.

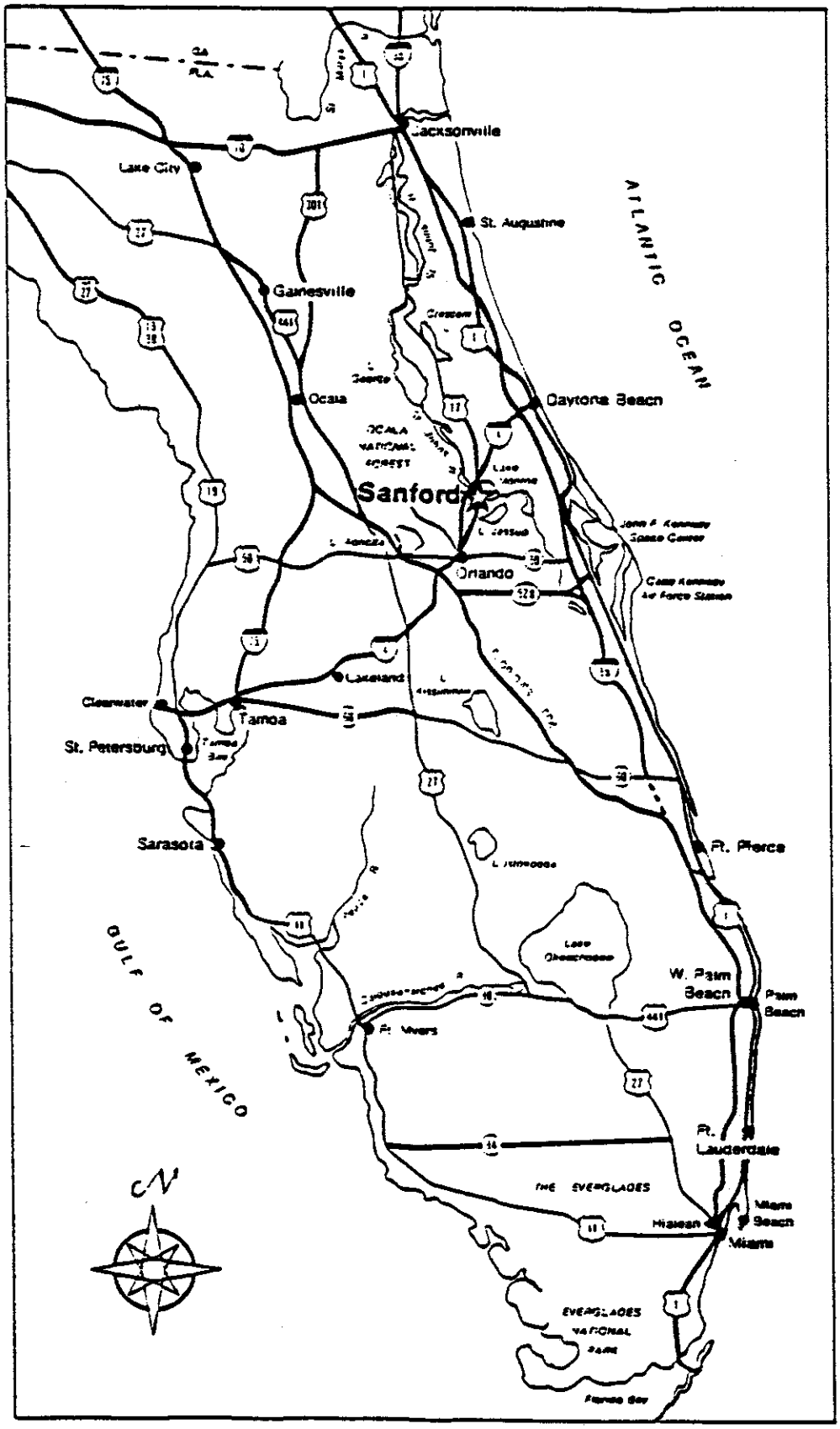


Figure 3-1. City of Sanford Location Map

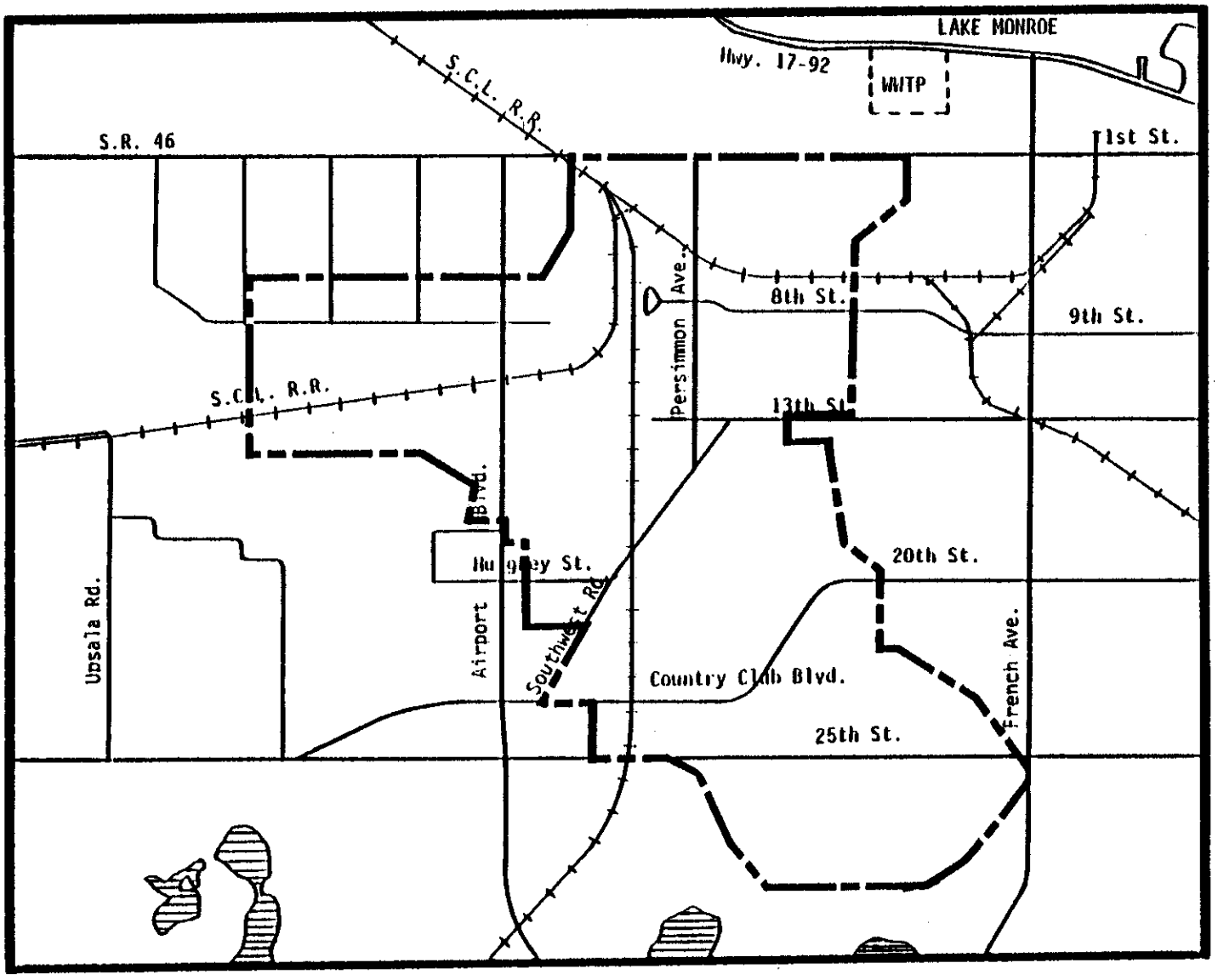


FIGURE 3-2 - MILL CREEK DRAINAGE BASIN

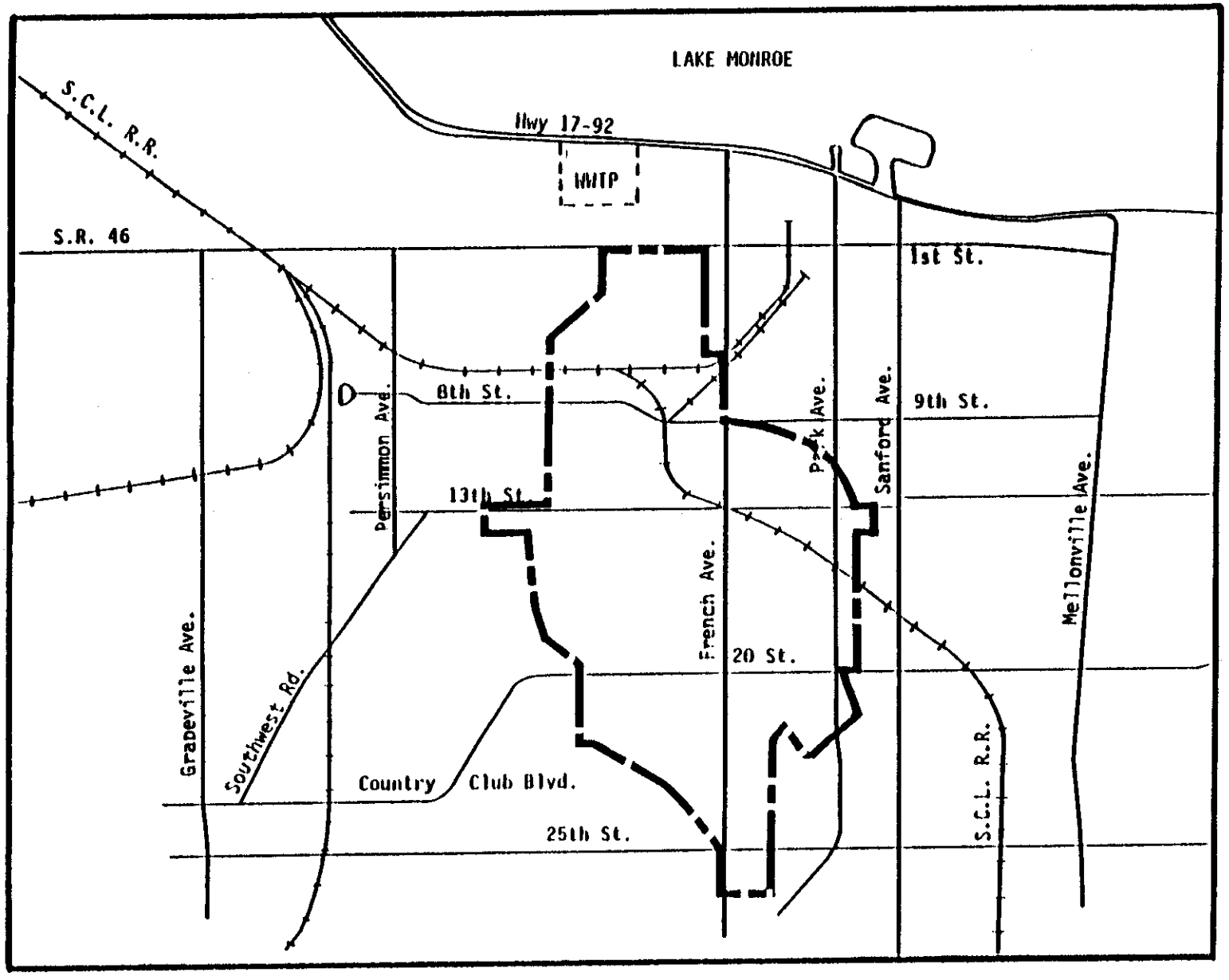


FIGURE 3-3 - CLOUD BRANCH DRAINAGE BASIN

3.2 PREVIOUS STUDIES

A preliminary engineering study on the Mill Creek and Cloud Branch Drainage Basins by Clark, Dietz, and Associates was completed in 1968. The study called for the enlargement and deepening of several sections of earthen channels; construction of several closed conduit interceptors; and the upgrading of numerous culvert crossings.

3.3 CLIMATE

The climate of the Sanford area is characterized by long, warm, typically humid summers and by mild, dry winters. The rainfall in the area averages about 53 inches on an annual basis. Of this annual rainfall, nearly 60 percent of the total falls in the four month period of June through September, with July being the wettest month. November is typically the driest month. The numerous water bodies in the immediate vicinity have a moderating effect on the temperature in both summer and winter. Prevailing winds in the area are generally southerly in the spring and summer and northerly in the fall and winter and generally range between 8 and 15 mph.

3.4 TOPOGRAPHY

3.4.1 MILL CREEK DRAINAGE BASIN

The topography of the Mill Creek Drainage Basin can, for classification purposes, be divided into two regions; the gently sloping lowlands portion of the basin between Lake Monroe and 6th Street and the uplands portion of the basin south of 6th Street. The lowlands portion of the basin slopes gently from approximately Elevation 7.0 FMSL at the Sanford

wastewater treatment plant (adjacent to the basin discharge point-Lake Monroe) to Elevation 15.0 FMSL near 6th Street approximately 3700 feet to the south. The higher upland (southerly) portion of the drainage basin, which includes several depressional areas, varies from Elevation 20.0 FMSL in the lower areas to Elevation 50.0 just south of 25th Street. The Mill Creek topography typically contains slopes less than 1.0 percent, with the majority of the fall in the basin being less than 0.5 percent. A topographic survey of the Sanford-Mill Creek area is presented in Figure 3-4 (U.S.G.S. Sanford Quadrangle, 1980).

3.4.2 CLOUD BRANCH DRAINAGE BASIN

The topography of the Cloud Branch drainage basin can also, for classification purposes, be divided into two regions; the lowlands portion of the basin between Lake Monroe and 6th St. and the uplands portion of the basin north of 6th St. The lowlands portion of the basin slopes gently from approximately Elevation 7.0 FMSL at the Sanford wastewater treatment plant (adjacent to basin discharge point) to Elevation 15.0 FMSL near 6th Street approximately 2500 feet to the south. The higher upland (southerly) portion of the drainage basin, which includes several depressional areas, varies from Elevation 20.0 FMSL in the lower areas to Elevation 50.0 FMSL near Highland Park. The Cloud Branch topography typically contains slopes less than 1.0 percent, with the majority of the fall in the basin being less than 0.5 percent. A topographic survey of the Sanford-Cloud Branch area is presented in Figure 3-5 (U.S.G.S. Sanford Quadrangle, 1980).

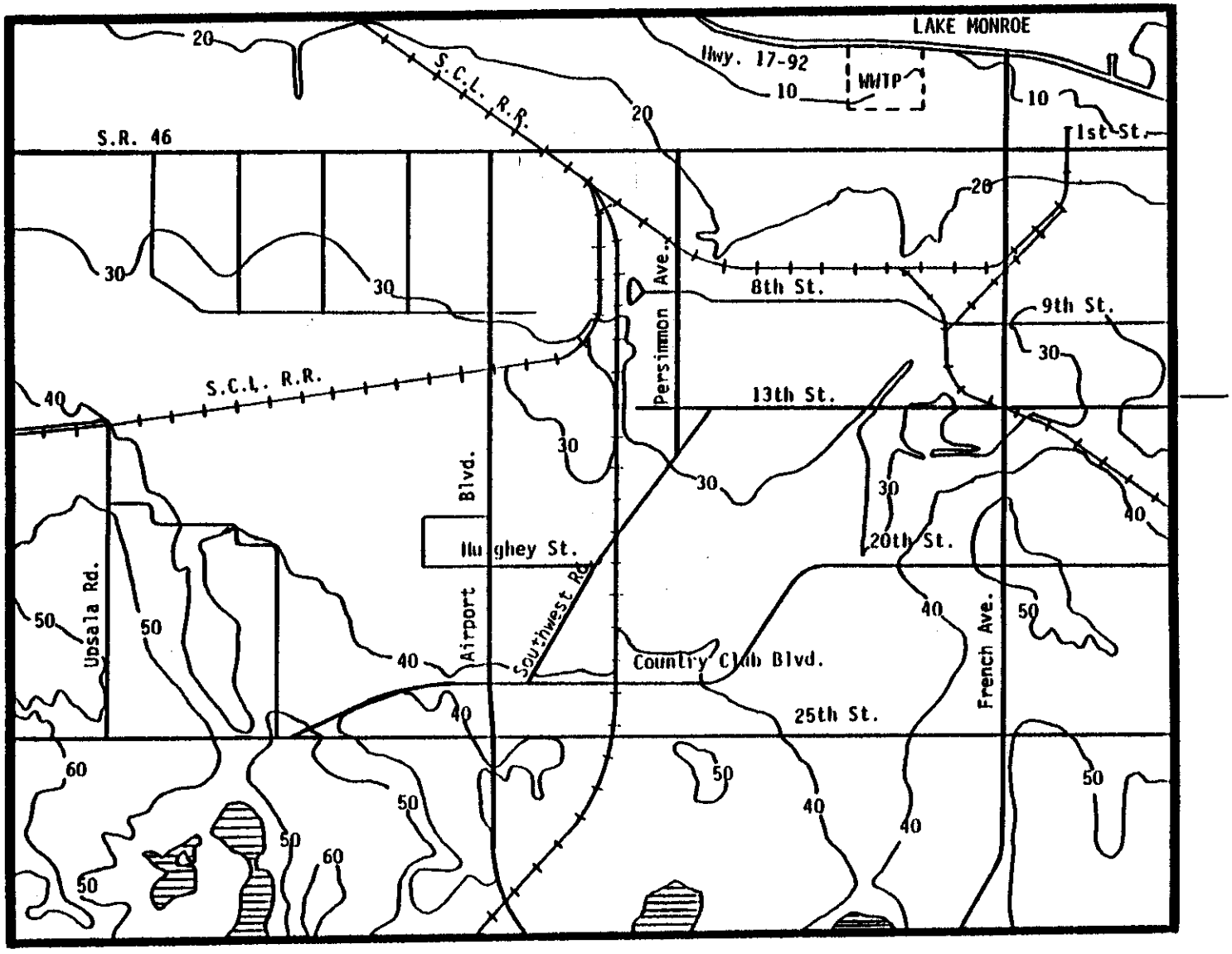


FIGURE 3-4. SANFORD/MILL CREEK DRAINAGE BASIN TOPOGRAPHIC MAP
(USGS Sanford Quadrangle, 1980)

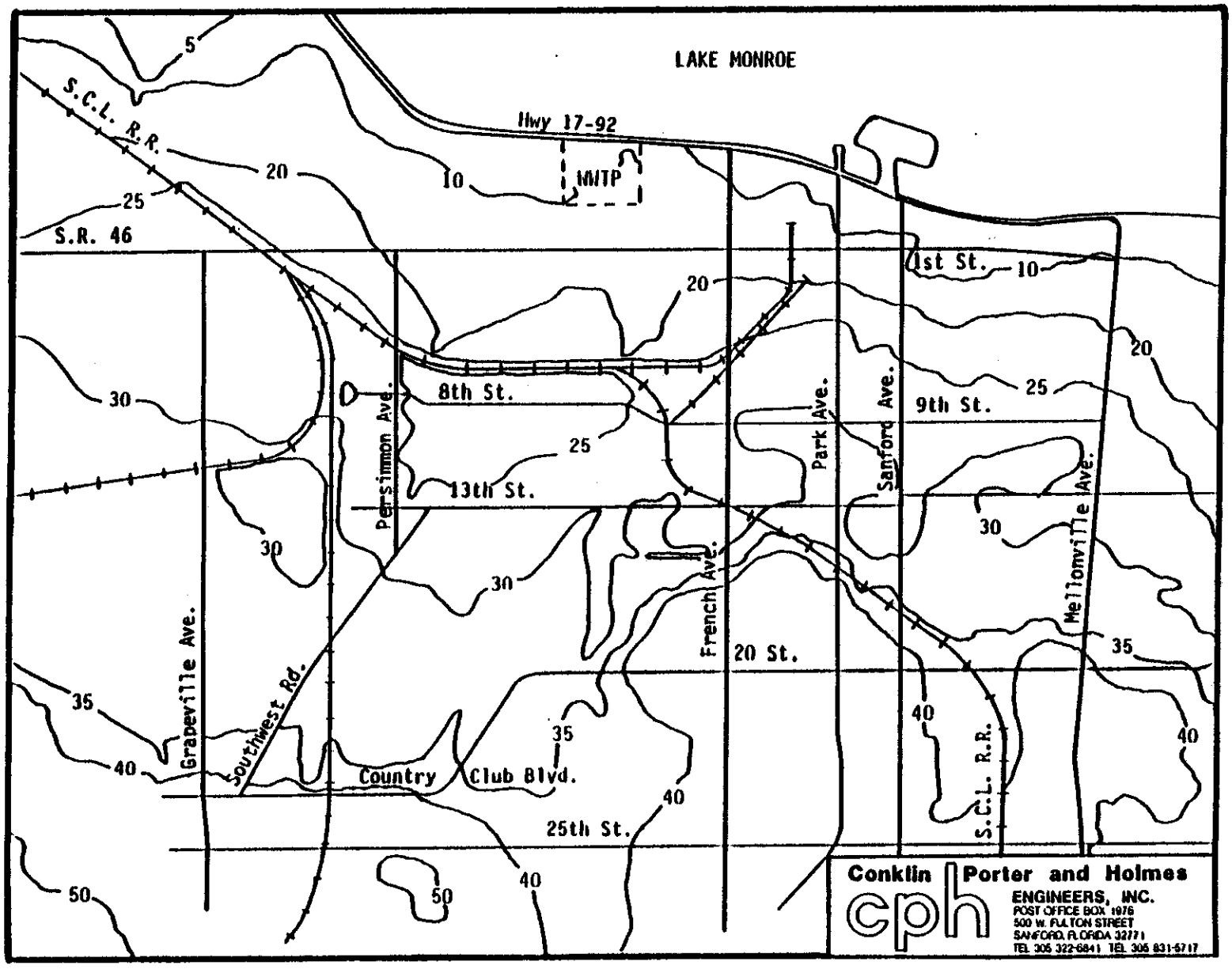


FIGURE 3-5. SANFORD/CLOUD BRANCH DRAINAGE BASIN TOPOGRAPHIC MAP
(USGS Sanford Quadrangle, 1980)

3.5 SOILS

3.5.1 MILL CREEK DRAINAGE BASIN

The surfacial soils in the Mill Creek Drainage Basin are of the Leon-Delray-Immokalee Series-Made Land in the northern portion of the basin and Leon-Brighton-St Johns Series-Made Land in the southern portion as shown in Figure 3-6. Leon Fine Sand (LfA) comprises approximately fifty-five (55%) percent of the overall basin acreage. This is a poorly drained, strongly acidic, low fertility soil which has a high water table (0-15 inches during the wet season). The surface layer is black to dark-gray, loose fine sand about four inches thick, and the second layer is white to gray, loose fine sand about twenty inches thick. The third layer, or pan, is dark brown to black, and is slightly hard to soft (about 12 inches thick).

St Johns Fine Sand (Sa) is found on approximately fifteen (15%) percent of the basin site. This is a somewhat poorly drained or poorly drained soil and is strongly acidic. The surface layer is black fine sand about 12 inches thick, underlain by 60 to 80 inches of loose fine sand with intermittant layers of weakly cemented fine sand stained with organic matter. This soil type has a fluctuating water table, a moderately low content of organic matter, and a sandy texture. Natural fertility is low.

The remaining site acreage is composed of isolated regions of:

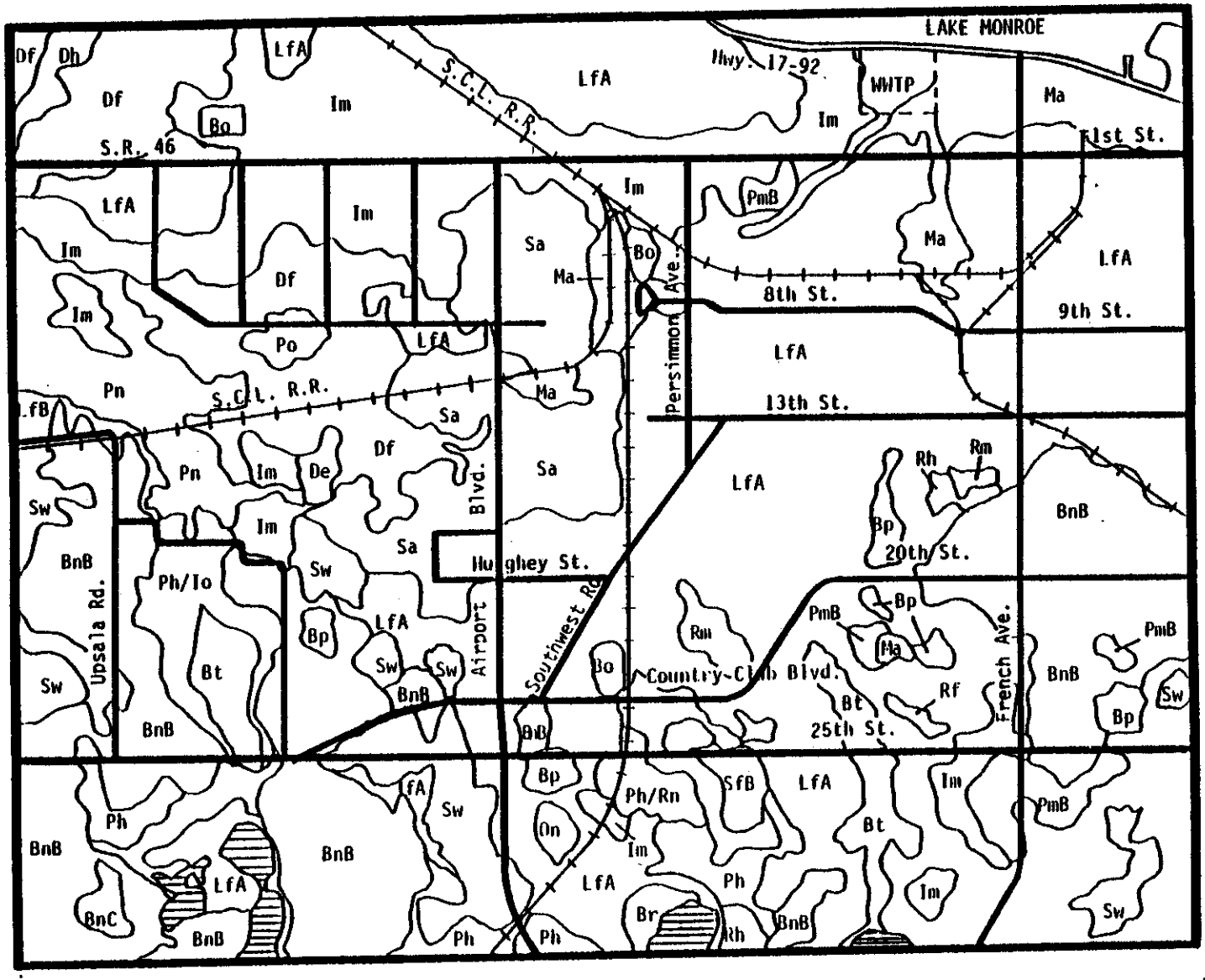


FIGURE 3-6. SANFORD/MILL CREEK SOILS MAP (SCS Seminole County Soils Survey, 1966)

Delray Fine Sand, High (Df) (8%)	A deep, poorly drained soil whose surface layer consists of dark gray to black fine sand, 8 to 24 inches in thickness. The content of organic matter is high, and natural fertility and the available moisture capacity are moderately high.
Immokalee Fine: Sand (Im) (7%)	A deep, somewhat poorly drained soil, and strongly acidic or very strongly acidic. The surface layer is blackish fine sand underlain by 25 to 42 inches of grayish loose fine sand. Natural fertility, the content of organic matter, and the available moisture capacity are low. This soil is droughty during dry periods and wet during periods of high rainfall.
Made Land (Ma): (4%)	Consists of clayey or sandy material, or both, that has been reworked by soil moving equipment. Some areas consist of raw geologic material, and some areas contain a large amount of organic matter.
Brighton, Istokpoga, and Okeechobee Soils (Bt) (3%) :	Consists of organic soils that are very wet and have a dense cover of vegetation. These soils are on low grassy flats and in wooded depressions, and they are covered by water most of the year.
Soil Types comprising less than 2% of the total site area (8%)	Pomello Fine Sand (1.6%) St Lucie Fine Sand (1.3%) Rutledge Mucky Fine Sand (1.3%) Pompano Fine Sand (1.2%) Borrow Pit (1.1%) Plummer Fine Sand (0.7%) Delray Fine Sand (0.5%) Rutledge Fine Sand (0.4%) Brighton Peat (0.2%)

3.5.2 CLOUD BRANCH DRAINAGE BASIN

The surfacial soils in the Cloud Branch Drainage Basin are of the Leon-Blanton-Brighton Series in the southern portion of the basin and Leon Series-Made Land in the northern portion as shown in Figure 3-7. Leon Fine Sand (LfA) comprises approximately sixty (60%) percent of the

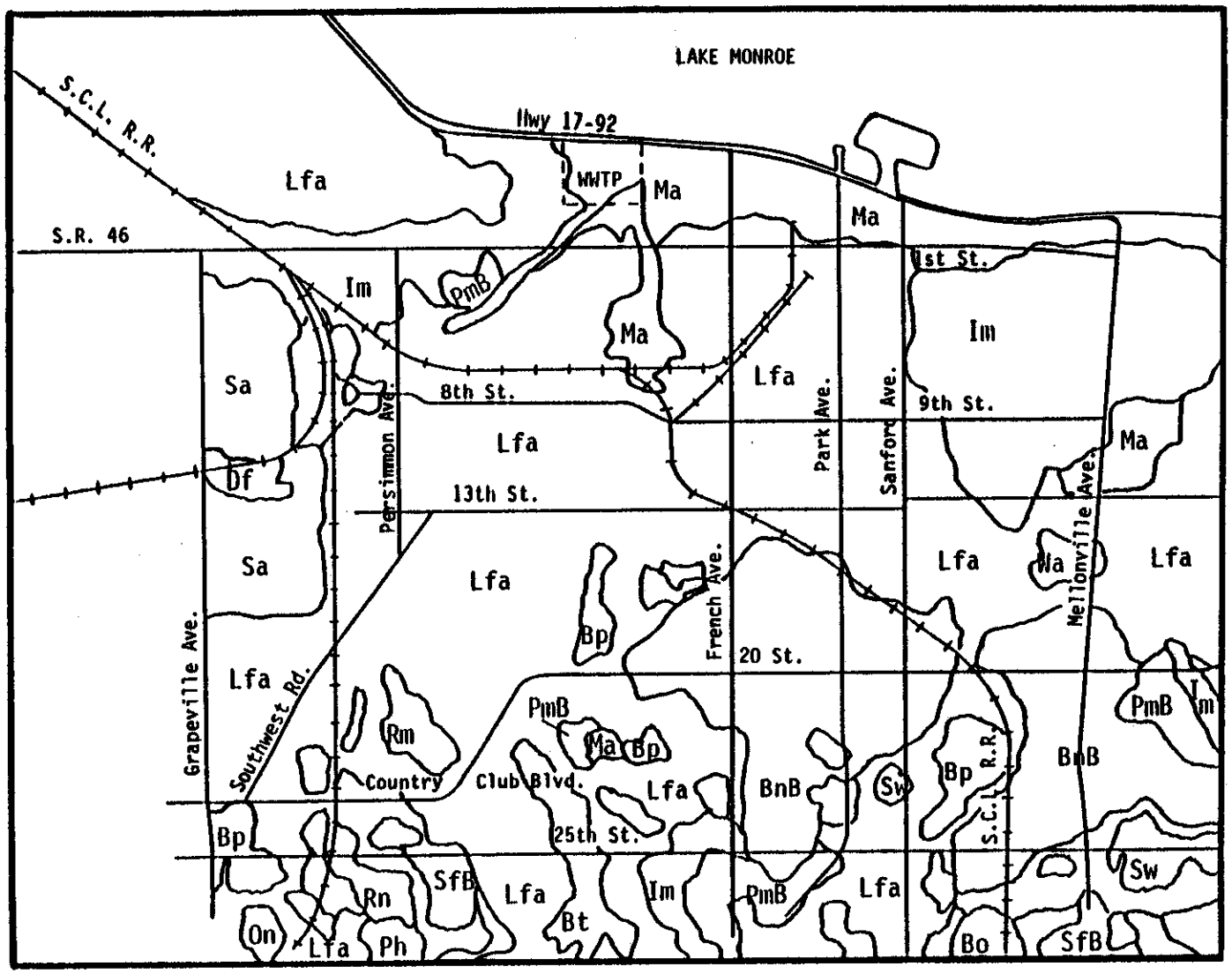


FIGURE 3-7. SANFORD/CLOUD BRANCH SOILS MAP
(SCS Seminole County Soil Survey, 1966)

overall basin acreage. This is a poorly drained, strongly acidic, low fertility soil which has a high water table (0-15 inches during the wet season). The surface layer is black to dark-gray, loose fine sand about four inches thick, and the second layer is white to gray, loose fine sand about twenty inches thick. The third layer, or pan, is dark brown to black, and is slightly hard to soft (about 12 inches thick).

Blanton Fine Sand (BnB) is found on approximately thirty (30%) percent of the basin site. This is a moderately well drained, deep, sandy soil on low, gently sloping ridges. The total thickness of the fine sand over finer textured material is more than 42 inches, with a loose grayish fine surface layer about four inches thick. This soil type has low natural fertility, is low in content of organic matter, and is strongly acidic.

The remaining site acreage is composed of isolated regions of:

Made Land (Ma): (4%)	Consists of clayey or sandy material, or both, that has been reworked by soil moving equipment. Some areas consist of raw geologic material, and some areas contain a large amount of organic matter.
Pomello Fine : Sand (PmB) (4%)	A moderately well drained soil, nearly level to very gently sloping, and very acidic. These soils are very porous and water moves rapidly through their profile.
Brighton Peat: (Bp) (2%)	This is a very poorly drained organic soil that is covered by water most of the year. The surface layer is black, decomposed, felty peat about four inches thick underlain by 36 to 60 inches of dark grayish-brown peat.

Not only are the surface soils within each drainage basin of importance but the underlying formations are also quite critical. The surface soils in the lowlands are generally underlain by an impervious layer of sand resulting in poor percolation of water. As these soils have a limited permeability, the soil voids fill up rapidly during storm events leading to a groundwater table that is at or near the surface. As a result, there is a general ponding effect in various areas with conveyance occuring by either sheet flow or natural evaporation.

3.6 EXISTING CHANNEL CONDITIONS

3.6.1 MILL CREEK DRAINAGE BASIN

At the present time, the conveyance of stormwater runoff in the Mill Creek channel is as shown in Figure 3-8 with accompanying stormwater drainage structures presented in Table 3-1. The headwaters of the Mill Creek Basin originate south of 25th St near Seminole High School, north of Lake Jennie. There is no improved drainage system in this part of the basin and water gathers in the low swampy area south of 25th Street between Hartwell and Marshall Avenues. From this low, swampy, depressional area, water drains north under 25th Street and into an improved grass ditch which traverses the east side of the Country Club Manor subdivision. An east-west open ditch along with a system of small pipes drains the Country Club Manor and outfalls to the main channel of Mill Creek (Tributary Channels A and B). These small pipes are restrictive and cause street flooding under moderate rainfalls. The main channel then proceeds north and crosses under 20th Street in a 43" x 27" culvert which significantly restricts the conveyance of the creek

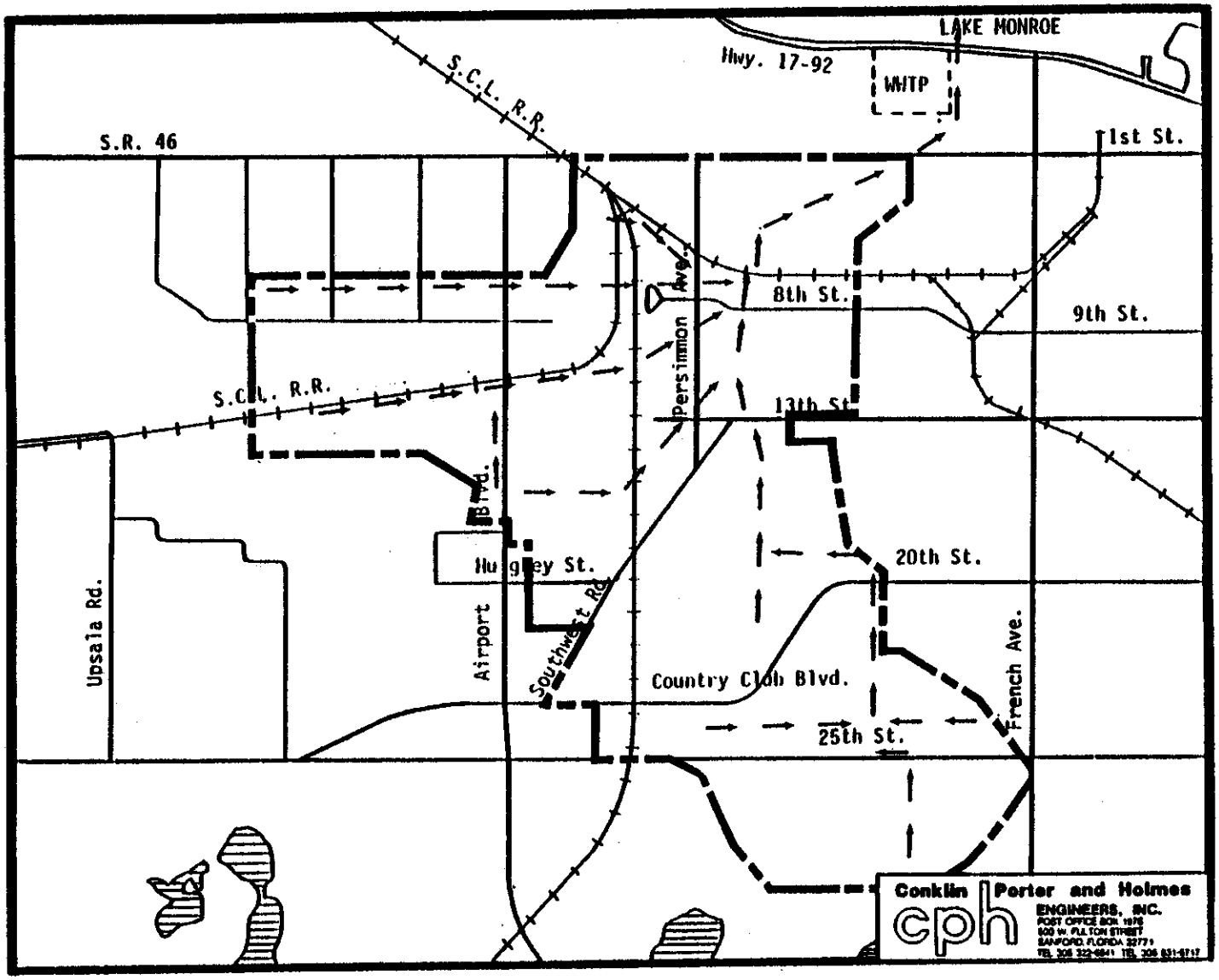


FIGURE 3-8. MILL CREEK EXISTING DRAINAGE PATTERN

TABLE 3-1

MILL CREEK DRAINAGE STUDY

EXISTING DRAINAGE STRUCTURES

LOCATION	CULVERT TYPE	QUANTITY
"MAIN CHANNEL - MILL CREEK"		
25th STREET	36" RCP	1
25th STREET DITCH	30" RCP	1
20th STREET (S)	43"x 27" CMP	1
20th STREET (N)	5'x 5" BOX	1
18th STREET	48" RCP	1
18th STREET	6'x 4' BRIDG	1
16th STREET	6'x 4' BRIDG	1
15th STREET	6'x 4' BRIDG	1
14th STREET	60" CMP	1
14th STREET	60" CMP	1
13th STREET	60" CMP	2
8th STREET	60" RCP	1
RR TRACK - SPUR	15'x 9' ARCH	1
RR TRACK - MAIN LINE	15'x 9' ARCH	1
3rd STREET	25'x 5' BRIDG	1
2nd STREET	25'x 5' BRIDG	1
1st ST (HWY-46)	7'x 8' BOX	3
U.S.HWY 17-92	39'x 9' BRIDG	1
TRIBUTARY CHANNEL "A" - COUNTRY CLUB MANOR		
CLUB AVENUE	26" CMP	1
BRADSHAW AVENUE	18"CMP	2
GEORGIA AVE	44"x 64" ECMP	1
TRIBUTARY CHANNEL "B" - COUNTRY CLUB MANOR		
CHASE AVENUE	18" RCP	1
MARSHALL AVENUE	18" RCP	1

TABLE 3-1 (CONT'D)

MILL CREEK DRAINAGE STUDY

EXISTING DRAINAGE STRUCTURES

LOCATION	CULVERT TYPE	QUANTITY
TRIBUTARY CHANNEL "C" - CROOMS ACADEMY		
McKEE RET POND	36" RCP	2
RR TRACK	46" RCP	2
DIXIE STREET	48" CMP	1
13th STREET	30" RCP	1
PERSIMMON AVENUE	30" RCP	1
TRIBUTARY CHANNEL "D" - NORTHERN CHANNEL		
MEISCH DRIVE	21" RCP	1
BEVIER ROAD	18"x 44" ERCP	2
AIRPORT BOULEVARD	8'x 3' BRIDG	1
RR TRACK - W SIDE	44" RCP	2
RR TRACK - E SIDE	69"x 66" ARCH	1
PERSIMMON AVENUE	56"x 58" ARCH	2
TRIBUTARY CHANNEL "E" - SOUTHERN CHANNEL		
AIRPORT BOULEVARD	3.7'x 4.0' BOX	1
RR TRACK - W SIDE	5.5'x 7.4' ARCH	1
RR TRACK - W SIDE	6' x 6' BOX	1
PERSIMMON AVE	78" RCP	1
8th STREET	48" x 75" ERCP	1
TRIBUTARY CHANNEL "F" - McCRACKEN RD & RR		
McCRACKEN ROAD	52" RCP	1

system.

Upon crossing 20th St, Mill Creek flows north along an old railroad right-of-way and then turns west along 18th Street. At Mulberry Avenue, the creek turns north and meanders through the Goldsboro residential area. The main channel passes close to residences and is poorly developed and inadequate in size, to handle any reasonable storm event without creating a flooded condition.

At 13th Street the flow is conveyed under the street by a pair of 60" CMP. North of 13th Street, the main channel meanders through residential areas along lot lines to 8th Street. Capacity of the stormwater conveyance system has been limited due to the encroachment of development upon the channel limits.

A tributary channel (C) originating from the Airport Boulevard/Lincoln Heights area joins Mill Creek. The tributary flows ~~west~~ east from Airport Blvd and crosses under the Seaboard Coast Line Railroad after which it takes a northern turn. The channel continues north for approximately 800 feet and then heads northeast through a residential area where the channel is relatively inadequate. It crosses under 13th Street and Persimmon Avenue near Crooms Academy and joins the main channel of Mill Creek at 11th Street. The channel then flows north to 8th Street and passes under the road in a 60" RCP culvert.

About a half block north of 8th Street the main channel of Mill Creek is joined by another tributary channel (Tributary E) which comes in along the Seaboard Coastline Railroad. This tributary is all open ditch and extends westward approximately 7700 feet along the railroad. The channel collects stormwater drainage from Airport Boulevard and the numerous agricultural areas in the basin. Drainage structures in this area of the Mill Creek Basin appear to be adequate with the exception of the culvert crossing at 8th Street.

South of the railroad crossing at 7th Street, the main channel of Mill Creek is joined by another western tributary (Tributary D). The channel extends out approximately 7300 feet from Mill Creek and conveys agricultural runoff from areas that would not otherwise flow into Mill Creek.

After crossing the Seaboard Coastline Railroad, the main channel of Mill Creek meanders north and east along a low, strong, topographic draw to 1st Street. In this region, development has stayed away from the creek and the adjacent ground is undeveloped. The crossing at 1st Street is a triple box culvert system (7' x 8') constructed by the State Road Department which brings in stormwater drainage from 1st Street (both east and west, respectively).

North of 1st Street the creek continues northeast until its juncture with Cloud Branch at the Sanford Wastewater Treatment Plant. The combined flow then heads due north, under the bridge at U. S. Hwy 17-92

and into Lake Monroe. A profile of the existing main channel profile is provided in Figure 3-9 and defines the channel bottom and culvert crossing road elevations throughout the Mill Creek Basin.

One of the major restrictions to flow throughout the entire system is the immense growth of plants, shrubs, and bushes within the confines of the channel. Many areas are completely overrun with growth which thereby limits the conveyance of flow through the Mill Creek channel. In order to rectify this situation, it is recommended that the City clean out the entire Mill Creek main channel and its adjacent tributaries from south of 25th Street to the bridge crossing at U. S. Hwy 17-92 removing all plant, natural, and manmade restrictions.

3.6.2 CLOUD BRANCH DRAINAGE BASIN

At the present time, the conveyance of stormwater runoff in the Cloud Branch channel is as shown in Figure 3-10 with accompanying stormwater drainage structures presented in Table 3-2. The Cloud Branch Basin originates near the intersection of French Avenue and 25th Street with State Road Department drainage from French Avenue emptying into Pinehurst Park. The channel takes a northerly route from the park and crosses under 20th and 19th streets with the latter culvert system restricting flow capacity. North of this area the channel progresses through low, undeveloped land to Roundtree and 14th Street. In this reach, the channel is poorly developed and inadequate in size to handle any reasonable storm event without creating a flooded condition. Again, the culvert crossing at Roundtree and 14th Street is also

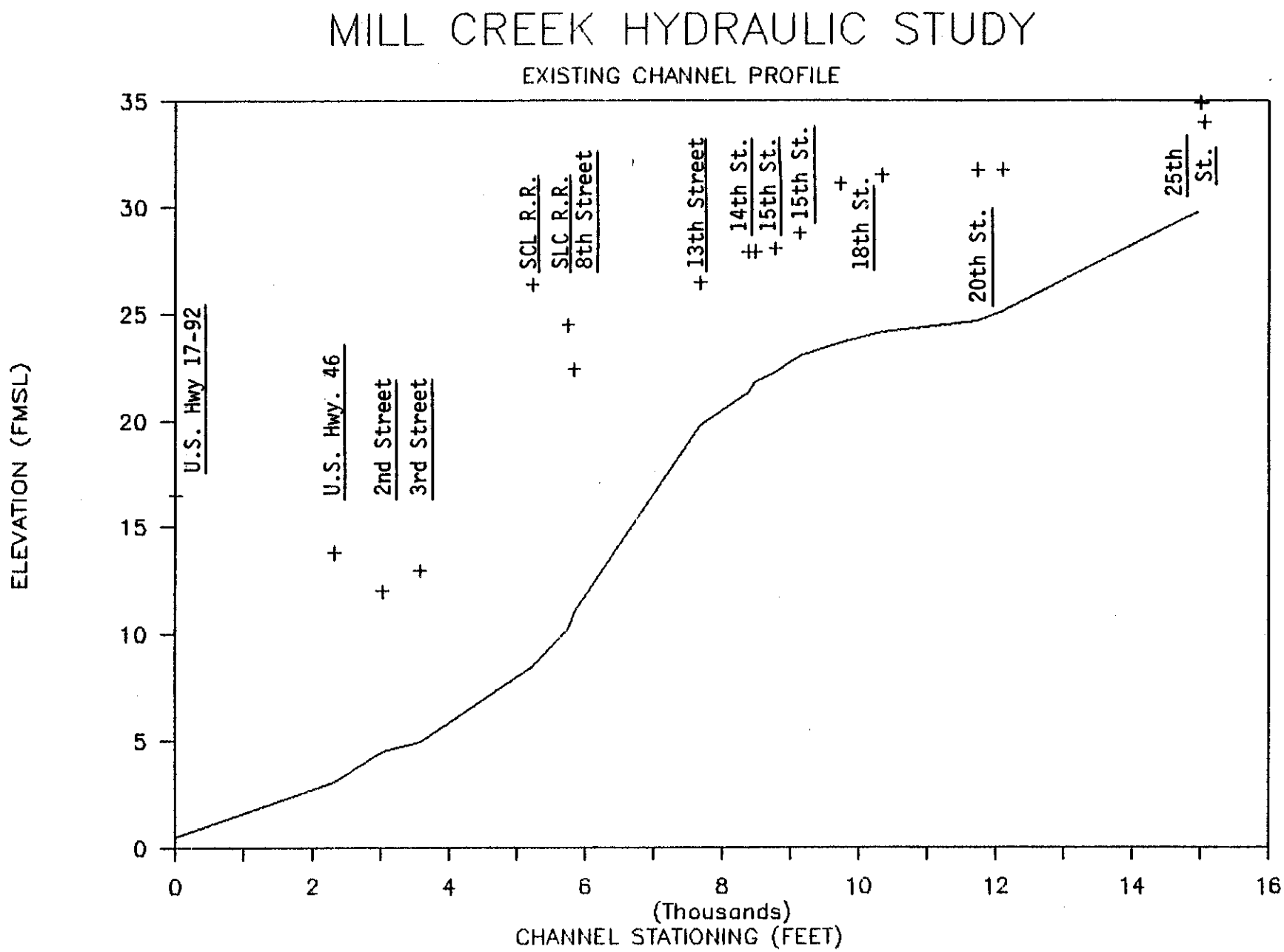


FIGURE 3-9. EXISTING CHANNEL PROFILE FOR THE MILL CREEK DRAINAGE BASIN

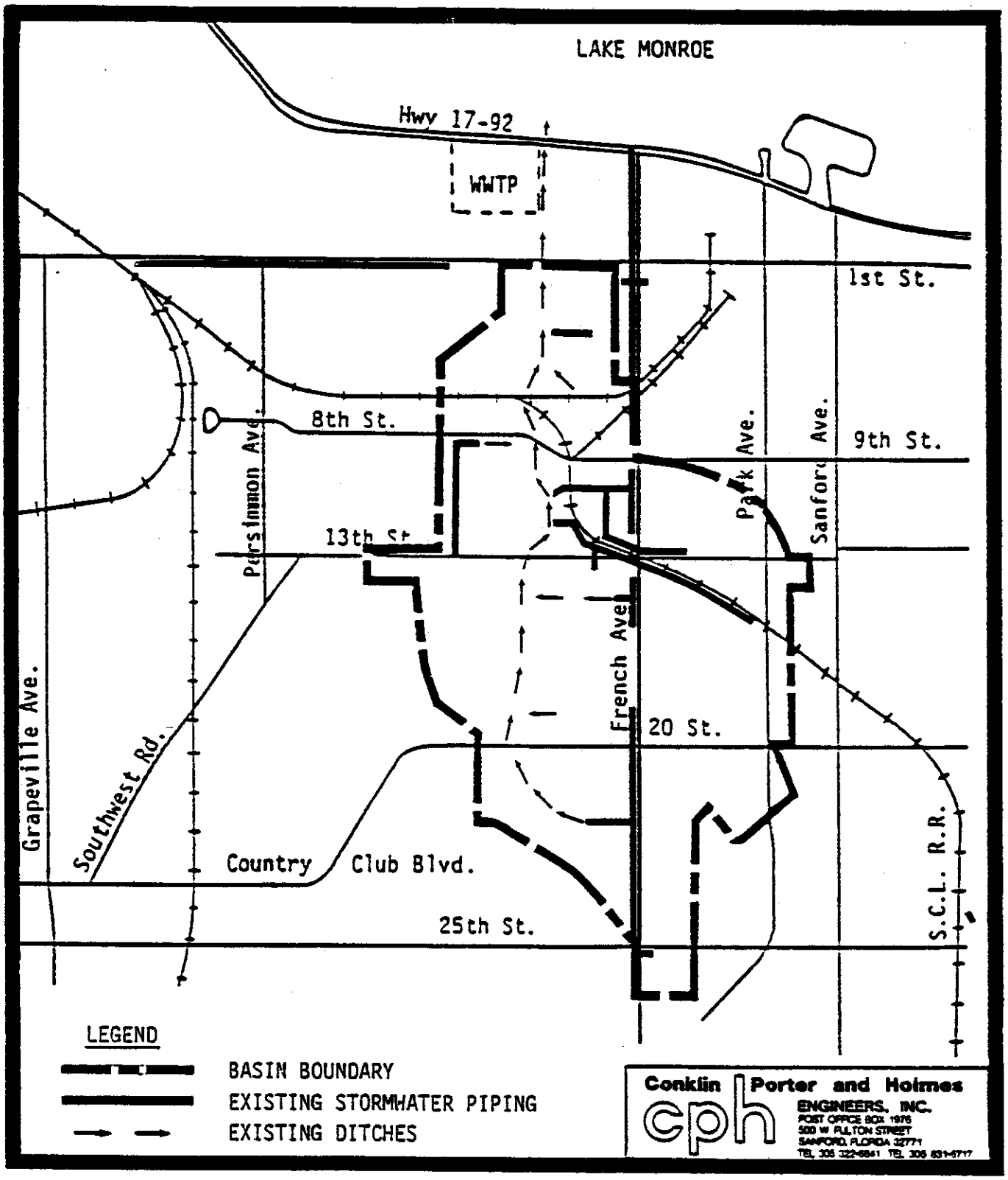


FIGURE 3-10. CLOUD BRANCH EXISTING DRAINAGE PATTERN

TABLE 3-2

CLOUD BRANCH DRAINAGE STUDY

EXISTING DRAINAGE STRUCTURES

LOCATION	CULVERT TYPE	QUANTITY
24th STREET	48" R.C.P.	1
PINEHURST PARK	48" C.M.P.	1
22nd STREET	48" C.M.P.	1
20th STREET	36" R.C.P.	2
19th STREET	43"x 27" R.C.P.	2
16th STREET	36" R.C.P.	1
14th STREET	30" C.M.P.	1
13th STREET	72" R.C.P. & 9'x 4' BOX CULV	1
12th STREET	42" R.C.P.	1
11th STREET	72"x 32" C.M.P.	1
10th STREET	48" R.C.P.	2
8th STREET	58" CONC ARCH	1
RR & 7th STREET	48" R.C.P.	2
6th STREET	10'x 4' BOX CULV	1
3rd STREET	100"x 56" CONC ARCH	1
HIGHWAY 46	7'x 7' BOX CULV	1
U.S. HWY 17-92	BRIDGE	1

undersized and creates a "backwater" flooding condition in the low areas south of the intersection. An eastern tributary channel which collects runoff from the State Road Department discharges to the main channel of the Cloud Branch Basin north of Roundtree and 14th Street.

Between 14th Street and 10th Street, the channel meanders through residential and commercial areas along lot lines and street right of way. Capacity of the stormwater conveyance system has been limited due to the encroachment of development upon the channel limits. Of major concern in this area is the apparent adverse flow condition which occurs between 10th and 13th Streets. The channel in this reach rises 2.28 feet and creates a significant backwatering effect on the upstream regions as well as a limitation of flow through the culvert at 13th Street. The lack of effective stage/storage in this region has also led to flooding problems over the years.

The main channel of the Cloud Branch Basin is joined by two stormwater piping systems in the area north of 11th Street. The systems pick up flow from the State Road Department between 9th and 12th Streets, and runoff in the area bounded by 13th Street on the north, S.C.L. Railroad on the south, and Southside School on the east. A dual 48" piping system carries the flow convergence in a westerly direction, after which a relatively large channel directs the runoff north along Poplar Avenue between 8th and 10th Streets. A small drainage area to the west joins the main channel at the 8th Street culvert crossing. North of 8th Street the channel crosses under each branch of the S.C.L. Railroad (dual 48"

RCP) and continues to head in a northerly direction toward 6th Street. The culvert systems at 8th St., 10th St, and the railroad are all undersized based on the amount of stormwater conveyance required at this point in the basin and the backwatering potential of the system due to the present state of these structures.

The channel flows through relatively undeveloped land north of 6th Street until its juncture with Mill Creek at the Sanford Wastewater Treatment Plant. The Stormwater control structures in this reach are all adequatley sized and create no backwatering problems in the upstream sections due to the large amount of natural fall in the geographic region. A profile of the existing channel is provided in Figure 3-11 and defines the channel bottom and culvert crossing road elevations throughout the Cloud Branch Basin.

One of the major restrictions to flow throughout the entire system is the immense growth of plants, shrubs, and bushes within the confines of the channel. Many areas are completely overrun with growth which thereby limits the conveyance of flow through the Cloud Branch channel. In order to rectify this situation, it is recommended that the City clean out the entire channel from 24th Street to 3rd Street removing all plant, natural and manmade restrictions as well as redefining the flow line of the channel between 10th and 13th Streets.

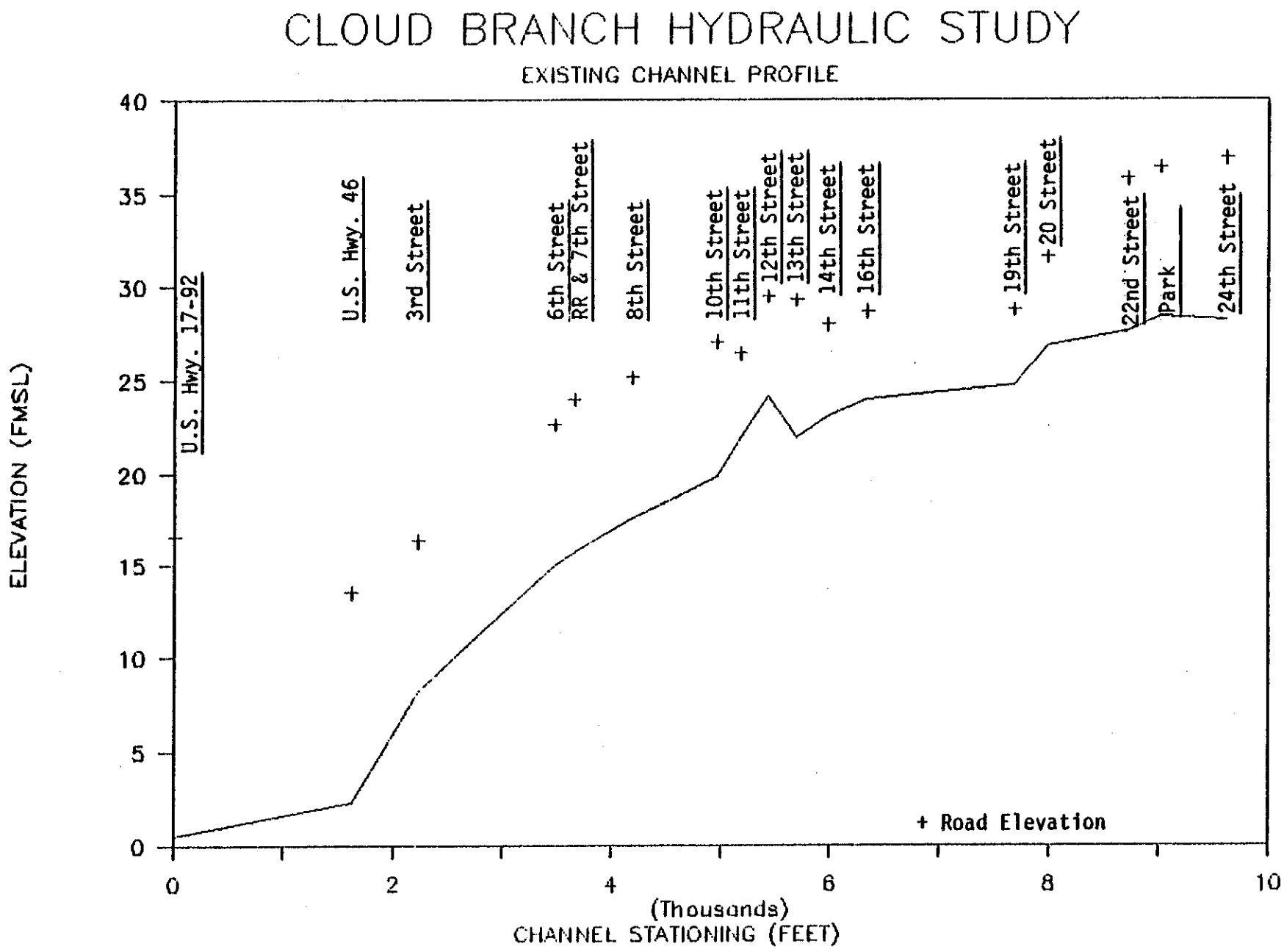


FIGURE 3-11. EXISTING CHANNEL PROFILE FOR THE CLOUD BRANCH DRAINAGE BASIN

4.0 HYDROLOGIC AND HYDRAULIC ANALYSIS TECHNIQUES

4.1 HYDROLOGIC DESIGN TECHNIQUES

4.1.1 GENERAL

In order to compute design storm hydrographs, the Mill Creek and Cloud Branch Drainage Basins were subdivided into 31 and 19 contributing subbasins, respectively, as shown in Figures A-1 and B-1 (Map Pockets A and B). Each basin was analyzed topographically for drainage patterns utilizing the U.S.G.S. topographic survey (Sanford Quadrangle, 1980) and digitally planimetered to determine the subbasin acreage. The Mill Creek Drainage Basin is approximately 1392 acres in size with the largest and smallest subbasins comprising 108 and 10.3 acres, respectively. Whereas the Cloud Branch Drainage Basin comprises approximately 664 acres, with subbasins ranging in size from 105 to 5 acres.

The Soil Conservation Service Unit Hydrograph Method was selected to compute design stormwater runoff hydrographs from the various subbasins within both the Mill Creek and Cloud Branch Drainage Basins. It provides a widely accepted basis for converting rainfall excess from a watershed to a runoff hydrograph. A unit hydrograph is defined as "a runoff hydrograph that is produced by one inch of rainfall excess distributed uniformly over a watershed and occurring at a uniform rate during the specified time period." The following assumptions constitute the basis of unit hydrograph theory:

1. The rainfall excess is uniformly distributed within its unit duration or specified period of time.

2. The rainfall excess is uniformly distributed in space over a particular watershed.

3. The time base for a direct runoff hydrograph due to a rainfall excess of unit duration is constant.

4. The ordinates of the direct runoff hydrographs, when a common unit duration is considered, are directly proportional to the total volume of direct runoff represented by each hydrograph.

5. For a given drainage basin, the hydrograph of runoff caused by a unit duration and volume of rainfall excess is invariable.

Figure 4-1 presents the SCS Unit Hydrograph, which has 37.5 percent of its total volume on the rising side, corresponding to one unit of time and one unit of discharge.

SCSUNIT, a computerized version of the SCS Unit Hydrograph Method (R. Ghioto, Advanced Engineering Technologies) was utilized in the evaluation of runoff hydrographs from both the Mill Creek and Cloud Branch Drainage Basins. The program requires physical input data for each subbasin as well as control data that are applied to all subbasins for which hydrographs are to be computed. These input parameters include:

1. Selection of a Design Rainfall Frequency, Rainfall Duration and Distribution

2. Selection of a Hydrograph Shape Factor

3. Subbasin Area, SCS Curve Number, Initial Abstraction, and Time of Concentratrion

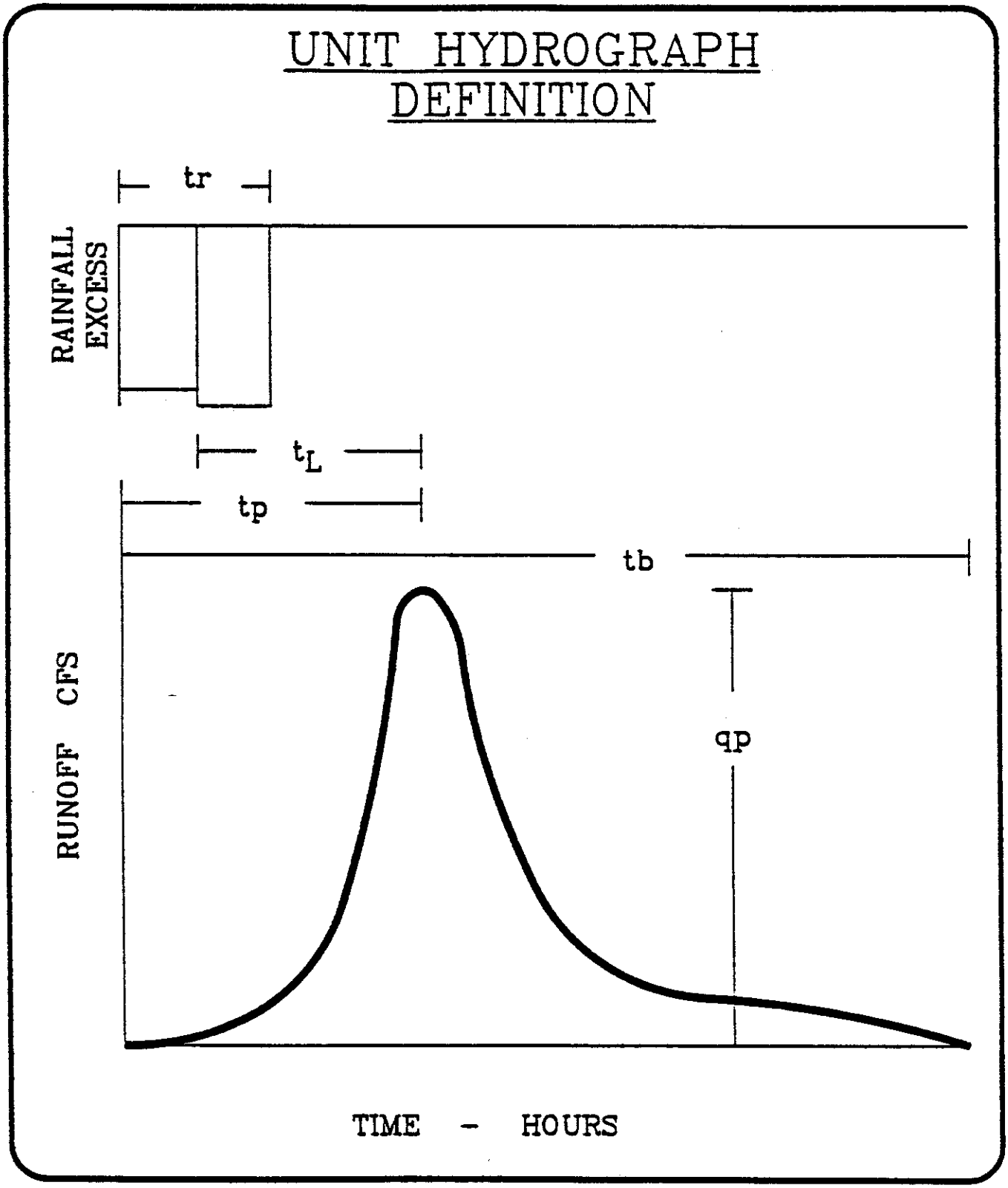


FIGURE 4-1. SOIL CONSERVATION SERVICE (SCS) UNIT HYDROGRAPH

4.1.2 DESIGN RAINFALL FREQUENCY

Stormwater facilities required for the adequate conveyance of rainfall induced runoff varies greatly, dependent upon the size of the area, site topography, soil types, antecedent moisture conditions, depressional storage, and level of protection desired. Protection against a storm of reasonable magnitude is normally required when considering the effects of flooding on both residential and commercial properties. Therefore, the selection of design rainfall criteria results from an evaluation of the economic balance between the cost of the stormwater facilites and the benefit derived from the level of protection it provides. This type of determination can be very cumbersome and costly to make, especially with the given topography of the Mill Creek and Cloud Branch Drainage Basins.

However, based on an examination of previous studies, Technical Paper 40, and a preliminary hydrologic evaluation of other storm frequencies, a design storm with a return period of 25 years was selected for purposes of computing design stormwater runoff hydrographs.

4.1.3 RAINFALL DURATION AND DISTRIBUTION

Annual average rainfall for the greater Sanford area is approximately 53 inches. A wide variation of precipitation has historically been seen in the area, ranging from 40 to 75 inches annually. The average monthly rainfall for the years 1986 and 1987 are presented in Figures 4-2 and 4-3.

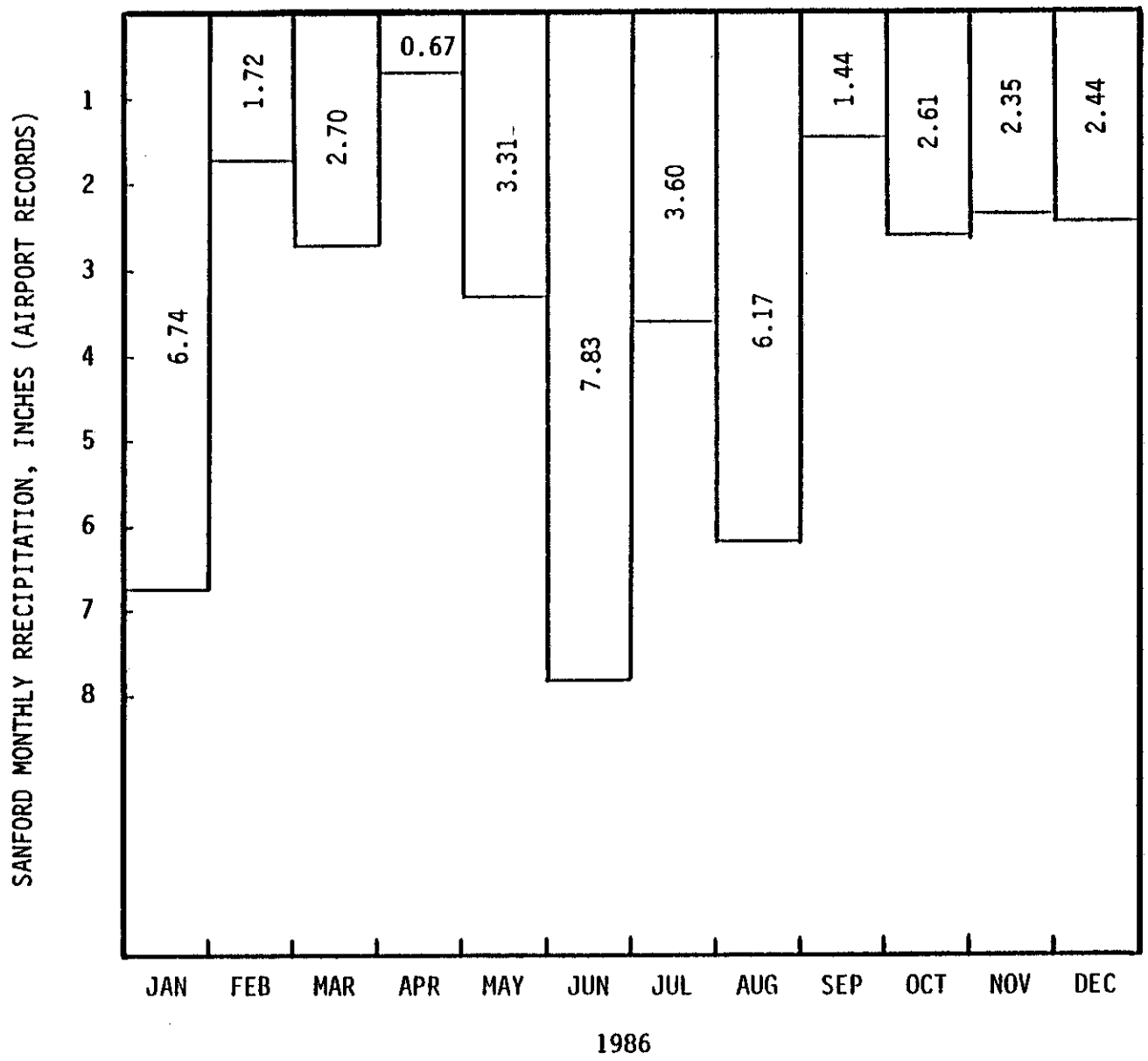


FIGURE 4-2. MONTHLY PRECIPITATION IN THE GREATER SANFORD AREA FOR THE YEAR (1986)
(Source: Sanford Airport Records)

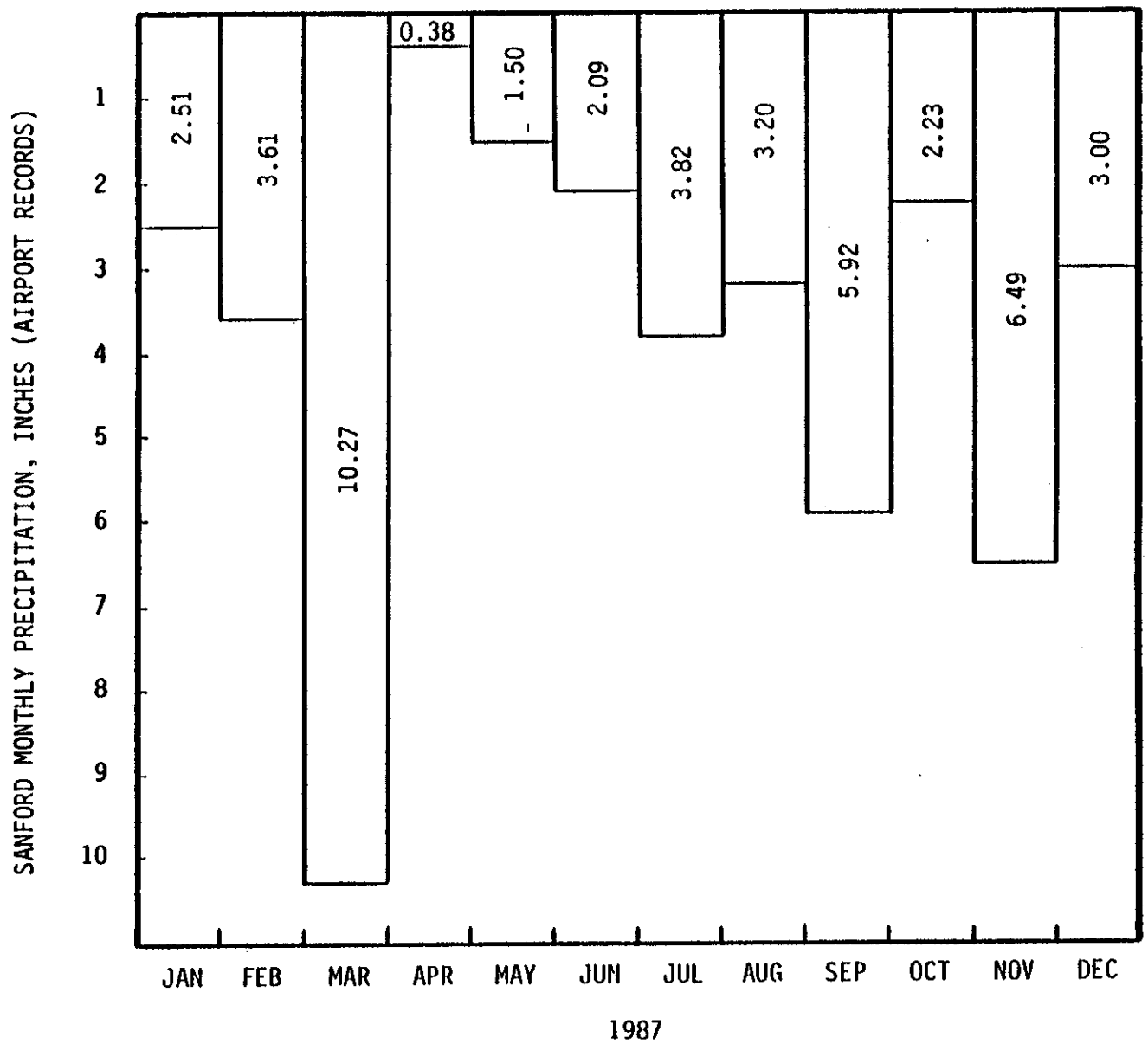


FIGURE 4-3. MONTHLY PRECIPITATION IN THE GREATER SANFORD AREA FOR THE YEAR 1987
(Source: Sanford Airport Records)

A careful evaluation process was employed with respect to selection of a design rainfall duration. Preliminary modeling of the Mill Creek and Cloud Branch Basins, utilizing various rainfall durations and total rainfall, revealed that the existing channels became inundated and reacted as a series of interconnected ponds under a total rainfall greater than 5.5 inches. Based on this data, the 25 Year Frequency-Six Hour Duration Rainfall was chosen as the Design Storm Event. Technical Paper No. 40 (U.S. Weather Bureau) defines this storm event as having a total rainfall equal to 6.00 inches as shown in Figure 4-4. For the purposes of evaluating the hydrologic/hydraulic phenomena within the Study Site, it was assumed that this rainfall would fall "uniformly" over the entire basin.

The 25 Year Frequency-Six Hour Duration Rainfall, referred to as the 25yr/6hr storm event throughout the rest of the study, was assumed to be distributed in accordance with the Seminole County Land Development Code for a storm of this frequency and duration. The Seminole County 25yr/6hr storm event is reproduced in Table 4-1 with the corresponding rainfall hyetograph presented in Figure 4-5.

4.1.4 Alternative Design Storm

An investigation into a higher level of protection against a storm, greater than the 25yr/6hr design storm, was found to be warranted based on the required design parameters of the local water management district. The 25-Year Frequency storm was again selected for purposes of computing alternative design storm runoff hydrographs. However, based on SJRWMD stormwater guidelines and Technical Paper No. 40, an

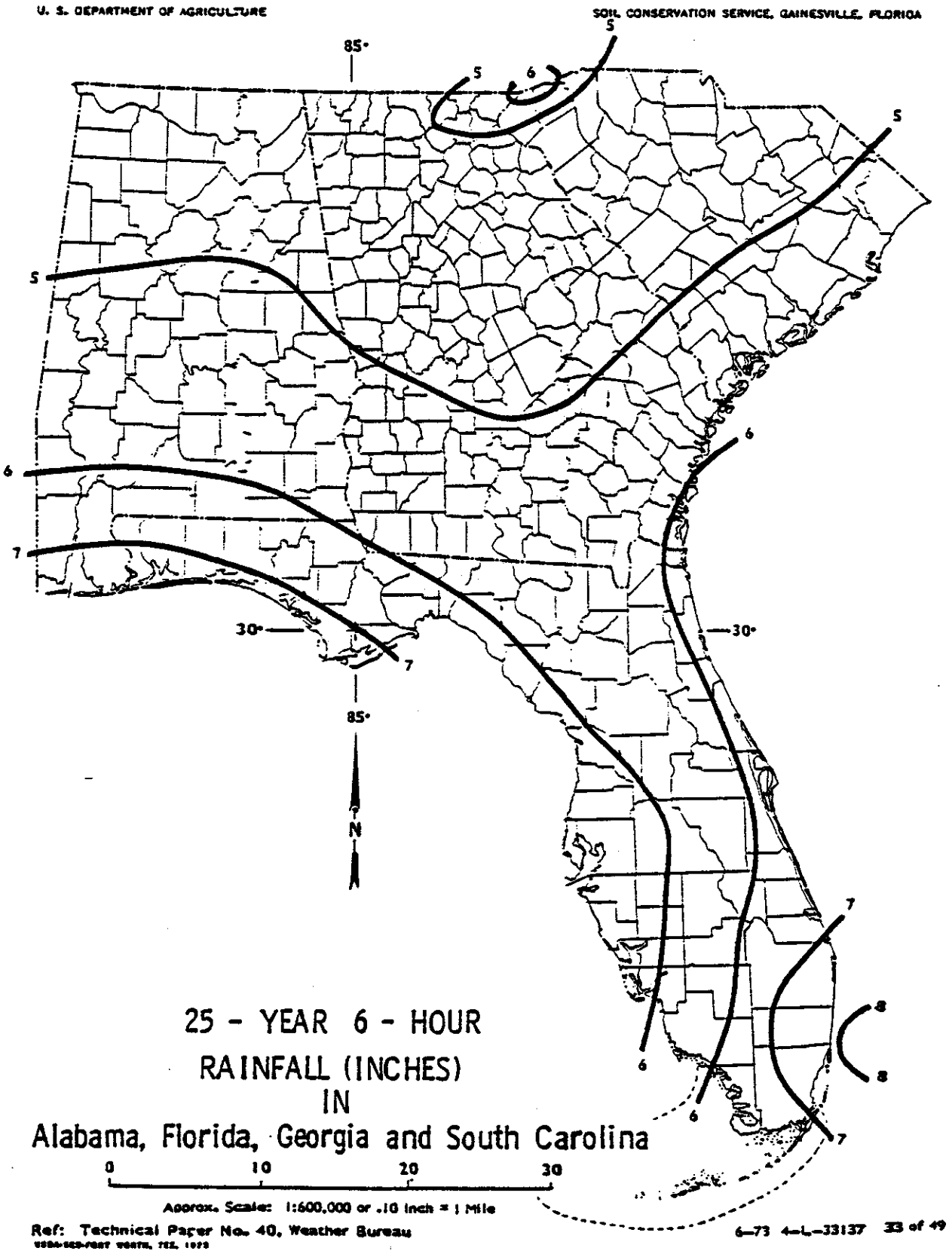


FIGURE 4-4. U.S. WEATHER BUREAU 25 Yr/6 Hr RAINFALL
(Technical Paper No. 40)

TABLE 4-1

SEMINOLE COUNTY

25 YEAR FREQUENCY-SIX HOUR DURATION
DESIGN RAINFALL

TIME (MIN)	TIME (HR)	CUMUL PREC (IN)	DELTA PREC (IN)
0	0.00	0.00	0.00
15	0.25	0.10	0.10
30	0.50	0.21	0.11
45	0.75	0.33	0.12
60	1.00	0.48	0.15
75	1.25	0.64	0.16
90	1.50	0.81	0.17
105	1.75	1.08	0.27
120	2.00	1.38	0.30
135	2.25	2.46	1.08
150	2.50	3.60	1.14
165	2.75	3.90	0.30
180	3.00	4.20	0.30
195	3.25	4.44	0.24
210	3.50	4.68	0.24
225	3.75	4.86	0.18
240	4.00	5.01	0.15
255	4.25	5.16	0.15
270	4.50	5.28	0.12
285	4.75	5.40	0.12
300	5.00	5.52	0.12
315	5.25	5.64	0.12
330	5.50	5.76	0.12
345	5.75	5.88	0.12
360	6.00	6.00	0.12

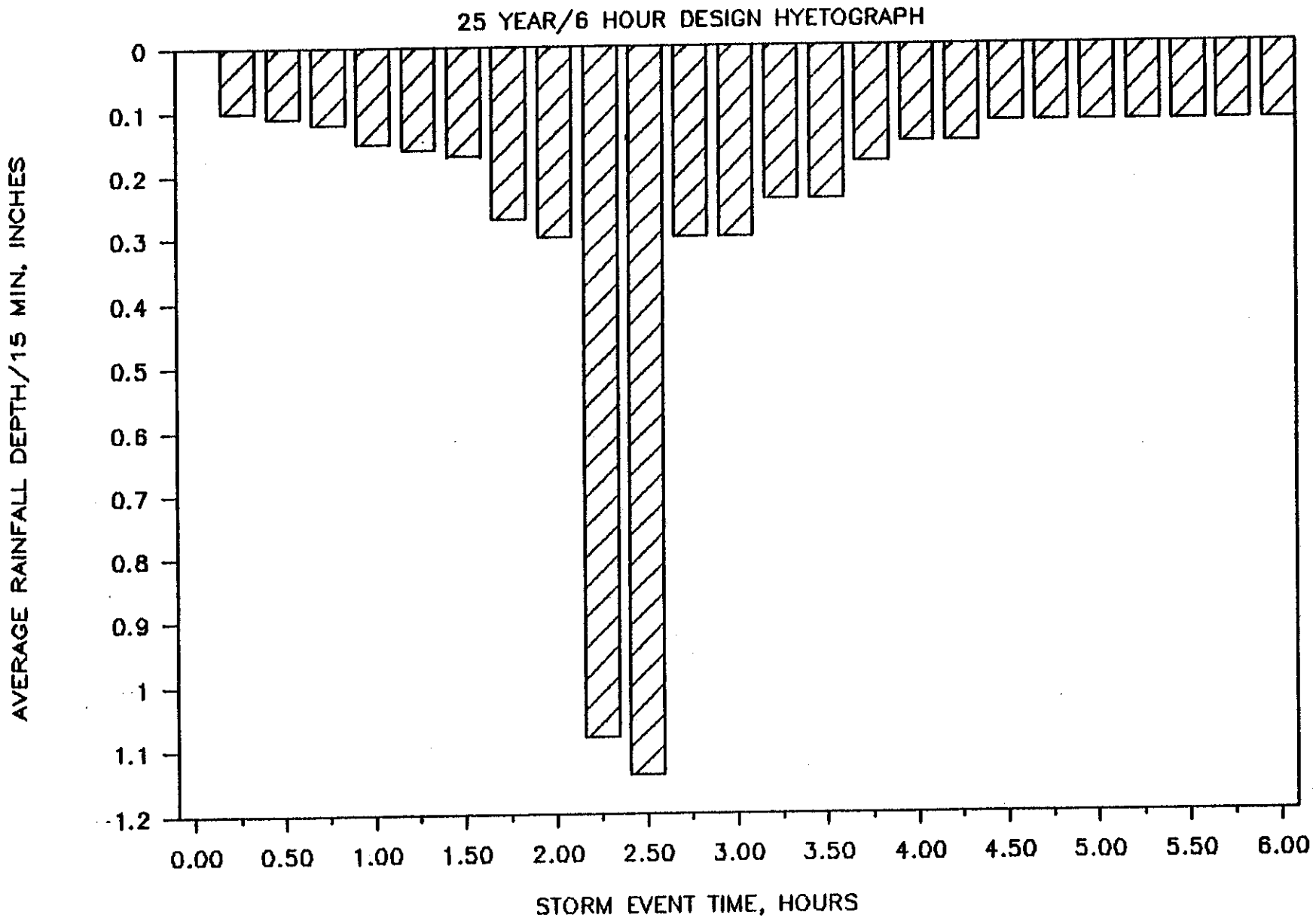


FIGURE 4-5. MILL CREEK/CLOUD BRANCH DESIGN RAINFALL HYETOGRAPH: 25 Yr/6 Hr STORM EVENT (Source: Seminole County)

alternative design rainfall and duration of 24 hours was chosen. The U. S. Weather Bureau (Technical Paper No. 40) defines the 25yr/24hr storm event as having a total rainfall equal to 8.60 inches as shown in Figure 4-6.

4.1.5 SCS UNIT HYDROGRAPH SHAPE FACTOR

The Unit Hydrograph shape factor, B, is generally considered to be constant for a given watershed, with the standard SCS dimensionless Unit Hydrograph based on a shape factor of 484. In preliminary analyses within the drainage basins, the use of the 484 shape factor appeared to produce results inconsistant with previous work done in the Study area. However, the Soil Conservation Service states that adjustments to the unit hydrograph shape may be warranted on a site specific basis. SCS recognizes that the shape factor can be expected to range from 600 in steep terrain to 300 in flat swampy areas. Therefore, based on a review of similar studies made in the past for similar value land with similar physiographic conditons, a design shape factor of 342 was selected for purposes of computing stormwater runoff hydrographs.

4.1.6 HYDROLOGIC SOIL CLASSIFICATION

For the purposes of computing stormwater runoff in the various Mill Creek and Cloud Branch Subbasins the Hydrologic Soil Classification Method of the U. S. Soil Conservation Service was utilized. Soils are classified into hydrologic soil groups based on their runoff potential. This potential is measured by the infiltration rate into the soil and the transmission rate through the soil. The four hydrologic soil groups

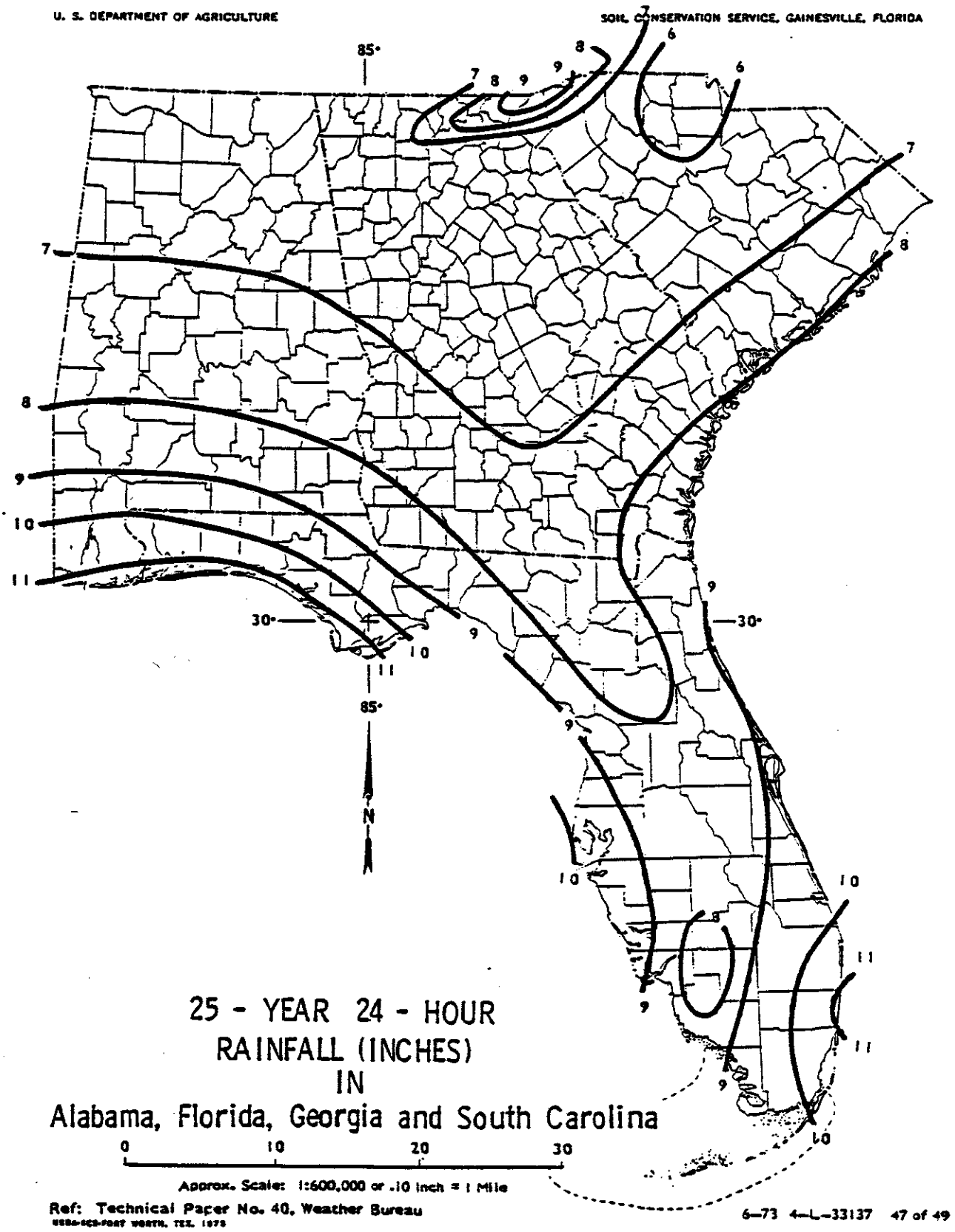


FIGURE 4-6. U.S. WEATHER BUREAU 25 Yr/24 Hr. RAINFALL (Technical Paper No. 40)

are classified as follows:

Group "A"	Soils having "low" runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well drained sands or gravels and have a high rate of water transmission, generally greater than 0.3 in/hr.
Group "B"	Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission, ranging from 0.15 to 0.30 in/hr.
Group "C"	Soils having low infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes the downward movement of water, and soils with moderately fine to fine texture. These soils have a low rate of water transmission ranging from 0.05 to 0.15 in/hr.
Group "D"	Soils having a "high" runoff potential due to very low infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission, ranging from 0.00 to 0.05 in/hr.

Numerous soil types within the Study area have been given a dual classification by the Soil Conservation Service (i.e., Leon Fine Sand, B/D). The first letter indicates the soils classification in the drained state, occuring when the groundwater table is below the surface. The second letter indicates the soils classification in the undrained state, occuring when the groundwater table is at or above the surface. In order to model the effect of the proposed design storm on the basin in the "worst case" scenario, the second letter classification would normally be utilized since most of the rainfall occurs in the summer season when the groundwater table is high. Yet, due to the large amount

of depressional and low lying areas within the Study site, the determination of runoff curve numbers in various areas was modified in order to account for this basin storage.

Made Land is also present within the drainage basins and has a variable soil classification due to its geologic content. Therefore, in order to evaluate the runoff potential of this soil, the Engineer has assumed it to have a classification of A/D.

4.1.7 SCS RUNOFF CURVE NUMBER DETERMINATIONS

Soil Conservation Service Runoff Curve Numbers (SCS CN) were determined for each subbasin based upon the Hydrologic Soil Group, antecedent moisture conditions, and land use cover present. SCS Runoff Curve Numbers for selected agricultural, suburban, and urban land uses are presented in Table 4-2. In the determination of an SCS Runoff Curve Number for each subbasin, a weighting procedure based on the percentage of the particular land use covered was utilized (Antecedent Moisture Condition 3 utilized for Mill Creek Subbasins). Land uses were divided into the following categories: residential, multifamily, school, commercial, open space, and industrial. Mill Creek and Cloud Branch subbasin Curve Numbers are presented in Tables 4-3 and 4-4, respectively. In order to evaluate the Drainage Basins for future developed conditions, the SCS curve numbers were increased 2 to 4 points to reflect a ten to fifteen percent increase in rainfall excess over existing developed conditions.

Land Use Description		Hydrologic Soil Group A	B	C	D
Cultivated Land[a]:					
Without conservation treatment		72	81	88	91
With conservation treatment		62	71	78	81
Pasture or range land:					
Poor condition		68	79	86	89
Good condition		39	61	74	80
Meadow: good condition		30	58	71	78
Wood or Forest Land:					
Thin stand, poor cover, no mulch		45	66	77	83
Good cover[b]		25	55	70	77
Open Spaces, Lawns, Parks, Golf Courses, Cemeteries:					
Good condition: grass cover on 75% or more of the area		39	61	74	80
Fair condition: grass cover on 50% to 75% of the area		49	69	79	84
Poor condition: grass cover on 50% or less of the area		68	79	86	89
Commercial and Business Areas (85% impervious)		89	92	94	95
Industrial Districts (72% impervious)		81	88	91	93
Residential[c]:					
Average lot size	Average % Impervious[d]				
1/8 acre or less	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
Paved Parking Lots, Roofs, Driveways[e]:		98	98	98	98
Streets and Roads:					
Paved with curbs and storm sewers[e]		98	98	98	98
Gravel		76	85	89	91
Dirt		72	82	87	89
Paved with open ditches		83	89	92	93
Newly graded area (no vegetation established)[f]		77	86	91	94

[a]For a more detailed description of agricultural land use curve numbers, refer to Table 5-9.

[b]Good cover is protected from grazing and litter and brush cover soil.

[c]Curve numbers are computed assuming the runoff from the house and driveway is directed toward the street with a minimum of roof water directed to lawns where additional infiltration could occur.

[d]The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

[e]In some warmer climates of the country, a curve number of 96 may be used.

[f]Use for temporary conditions during grading and construction.

TABLE 4-2. SCS RUNOFF CURVE NUMBERS FOR SELECTED AGRICULTURAL, SUBURBAN, AND URBAN LAND USE (Antecedent Moisture Condition II, and $I_a = 0.25$)

SUB-BASIN NUMBER	RESIDENTIAL PERCENT.	MULTIFAMILY PERCENT.	SCHOOL PERCENT.	COMMERCIAL PERCENT.	OPEN AREA PERCENT.	INDUSTRIAL PERCENT.	OVERALL BASIN CN	SOIL ADJ * BASIN CN
100	58	17	0	1	24	0	60	60
105	67	17	0	1	15	0	62	68
200	66	0	0	0	34	0	58	71
210	64	0	0	0	36	0	57	70
220	97	0	0	0	3	0	62	69
300	17	0	0	0	41	42	66	75
400	9	0	0	0	74	17	56	71
410	100	0	0	0	0	0	62	66
420	100	0	0	0	0	0	62	66
500	92	0	0	8	0	0	64	68
610	94	0	0	6	0	0	64	68
620	20	67	13	0	0	0	68	71
625	0	0	82	0	18	0	64	68
630	27	0	0	0	19	54	71	80
640	76	0	0	0	0	24	67	77
650	100	0	0	0	0	0	62	66
700	100	0	0	0	0	0	62	66
710	15	0	0	0	57	28	61	66
810	74	0	0	0	26	0	59	70
820	24	0	0	0	56	20	59	70
830	0	0	0	0	71	29	59	70
840	0	0	0	0	100	0	49	65
910	0	0	0	0	61	39	63	70
920	0	0	0	0	44	56	69	75
930	0	0	0	0	67	33	61	87
940	22	0	0	0	78	0	52	64
950	0	0	0	0	94	6	51	63
960	0	0	0	0	100	0	49	61
1000	20	49	0	0	31	0	62	66
1100	100	0	0	0	0	0	62	66
1200	22	0	0	12	18	47	74	77

* DERIVED FROM SOILS FOUND WITHIN EACH BASIN AND ADJUSTMENT TO ANTECEDENT MOSITURE CONDITION 3

RESIDENTIAL SCS CN	62
MULTIFAMILY SCS CN	70
SCHOOL SCS CN :	67
COMMERCIAL SCS CN	90
OPEN SPACE SCS CN	49
INDUSTRIAL SCS CN	84

TABLE 4-3. MILL CREEK SUB-BASIN SCS CURVE NUMBER GENERATION.

SUB-BASIN NUMBER	RESIDENTIAL PERCENT.	MULTIFAMILY PERCENT.	SCHOOL PERCENT.	COMMERCIAL PERCENT.	OPEN AREA PERCENT.	INDUSTRIAL PERCENT.	OVERALL BASIN CN
100	62	0	0	34	4	0	71
200	29	0	0	10	61	0	57
300	70	0	0	0	30	0	58
400	100	0	0	0	0	0	62
500	61	0	0	0	28	11	61
600	54	0	17	0	25	4	60
700	0	0	0	72	28	0	79
800	0	0	20	37	43	0	68
900	56	0	0	3	41	0	58
1000	63	0	0	27	10	0	68
1100	24	0	0	76	0	0	83
1200	80	0	0	0	20	0	59
1300	95	0	0	0	5	0	61
1400	70	0	0	21	9	0	67
1500	88	0	0	0	12	0	60
1600	35	0	0	42	23	0	71
1700	32	18	0	4	20	26	68
1800	94	0	0	6	0	0	64

RESIDENTIAL SCS CN	62
MULTIFAMILY SCS CN	70
SCHOOL SCS CN :	67
COMMERCIAL SCS CN	90
OPEN SPACE SCS CN	49
INDUSTRIAL SCS CN	84

TABLE 4-4. CLOUD BRANCH SUBBASIN SCS CRUVE NUMBER GENERATION

4.1.8 INITIAL ABSTRACTION

Initial Abstraction (Ia) is the total storage of water that can be accumulated in small surface depressions, vegetation, evaporation, and infiltration. Ia is highly variable but is generally correlated with soil and cover parameters. Computation of unit hydrographs by the SCSUNIT model requires the input of a dimensionless initial abstraction ratio (IR), which is the ratio of the total initial abstraction storage within the watershed, to the maximum potential soil storage. Based on the topography of the Study site, with its many depressional areas, an initial abstraction ratio of 0.30 was selected for use in the determination of stormwater runoff hydrographs.

4.1.9 TIME OF CONCENTRATION

The time of concentration (Tc) of each subbasin, required for the computation of stormwater runoff hydrographs, is defined as the time required for the rainfall excess to travel from the furthest boundary of the basin to its outlet. The subbasins were analyzed topographically for drainage patterns and an overall time of concentration for each was determined using the following criteria:

1. 30 FPM over open/grass areas
2. 60 FPM over roadways
3. 120 FPM through pipe systems

The computed times of concentration for the drainage subbasins along with all other pertinent hydrologic/hydraulic parameters is presented in Table 4-5 and 4-6.

SUB-BASIN No.	TO NODE No.	SUB-BASIN AREA (ACRES)	EXIST SCS CN	FUTURE SCS CN	Tc * (MIN)
100	100	30.5	63	66	65
105	200	24.5	68	71	55
200	220	53.1	71	74	46
210	210	46.9	70	73	46
220	200	92.4	69	72	43
300	200	21.9	75	78	17
400	300	108.0	71	74	90
410	400	35.0	66	69	32
420	400	31.0	66	69	25
500	400	18.3	68	71	24
610	400	23.5	68	71	27
620	400	55.8	71	74	40
625	410	11.7	68	71	25
630	620	72.5	80	83	61
640	620	78.9	77	80	54
650	410	38.3	66	69	45
700	600	16.0	66	69	26
710	640	37.0	66	69	28
810	625	29.6	70	73	29
820	630	74.5	70	73	55
830	610	27.3	70	73	29
840	610	30.8	65	68	32
910	670	31.6	70	73	33
920	660	78.3	75	78	65
930	600	10.3	87	90	3
940	660	48.0	64	67	39
950	650	56.8	63	66	45
960	650	62.2	61	64	48
1000	700	69.5	66	69	38
1100	800	23.0	66	69	26
1200	900	54.0	77	80	56

* TIME OF CONCENTRATION BASED ON THE FOLLOWING:

A. 30 FPM OVER OPEN/GRASS AREAS
B. 60 FPM OVER ROADWAYS
C. 120 FPM THROUGH PIPE SYSTEMS

TABLE 4-5. MILL CREEK DRAIN STUDY SUB-BASIN HYDROLOGIC/HYDRAULIC PARAMETERS.

SUB-BASIN No.	TO NODE No.	SUB-BASIN AREA (ACRES)	EXIST SCS CN	FUTURE SCS CN	RUNOFF "C"	Tc * (MIN)
100	100	90	71	74	0.47	33
200	200	12	57	60	0.31	20
300	300	37	58	61	0.37	25
400	400	12	62	65	0.37	28
500	700	44	61	64	0.38	38
600	700	27	60	63	0.3	52
700	500	23	79	82	0.53	25
800	500	26	68	71	0.45	36
900	600	6.4	58	61	0.29	28
1000	700	25	68	71	0.37	41
1100	1000	13.3	83	86	0.37	24
1200	1000	9.8	59	62	0.37	22
1300	800	95	61	64	0.43	49
1400	900	105	67	70	0.45	86
1500	1100	26.3	60	63	0.34	21
1600	1200	42	71	74	0.59	43
1700	1300	47	68	71	0.41	27
1800	1400	23	64	67	0.43	19

* TIME OF CONCENTRATION BASED ON THE FOLLOWING:

A. 30 FPM OVER OPEN/GRASS AREAS
B. 60 FPM OVER ROADWAYS
C. 120 FPM THROUGH PIPE SYSTEMS

TABLE 4-6. CLOUD BRANCH DRAIN STUDY SUB-BASIN HYDROLOGIC/HYDRAULIC PARAMETERS.

4.2 HYDRAULIC DESIGN TECHNIQUES

4.2.1 GENERAL

In order to simulate the water surface profiles of the main conveyance channel within the Mill Creek and Cloud Branch Drainage Basins, an appropriate analytical model was required. The model would have to account for the following parameters: inflow hydrographs from subbasins, channel geometry, stormwater control structures (culverts), time variable tailwater conditions, and submergence. Two preliminary modeling techniques were selected, the Rational Method and the Hydraflow Open Channel Analyis Model.

The Rational Method has been utilized to a great degree on small and medium size watersheds throughout the country. The analytical technique involves the utilization of the rational formula, $Q = cIA$, where Q is the quantity of runoff; c is the runoff coefficient which is a function of Hydrologic Soil Type, antecedent moisture conditions, and land use cover (similar to the SCS Curve Number); I is the single-point rainfall intensity in inches per hour determined from rainfall-intensity-duration curves and is assumed to occur at a constant rate over the drainage area for a length of time equal to that required for water falling on the most remote portion of the watershed to flow to the point of concentration; and, A is the drainage area.

The Hydraflow Open Channel Analysis Model is a computer model designed for determining water surface profiles through channels and stream networks. Application of the model involves the division of the

proposed stream into either channel, bridge, or culvert sections upon which hydraulic and geometric parameters must be characterized. A modified standard step hydraulic procedure is used to calculate the hydraulic profile of the stream.

Preliminary simulations were performed utilizing both techniques on the existing basin systems under the influence of a 25yr/6hr storm event. Both models led to the same conclusion; that the main channel acted not as a conveyance stream/channel, yet as a series of interconnected ponds controlled by the stormwater facilities connecting them (culverts). As a result, the Rational Method and Hydraflow Analysis Techniques were determined to be unsuitable for this type of evaluation based upon the limitations regarding their use. Therefore, a more sophisticated, stochastic type model would be required.

The method selected to perform the hydraulic analyses on the Mill Creek and Cloud Branch Drainage Systems is Advanced Engineering Technologies' "Interconnected Pond Routing Model (ICPR)". ICPR is an interactive software package designed to route flood hydrographs through single pond systems as well as multiple interconnected ponds, lakes or reservoirs. Factors such as stochastic tailwater conditions, submergence, flow reversal and multiple boundary conditions are integrated into the algorithm. Connections between ponds can be modeled using sharp/broad crested weirs; circular, elliptical, arch and box culverts; gates and orifices; trapezoidal and parabolic channels; risers; and, rating curves. Flood routing procedures and structure

hydraulics utilized in the ICPR model are presented in Appendix A.

4.2.2 MILL CREEK HYDRAULIC MODEL

4.2.2.1 MODELING ASSUMPTIONS

In applying the ICPR model to the Mill Creek Basin, the following engineering assumptions were made:

1. The entire Mill Creek main channel and its adjacent tributaries from south of 25th St. to the bridge crossing at U.S. Hwy 17-92 is to be cleaned out by the City so as to produce no appreciable retardance to flow (Manning roughness coefficient approximately 0.020). This includes, but is not limited to, vegetative growth in both the thalweg and overbank areas, and any man-induced obstructuions.

2. The stormwater control structures at Club Avenue and Dixie Drive were determined to be non-restrictive and therefore left out of the model.

3. The culverts at 18th, 16th, 15th, 14th, and 13th Streets, along the main channel, are to be replaced with a closed conduit system extending from 18th Street to an area just north of 13th Street.

4. A stage-time relationship for Lake Monroe will be utilized with regard to tailwater conditions (U. S. Army Corp of Engineers Study, 1971).

5. The model will not take into account the convergence of Mill Creek and Cloud Branch.

4.2.2.2 MODEL NODES AND REACHES

A model or pond network is comprised of "nodes" and "reaches". Ponds and boundary conditions are referred to as "nodes" and connections between nodes referred to as "reaches". Flow from and between nodes depends directly on the type of outfall and its associated hydraulic

characteristics.

Twenty-One nodes were defined within the Mill Creek hydraulic network. Ten of the nodes present are within the main channel of Mill Creek with the other eleven being found in the adjacent tributary channels. A listing of the nodes is as follows:

NODE	LOCATION
100	Channel south of 25th Street
200	Channel between 25th and 20th Street
210	Channel between Chase Ave and Mill Creek
220	Channel between Club Drive and Mill Creek
300	18th Street Retention/Detention Pond
400	Closed Conduit Section from 13th to 18th Street
410	Channel between Dixie and 13th Street
600	8th Street Retention/Detention Pond
610	Channel west of Airport Boulevard
620	Channel between Airport Blvd and RR Crossing
625	McCracken Road Retention/Detention Pond
630	Channel between McCracken Rd Pond and Airport Bl
640	Channel between RR crossing and Persimmon Avenue
650	Channel between Meisch and Bevier Roads
660	Channel between Bevier Road and RR Crossing
670	Channel between RR Crossing and Persimmon Avenue
700	Channel between RR Crossing and 3rd Street
800	Channel between 3rd and 2nd Streets
900	Channel between 2nd and 1st Streets
1000	Channel between 1st Street and U.S. Hwy 17-92
1100	Lake Monroe

Reaches within the hydraulic model can be classified into two types: Control Structure reaches and Overflow reaches. Control Structure reaches are defined as reaches in which circular, elliptical, or box culvert convey stormwater runoff under roadways. Conversely, overflow reaches are defined as reaches in which broad crested weirs, and parabolic or trapezoidal channels convey stormwater runoff over roadways

when the channel system becomes inundated. A total of twenty (20) reaches, corresponding to the twenty-one nodes in the model, were defined for the hydraulic network. A nodal network diagram for the Mill Creek Drainage Basin is presented in Figure 4-7.

4.2.2.3 CHANNEL GEOMETRY AND PROFILE

In the ICPR method, a relationship between stage elevation and stage volume (referred to as stage/storage) is required for each individual node within the hydraulic network. Several cross-sections along the main channel were surveyed, one within each nodal segment, and the data used to compile the required stage/storage data file. Typical cross-sections for each of the main channel nodes is presented in Appendix B.

The channel profile to be utilized in the hydraulic simulation is presented in Figure 4-8. It incorporates the existing profile, as previously shown, and modeling modifications based on the engineering assumptions described in Section 4.2.2.1 of this Study.

4.2.3 CLOUD BRANCH HYDRAULIC MODEL

4.2.3.1 MODELING ASSUMPTIONS

In applying the ICPR model to the Cloud Branch Basin, the following engineering assumptions were made:

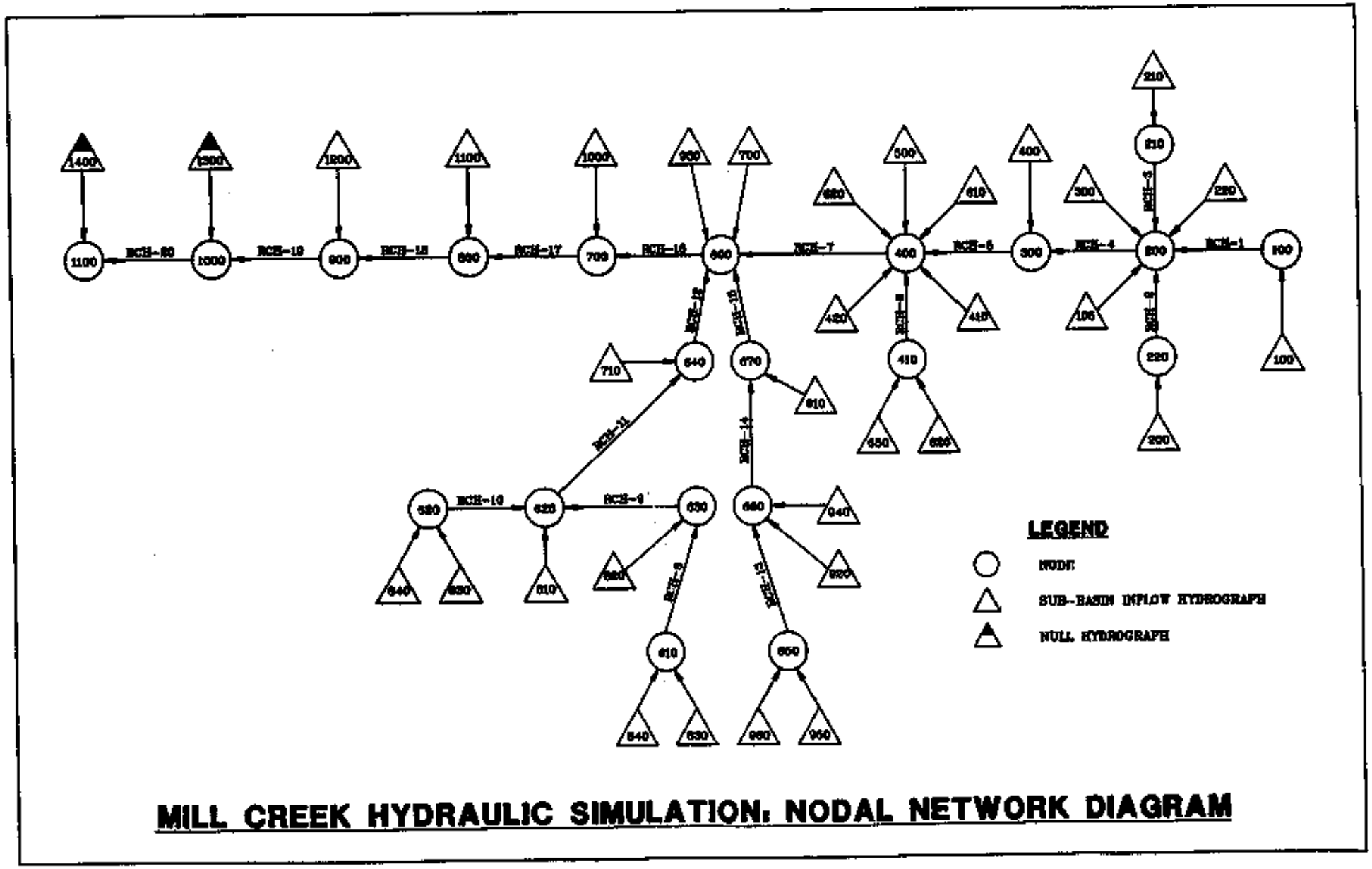


FIGURE 4-7. MILL CREEK HYDRAULIC SIMULATION: NODAL NETWORK DIAGRAM

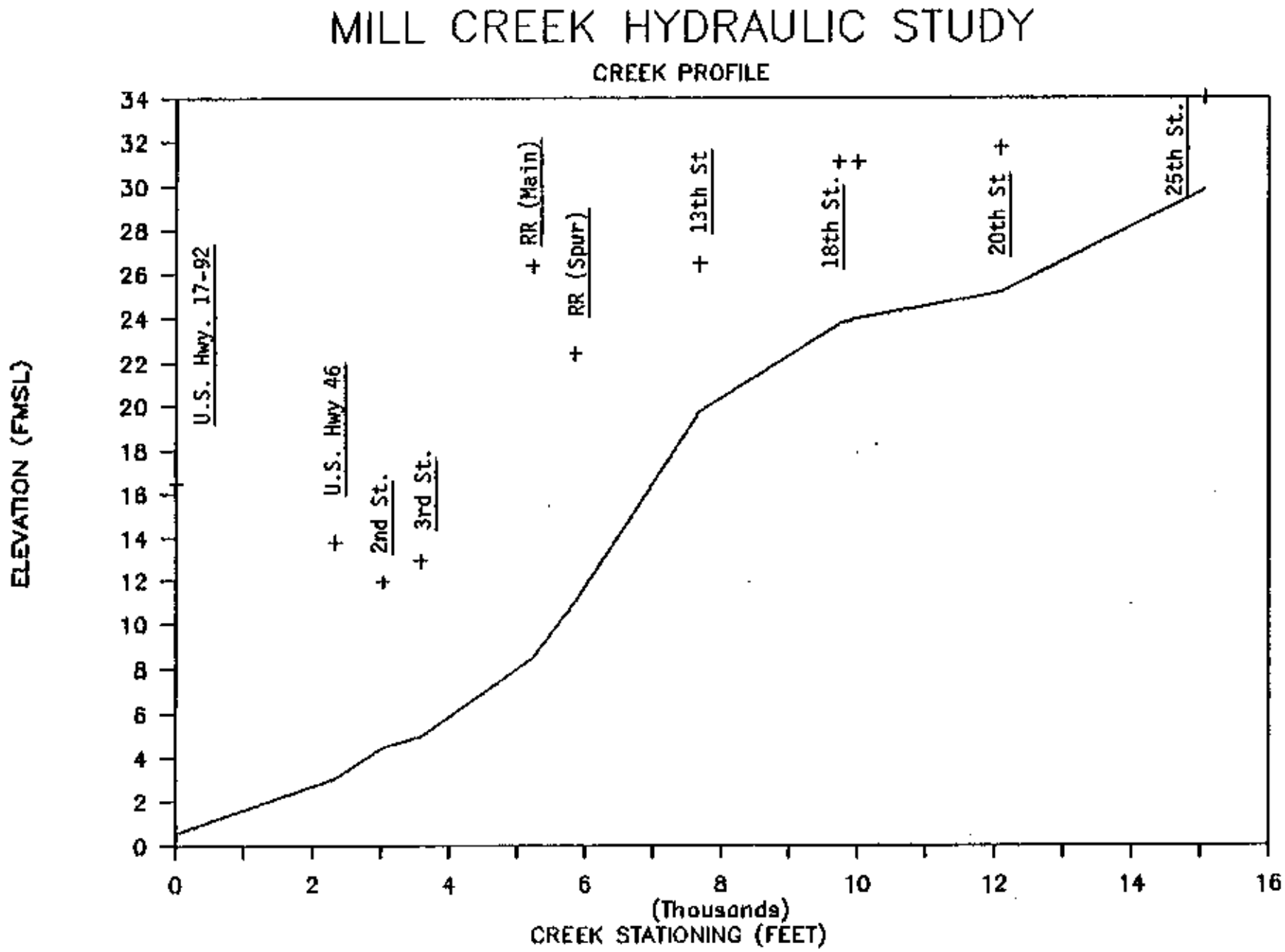


FIGURE 4-8. CHANNEL PROFILE FOR THE MILL CREEK DRAINAGE BASIN TO BE USED IN THE HYDRAULIC ANALYSIS

1. The main channel from 24th Street to 3rd Street is to be cleaned out by the City so as to produce no appreciable retardance to flow (Mannings roughness coefficient approximately 0.020). This includes, but is not limited to, vegetative growth in both the thalweg and overbank areas, and any man-induced obstructions.

2. The hydraulic flow lines in the portion of the main channel between 13th and 10th Streets are to be reconfigured in order to promote the positive conveyance of stormwater.

3. The stormwater control structures at 24th St, Pinehurst Park, 22nd St, and 12th St were determined to be non-restrictive and therefore left out of the model.

4. The culverts at 16th, 14th and 11th Streets are to be replaced with larger, non-restrictive structures. These culverts are also to be withheld from the model.

5. A stage-time relationship for Lake Monroe will be utilized with regard to tailwater conditions (U. S. Army Corp of Engineers Study, 1971).

6. The model will not take into account the convergence of Mill Mill Creek and Cloud Branch.

4.2.2.2 MODEL NODES AND REACHES

Sixteen nodes were defined within the Cloud Branch hydraulic network. Ten of the nodes are present within the main channel with the other six accounting for upstream storage within the basin. A listing of the nodes is as follows:

NODE	LOCATION
100	Upstream Storage
200	Upstream Storage
300	Channel between 24th and 20th Street
400	Channel between 20th and 19th Street
500	Upstream Storage
600	Upstream Storage
700	Channel between 19th and 13th Street
800	Upstream Storage
900	Upstream Storage
1000	Channel between 13th and 10th Street

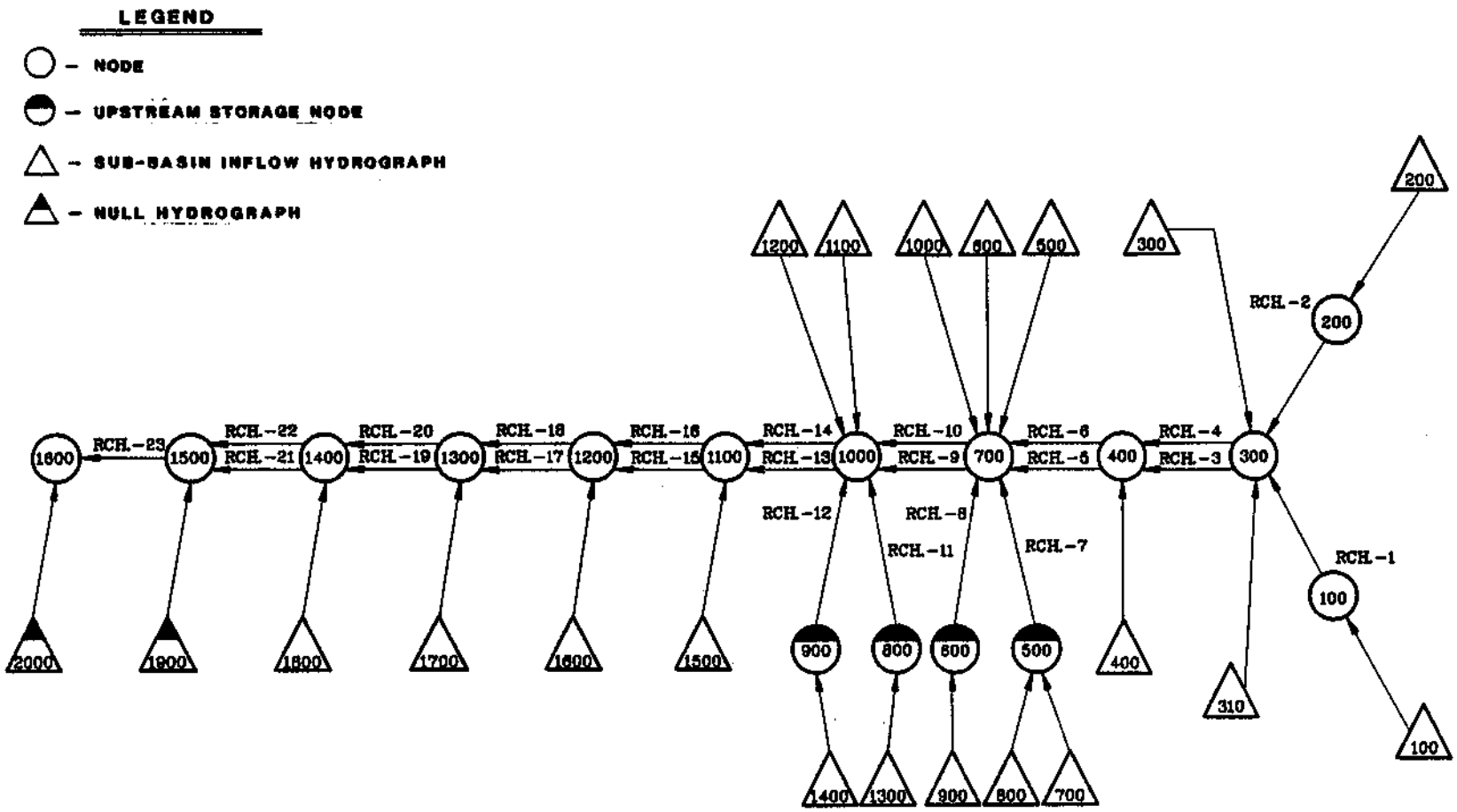
NODE	LOCATION
1100	Channel between 10th and 8th Street
1200	Channel between 8th and 7th Street
1300	Channel between 7th and 3rd Street
1400	Channel between 3rd and 1st Street
1500	Channel between 1st Street and U.S. Hwy 17-92
1600	Lake Monroe

A total of twenty-three (23) reaches, corresponding to the sixteen nodes in the model, were defined for the hydraulic network. A nodal network diagram for the Cloud Branch Drainage Basin is presented in Figure 4-9.

4.2.3.3 CHANNEL GEOMETRY AND PROFILE

In the ICPR method, a relationship between stage elevation and stage volume (referred to as stage/storage) is required for each individual node within the hydraulic network. Several cross-sections along the main channel were surveyed, one within each nodal segment, and the data used to compile the required stage/storage data file. Typical cross-sections for each of the main channel nodes is presented in Appendix B.

The channel profile to be utilized in the hydraulic simulation is presented in Figure 4-10. It incorporates the existing profile, as previously shown, and modeling modifications based on the engineering assumptions described in Section 4.2.3.1 of this study.



CLOUD BRANCH HYDRAULIC SIMULATION: NODAL NETWORK DIAGRAM

FIGURE 4-9. CLOUD BRANCH HYDRAULIC SIMULATION: NODAL NETWORK DIAGRAM

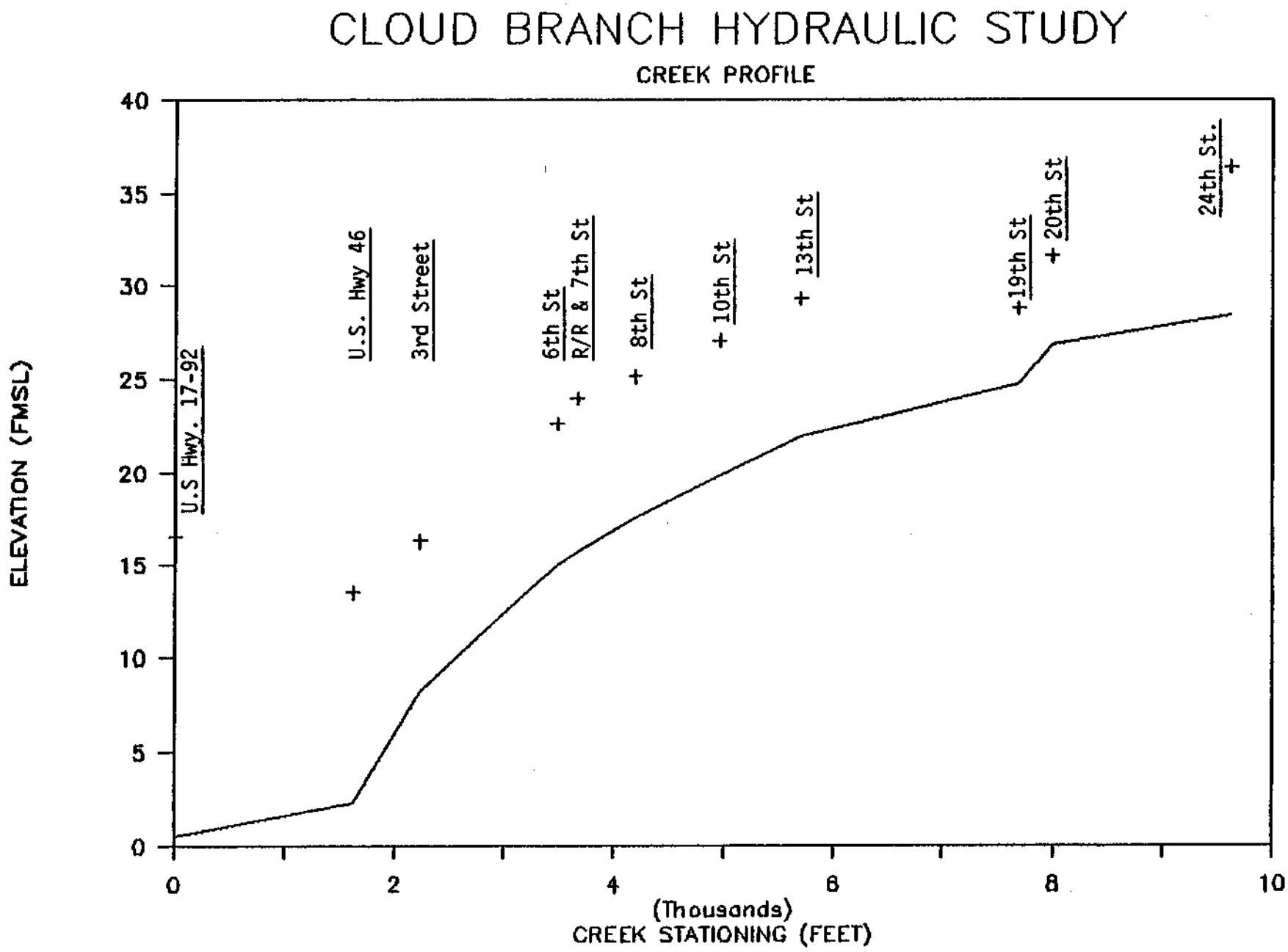


FIGURE 4-10. CHANNEL PROFILE FOR THE CLOUD BRANCH DRAINAGE BASIN TO BE USED IN THE HYDRAULIC ANALYSIS

5.0 RESULTS OF HYDROLOGIC/HYDRAULIC ANALYSES

5.1 Project Design Flows

The project design flows from subbasins comprising both the Mill Creek and Cloud Branch Drainage Basins were, as previously stated, calculated using the Soil Conservation Services Unit Hydrograph Method. Drainage Basin parameters were entered into the model (area, time of concentration, initial abstraction ratio, and design SCS curve number) in conjunction with their specific subbasin-node relationship. The computed design subbasin flows along with the individual subbasin hydrologic characteristics are presented in Tables 5-1 (Mill Creek) and 5-2 (Cloud Branch).

Peak flow rates within the Mill Creek Drainage Basin ranged from 15 to 102 cfs among the 31 subbasins, producing a total rainfall excess (runoff) of 312 acre-feet (101.6 MG). Initial Abstraction and Total Runoff values varied throughout the basin, ranging from 0.61 to 1.69 inches, and 1.81 to 4.51 inches, respectively.

Initial Abstraction and Total Runoff values also showed a wide variation within the Cloud Branch Drainage Basin, ranging from 0.49 to 2.00 inches, and 1.42 to 4.06 inches, respectively, among the 19 contributing subbasins. Peak flow rates within the basin range from 4 to 115 cfs, with Cloud Branch producing a total rainfall excess (runoff) of 125 acre-feet (40.6 MG).

TABLE 5-1

MILL CREEK DRAINAGE STUDY
HYDROLOGIC SIMULATION

25YR/6YR STORM EVENT
FUTURE BASIN CONDITIONS

BASIN No.	BASIN AREA (ACRES)	TIME OF CONCENT (MIN)	DESIGN SCS RUNOFF CN	INITIAL ABSTR Ia (INCHES)	TOTAL RUNOFF (INCHES)	PEAK RUNOFF RATE (CFS) 1
100	30.5	65	66	1.55	2.00	16
105	24.3	55	71	1.23	2.49	20
200	53.1	46	74	1.05	2.80	57
210	46.9	46	73	1.11	2.70	48
220	92.4	43	72	1.17	2.60	93
300	21.9	17	78	0.85	3.23	48
400	108.0	90	74	1.05	2.80	77
410	35.0	32	69	1.35	2.29	35
420	31.0	25	69	1.35	2.29	36
500	18.3	24	71	1.23	2.49	24
610	23.5	27	71	1.23	2.49	29
620	55.9	40	74	1.05	2.80	65
625	11.7	25	71	1.23	2.49	15
630	72.5	61	83	0.61	3.78	99
640	78.9	54	80	0.75	3.45	102
650	38.3	45	69	1.35	2.29	31
700	16.0	26	69	1.35	2.29	18
710	37.0	29	69	1.35	2.29	40
810	29.6	29	73	1.11	2.70	40
820	74.5	55	73	1.11	2.70	68
830	27.3	29	73	1.11	2.70	37
840	30.9	32	63	1.41	2.20	29
910	31.6	33	73	1.11	2.70	39
920	78.8	65	78	0.85	3.23	83
930	10.3	3	90	0.33	4.51	36
940	48.0	39	67	1.48	2.10	37
950	56.9	45	66	1.55	2.00	38
960	62.2	48	64	1.69	1.81	34
1000	69.5	38	69	1.35	2.29	63
1100	23.0	26	69	1.35	2.29	26
1200	54.0	56	80	0.75	3.45	68

1 FLOW RATES DERIVED FROM SCS UNIT HYDROGRAPH TECHNIQUE; SHAPE FACTOR=342, Ia=0.30

TABLE 5-2

CLOUD BRANCH DRAINAGE STUDY
HYDROLOGIC SIMULATION

25YR/6HR STORM EVENT
FUTURE BASIN CONDITIONS

BASIN No.	BASIN AREA (ACRES)	TIME OF CONCENT (MIN)	DESIGN SCS RUNOFF CN	INITIAL ABSTR Ia (INCHES)	TOTAL RUNOFF (INCHES)	PEAK RUNOFF RATE (CFS)
100	90	33	74	1.05	2.77	115
200	12	20	60	2.00	1.42	7
300	5	15	61	1.92	1.52	4
310	32	25	61	1.92	1.51	19
400	12	28	65	1.62	1.87	9
500	44	38	64	1.69	1.78	27
600	27	52	63	1.76	1.69	14
700	23	25	82	0.66	3.62	49
800	26	36	71	1.23	2.47	27
900	6.4	28	61	1.92	1.51	4
1000	25	41	71	1.23	2.45	24
1100	13.3	24	86	0.49	4.06	33
1200	9.8	22	62	1.84	1.60	7
1300	95	49	64	1.69	1.78	53
1400	105	86	70	1.29	2.36	65
1500	26.3	21	63	1.76	1.68	20
1600	42	43	74	1.05	2.76	47
1700	47	27	71	1.23	2.46	56
1800	23	19	67	1.48	2.04	25

1
AREA IN ACRES, Tc IN MINUTES
2
FLOW RATES DERIVED FROM SCS UNIT HYDROGRAPH
TECHNIQUE; SHAPE FACTOR=342, Ia=0.30

5.2 Design Hydraulic Analyses

The hydraulic modeling of the Mill Creek and Cloud Branch Drainage Basins was simulated, as previously described, using the Interconnected Pond Routing Model (ICPR). Design storm event hydrographs (generated by the SCS Unit Hydrograph Method) were input into the model along with the hydraulic characteristics of each drainage basin. Three routings were performed per drainage basin, incorporating the aforementioned modeling assumptions, in order to achieve a stormwater management system which would satisfy the objectives of the study.

5.2.1 Mill Creek Hydraulic Analysis

A preliminary simulation was run on the Mill Creek Drainage Basin utilizing the existing stormwater management facilities in conjunction with the 25yr/6hr design storm event. The modeling results verified the fact that various areas within the basin have inadequately sized culvert systems and are subject to potential flooding. The large amount of stormwater runoff produced during this size storm event requires proper flow attenuation through retention/detention facilities in order to reduce the size of new stormwater mangagement systems and the potential property damage due to flooding.

Simulation No. 1 included the addition of the following appurtenances to the Mill Creek Stormwater Management System:

a. Replacement of the Bradshaw Ave culvert with a 36" R.C.P. and headwall system
b. Additional 18" culvert added at Chase Ave
c. Replacement of Marshall Ave culvert with a 29"x 45" ERCP
d. Replacement of the existing 20th St culvert with a dual 48"

R.C.P. and headwall system

e. Addition of 3 retention/detention ponds at 18th St (23 ac), 8th St (3 ac), and McCracken Road (6 ac)
f. Additional 30" culvert added at 25th St (north side of rd)
g. Closed Conduit piping system from 18th St pond to 13th St (75 to 100 ft north of 13th St), with headwalls
h. Upgrade of 8th St culvert (main channel) to 72" RCP, with headwalls
i. Additional 36" culvert added at 8th St (Tributary "E"), with headwalls
j. Pond Diversion System at 18th St

The results of this hydraulic analysis are presented in Table 5-3 and shown graphically in Figure C-1 (Map Pocket C). The addition of the retention/detention ponds provided a significant attenuation of peak flows throughout the drainage basin. The 18th St pond had a peak storage of 60.2 ac-ft, with the ponds at McCracken Road and 8th St storing 21.3 and 19.0 ac-ft, respectively. This attenuation of the channel flows accompanied by the design culvert system described above led to a significant reduction in flood potential throughout the Drainage Basin. Peak stormwater discharge rates at nodes varied from approximately 16.0 cfs at the head of the Mill Creek system (Node 100 at t = 4.09 hrs) to 725 cfs (Node 1000 at t = 4.63 hrs) at Hwy 46. By the end of the 6.0 hour storm duration, approximately 61 percent of the rainfall excess, or 189.8 ac-ft, had passed through the stormwater system and into Lake Monroe. Despite this decrease in potential flood damage, there were areas of localized flooding where the channel/culvert systems were unable to convey the stormwater without staging out of bank and over the culvert crossings (Marshall Ave, Bevier Road, and the S.C.L. Railroad crossing just south of the McCracken Road retention/detention pond).

TABLE 5-3

MILL CREEK DRAINAGE STUDY
HYDRAULIC SIMULATION

STORMWATER ROUTING ANALYSIS: SIMULATION No. 1

25YR/6HR STORM EVENT

NODE	DESCRIPTION	INLET BASINS	DRAINAGE AREA (AC)	PEAK STAGE (FMSL)	PEAK STORAGE (AC-FT)	PEAK DISCHARGE (CFS)	DISCH. TO NODE No.
100	CHAN S OF 25th ST	100	30.50	32.13	0.35	16	200
200	CHANNEL BETWEEN 25th AND 20th STREET	105,220 300	138.80	30.38	6.35	197	300
210	CHANNEL BETWEEN CHASE AVE & MILL CRK	210	46.90	32.89	1.50	40	200
220	CHANNEL BETWEEN CLUB DR & MILL CRK	200	53.10	31.36	0.38	55	200
300	18th ST RET/DET POND	400	108.00	26.64	60.22	151	400
400	PIPED SECTION BTWN 12th & 8th STREETS	410,420 500,610,620	163.60	17.83	2.41	223	600
410	CHANNEL BETWEEN BILLIE & 13th STREETS	625,650	50.00	24.69	1.78	29	400
600	RR/RR TRACK POND	700,930	26.30	14.79	18.95	633	700
610	CHAN W OF AIRP BLVD	830,840	58.10	28.62	0.90	55	630
620	CHANNEL BETWEEN McKEE POND AND RR I	630,640	151.40	31.18	5.23	163	625
625	McCRACKEN RD POND 8th & 10th STREETS	810	29.60	25.04	21.28	266	640
630	CHANNEL BETWEEN AIRP BL & McCR POND	820	74.50	25.50	2.20	114	625
640	CHANNEL BETWEEN RR I & PERSIMMON AVE	710	37.00	25.81	2.91	282	600
650	CHANNEL BETWEEN MEISCH AND DEVIER RDs	950,960	119.00	29.84	0.73	69	660
660	CHANNEL BETWEEN DEVIER RD & RR I-INB	920,940	126.80	25.45	2.07	176	670
670	CHANNEL BETWEEN RR I-INB & PERSIMMON	910	31.60	16.58	1.30	203	600
700	CHANNEL BETWEEN RR I-INB & 3rd ST	1000	69.50	10.51	3.20	669	800
800	CHANNEL BETWEEN 3rd & 2nd STREETS	1100	23.00	9.77	1.56	679	900
900	CHANNEL BETWEEN 2nd & 1st STREETS	1200	54.00	8.81	2.32	725	1000
1000	CHANNEL BETWEEN 1st ST & HWY 17-92	* 1300	0.00	5.01	5.78	723	1100
1100	LAKE MONROE	* 1400	0.00	3.09	189.82	---	---

* NULL INLET BASIN FOR STORMWATER ROUTING ANALYSIS

Simulation No. 2, utilizing the results of the first analysis, included the addition of the following appurtenances in an effort to reduce the effects of localized flooding in the areas outlined in Simulation No. 1:

a. Addition of a second 29"x 45" ERCP at Marshall Ave
b. Addition of an 18"x 44" ERCP at Bevier Rd, with headwalls
c. Replacement of the existing RR crossing south of the McCracken Rd pond with a 4'x 5' box culvert

The results of the stormwater routing are presented in Table 5-4 and shown graphically in Figure D-1 (Map Pocket D). Peak nodal discharge rates increased 3 percent due to the improvements, from approximately 16 cfs at 25th St (Node 100 at t = 4.09 hrs) to 744 cfs at U.S. Hwy 46 (Node 1000 at t = 4.45 hrs). Approximately 61.3 percent of the rainfall excess, or 190.9 ac-ft, had passed through the stormwater basin and into Lake Monroe by the end of the design storm duration. Additon of the new improvements for this routing relieved the flooding in all areas except the railroad crossing just south of the McCracken Road Pond. As a result, the 4' x 5' box culvert was determined to be restrictive due to the backwater condition which it was creating upstream.

Simulation No. 3, included the removal of the 4' x 5' box culvert at the aforementioned railroad crossing and the subsequent upgrading of the existing 48" culvert with a second culvert of the same material and size in an effort to provide the non-restrictive conveyance of flow through this portion of the Mill Creek tributary system. The results of the modeling process produced a stormwater management system for the main channel of Mill Creek and its adjacent tributaries which provides a positive, non-restrictive conveyance of stormwater flows for a design

TABLE 5-4

HILL CREEK DRAINAGE STUDY
HYDRAULIC SIMULATION

STORMWATER ROUTING ANALYSIS: SIMULATION No. 2

25YR/6HR STORM EVENT

NODE	DESCRIPTION	INLET BASINS	DRAINAGE AREA (AC)	PEAK STAGE (FMSL)	PEAK STORAGE (AC-FT)	PEAK DISCHARGE (CFS)	DISCH. TO NODE No.
100	CHAN S OF 25th ST	100	30.50	32.13	0.35	16	200
200	CHANNEL BETWEEN 25th AND 20th STREET	105,220 300	138.80	30.46	6.50	197	300
210	CHANNEL BETWEEN CHASE AVE & HILL CRK	210	46.90	31.68	1.08	44	200
220	CHANNEL BETWEEN CLUB DR & HILL CRK	200	53.10	31.36	0.38	55	200
300	18th ST RET/DET POND	400	108.00	26.64	60.26	151	400
400	PIPED SECTION BTWN 13th & 9th STREETS	410,420 500,610,620	163.60	17.84	2.42	223	600
410	CHANNEL BETWEEN DIXIE & 13th STREETS	625,650	50.00	24.69	1.78	29	400
600	RR/RR TRACK POND	700,930	26.30	14.85	19.13	649	700
610	CHAN W OF AIRP BLVD	830,840	58.10	28.62	0.90	55	630
620	CHANNEL BETWEEN McKEE POND AND RR I	630,640	151.40	28.75	3.24	183	625
625	McCRACKEN RD POND 9th & 10th STREETS	810	29.60	25.07	21.47	274	640
630	CHANNEL BETWEEN AIRP BL & McCR POND	820	74.50	25.55	2.26	113	625
640	CHANNEL BETWEEN RR I & PERSIMMON AVE	710	37.00	25.77	3.01	291	600
650	CHANNEL BETWEEN MEISCH AND DEVIER RDs	950,960	119.00	29.06	0.50	70	660
660	CHANNEL BETWEEN DEVIER RD & RR I-ING	920,940	126.80	23.47	2.10	177	670
670	CHANNEL BETWEEN RR I-ING & PERSIMMON	910	31.60	16.60	1.31	204	600
700	CHANNEL BETWEEN RR I-ING & 3rd ST	1000	69.50	10.65	3.34	686	800
800	CHANNEL BETWEEN 3rd & 2nd STREETS	1100	23.00	9.87	1.60	697	900
900	CHANNEL BETWEEN 2nd & 1st STREETS	1200	54.00	8.91	2.38	744	1000
1000	CHANNEL BETWEEN 1st ST & HWY 17-92	* 1300	0.00	5.09	5.92	741	1100
1100	LAKE HENRIE	* 1400	0.00	3.06	190.90	---	---

* NULL INLET BASIN FOR STORMWATER ROUTING ANALYSIS

storm of 25 year frequency-6 hour duration. The results of the final hydraulic simulation are presented in Table 5-5 and graphically in Figures 5-1 through 5-4 and Figure E-1 (Map Pocket E). Inflow and Outflow hydrographs from the retention/detention ponds at 18th St, 8th St, and McCracken Rd are presented in Figures 5-5 through 5-7. Peak stormwater discharges remained unchanged in the upstream portion of the basin and reduced to a peak flow of 683 cfs at U. S. Hwy 46 due to the improved stormwater facilities in the drainage basin. Approximately 58 percent of the total rainfall excess, or 180.8 ac-ft, had passed through the system and into Lake Monroe by the end of the design storm duration.

5.2.2 Cloud Branch Hydraulic Analysis

A preliminary simulation was run on the Cloud Branch Drainage Basin utilizing the existing stormwater facilities in conjunction with the 25yr/6hr design storm event. The modeling results verified the fact that various areas within the basin have inadequately sized culvert systems and are subject to potential flooding. The large amount of stormwater runoff produced during this size storm event requires proper flow attenuation through retention/detention facilities in order to reduce the size of new stormwater management systems and the potential property damage due to flooding.

Simulation No. 1 included the addition of a 48" equivalent elliptical culvert (ERCP) at 19th street over and above the assumptions previously mentioned. The results of this hydraulic analysis are presented in

TABLE 5-5

HILL CREEK DRAINAGE STUDY
HYDRAULIC SIMULATION

STORMWATER ROUTING ANALYSIS: SIMULATION No. 3

25YR/6HR STORM EVENT

NODE	DESCRIPTION	INLET BASINS	DRAINAGE AREA (AC)	PEAK STAGE (FMSL)	PEAK STORAGE (AC-FT)	PEAK DISCHARGE (CFS)	DISCH. TO NODE No.
100	CHAN S OF 25th ST	100	30.50	32.13	0.35	16	200
200	CHANNEL BETWEEN 25th AND 20th STREET	105,220 300	138.00	30.46	6.50	199	300
210	CHANNEL BETWEEN CHASE AVE & HILL CRK	210	46.90	31.68	1.08	44	200
220	CHANNEL BETWEEN CLUB DR & HILL CRK	200	53.10	31.36	0.38	55	200
300	18th ST RET/DET POND	400	108.00	26.64	60.26	151	400
400	PIPED SECTION BTWN 13th & 8th STREETS	410,420 500,610,620	163.60	17.84	2.42	223	600
410	CHANNEL BETWEEN DIXIE & 13th STREETS	625,650	50.00	24.69	1.78	29	400
600	RR/RR TRACK POND	700,930	26.30	14.68	18.61	601	700
610	CHAN W OF AIRP BLVD	830,840	58.10	28.62	0.90	55	630
620	CHANNEL BETWEEN McKEE POND AND RR I	630,640	151.40	27.69	2.37	188	625
625	McCRACKEN RD POND 8th & 10th STREETS	810	29.60	26.30	29.05	242	640
630	CHANNEL BETWEEN AIRP BL & McCR POND	820	74.50	26.61	3.53	110	625
640	CHANNEL BETWEEN RR I & PERSIMMON AVE	710	37.00	25.34	2.61	256	600
650	CHANNEL BETWEEN NEISCH AND DEVIER RDs	950,960	119.00	29.06	0.50	70	660
660	CHANNEL BETWEEN DEVIER RD & RR I-ING	920,940	126.80	25.47	2.10	177	670
670	CHANNEL BETWEEN RR I-ING & PERSIMMON	910	31.60	16.60	1.31	204	600
700	CHANNEL BETWEEN RR I-ING & 3rd ST	1000	69.50	10.21	2.09	638	800
800	CHANNEL BETWEEN 3rd & 2nd STREETS	1100	23.00	7.54	1.48	644	900
900	CHANNEL BETWEEN 2nd & 1st STREETS	1200	54.00	8.58	2.19	682	1000
1000	CHANNEL BETWEEN 1st ST & HWY 17-92	* 1300	0.00	4.83	5.46	681	1100
1100	LAKE MONROE	* 1400	0.00	3.06	100.83	---	---

* NULL INLET BASIN FOR STORMWATER ROUTING ANALYSIS

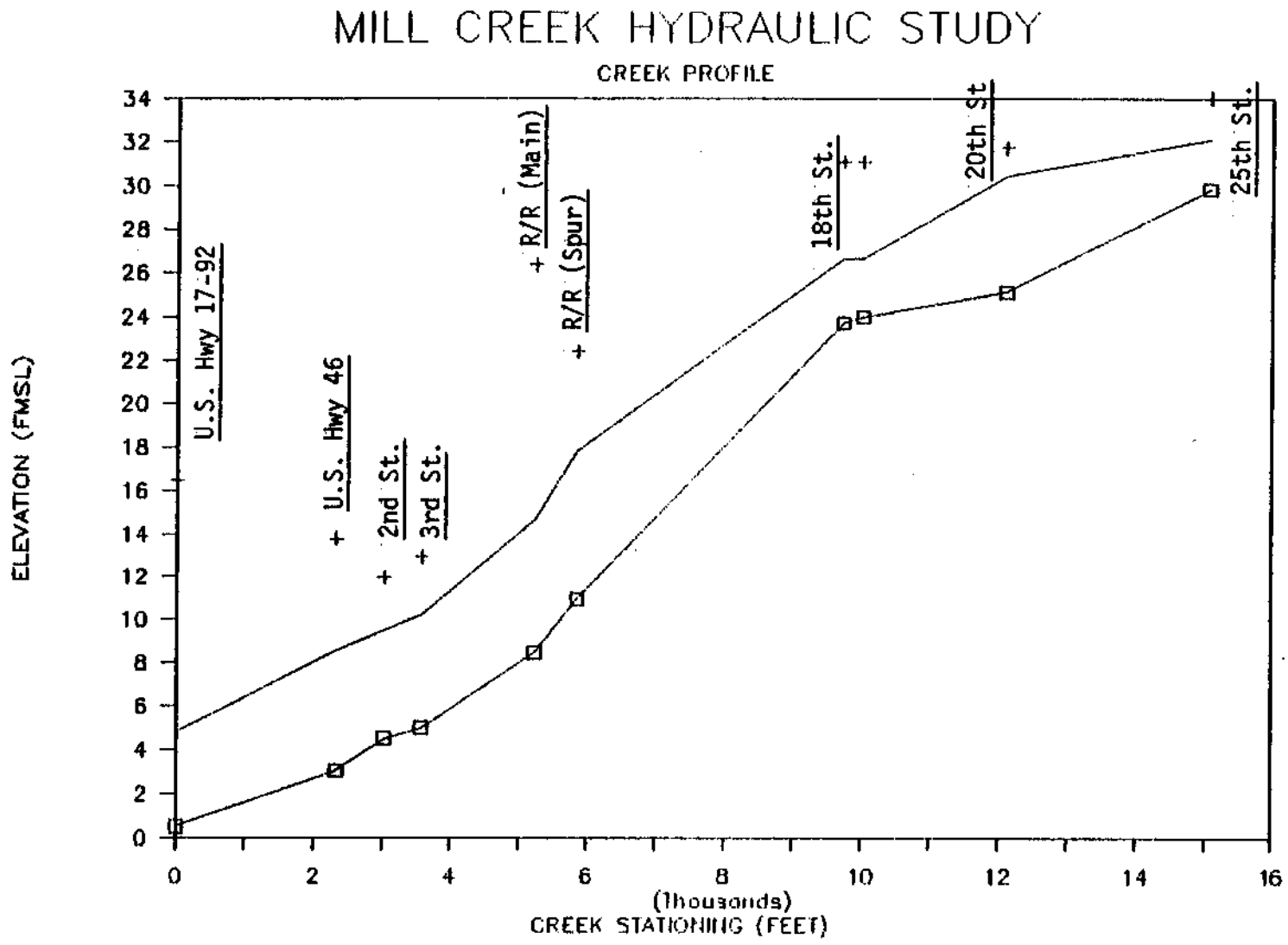


FIGURE 5-1. HYDRAULIC PROFILE OF THE MILL CREEK DRAINAGE BASIN WITH THE NEW STORMWATER MANAGEMENT IMPROVEMENTS: MAIN CHANNEL.

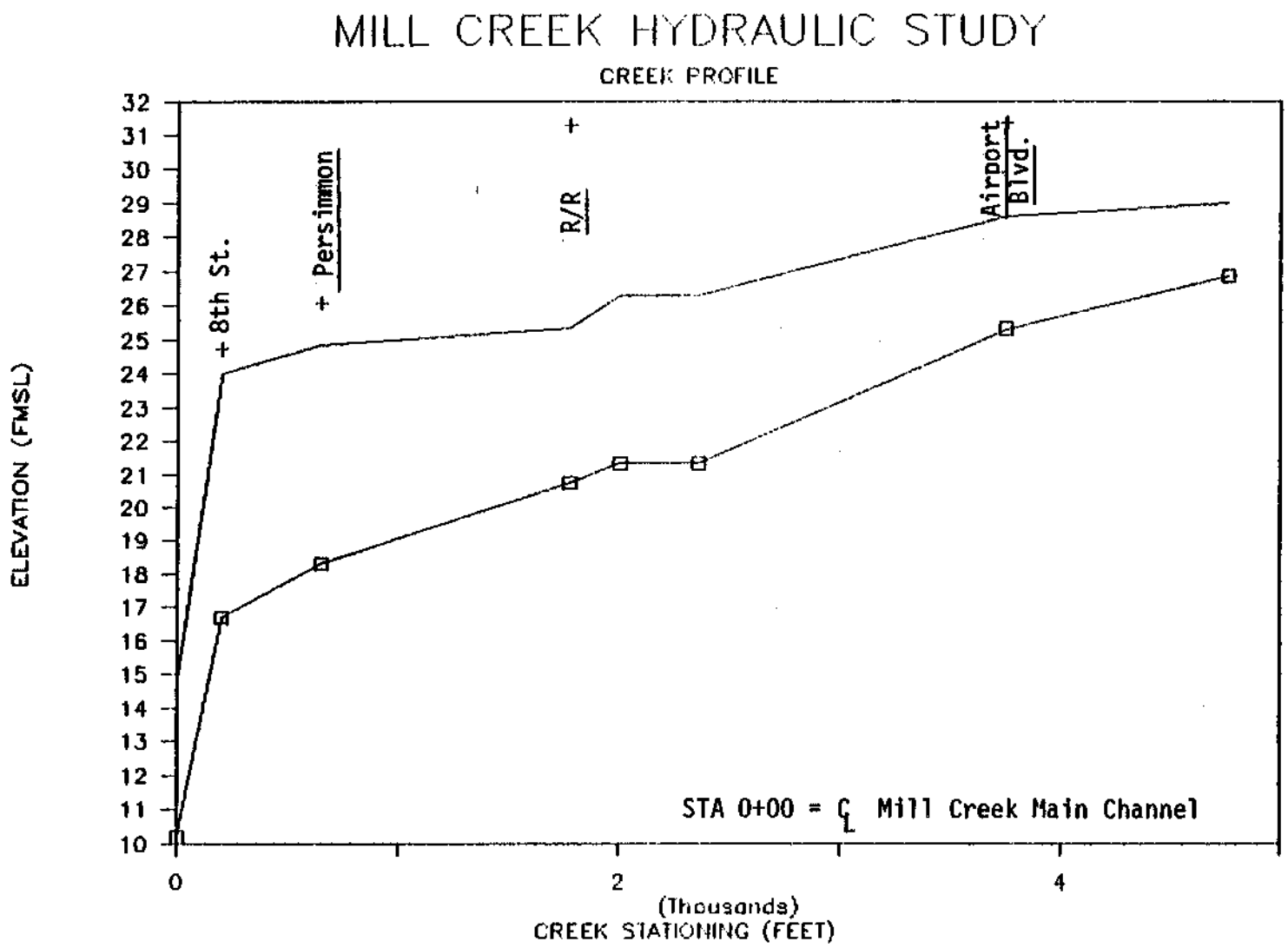
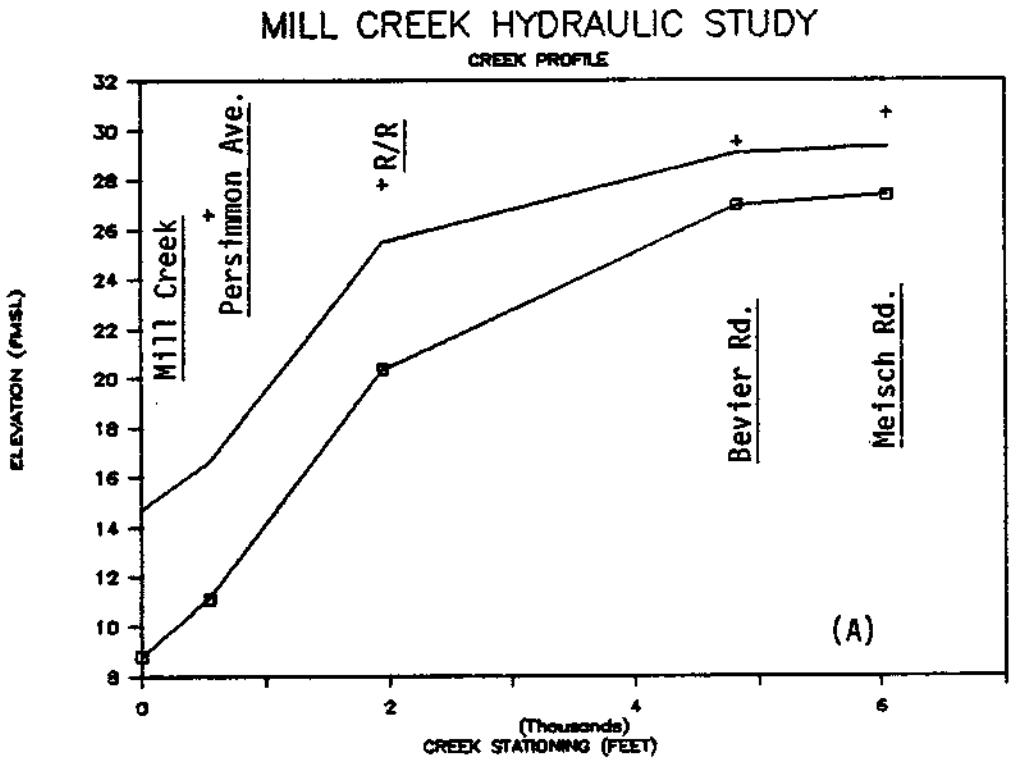


FIGURE 5-2. HYDRAULIC PROFILE OF THE MILL CREEK DRAINAGE BASIN WITH THE NEW STORMWATER MANAGEMENT IMPROVEMENTS -- TRIBUTARY CHANNEL "E"



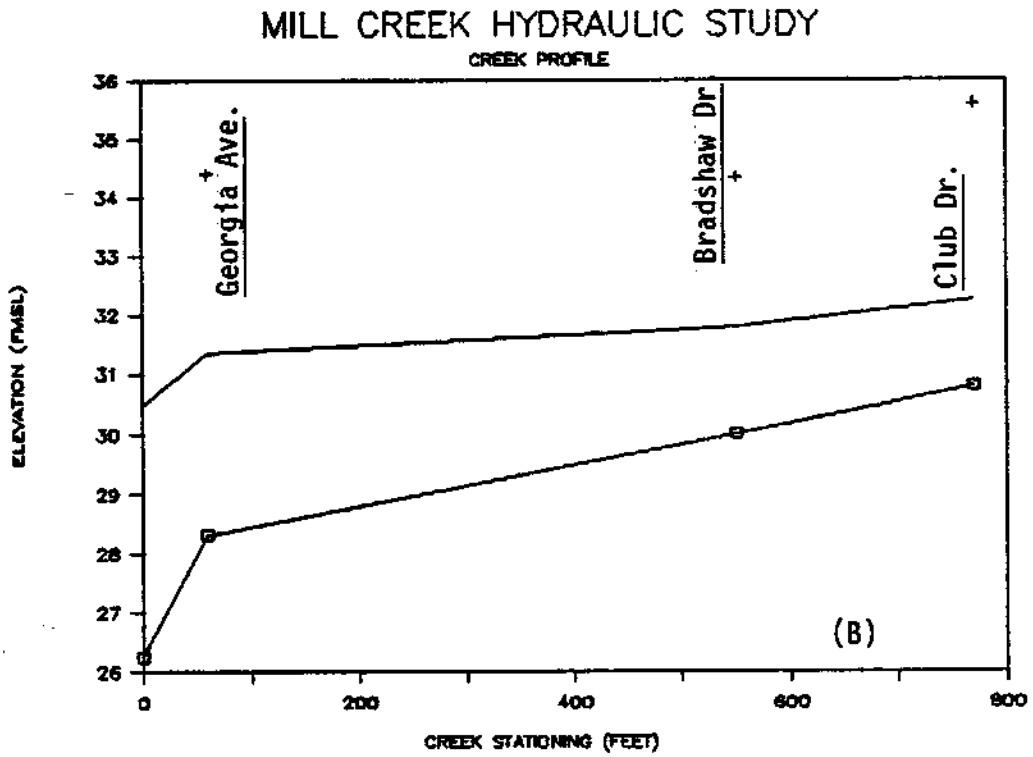
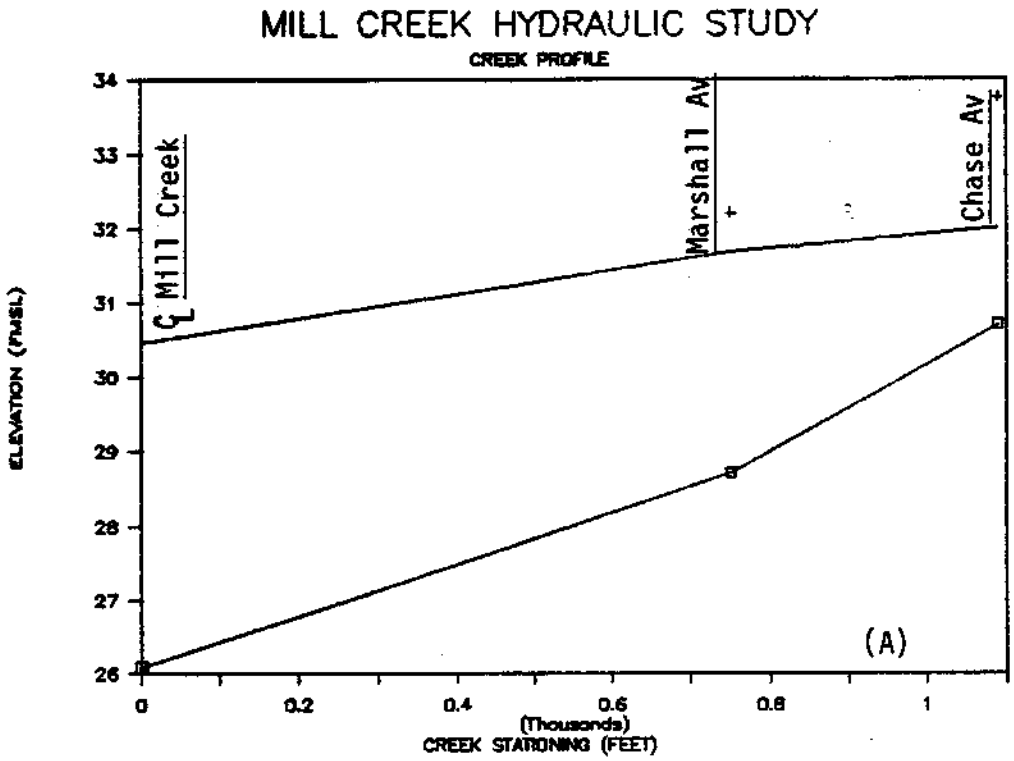


FIGURE 5-3. HYDRAULIC PROFILE OF THE MILL CREEK DRAINAGE BASIN WITH THE NEW STORMWATER MANAGEMENT IMPROVEMENTS (A) TRIBUTARY "D", (B) TRIBUTARY "A"



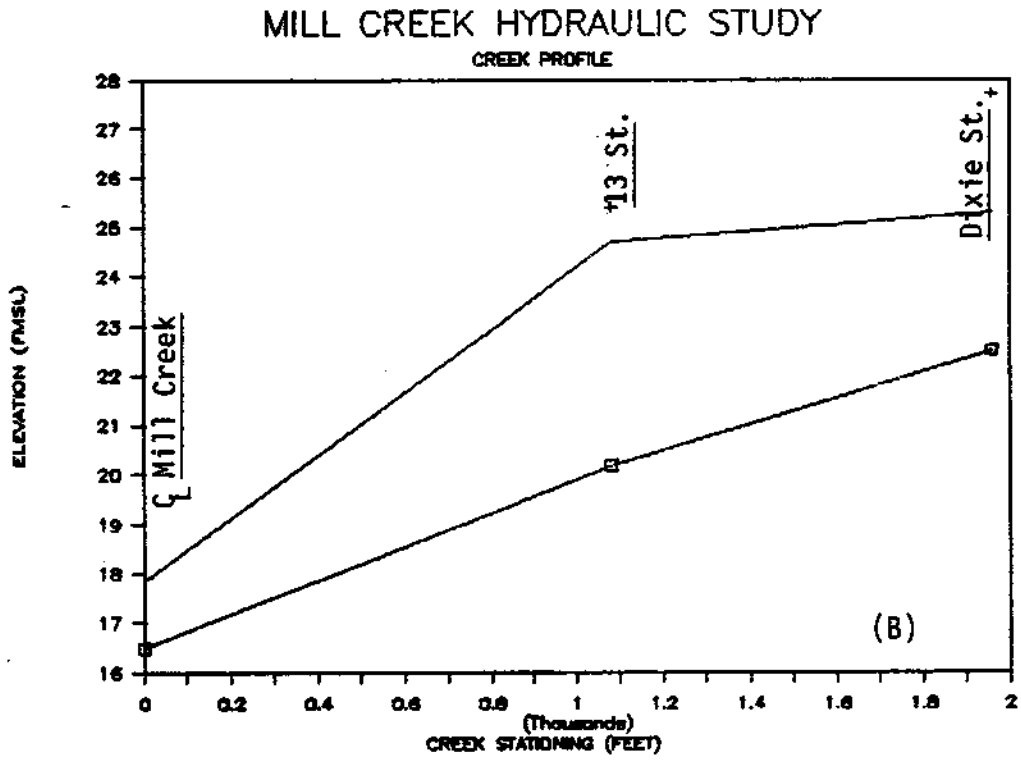


FIGURE 5-4. HYDRAULIC PROFILE OF THE MILL CREEK DRAINAGE BASIN WITH THE NEW STORMWATER MANAGEMENT IMPROVEMENTS (A) TRIBUTARY "B", (B) TRIBUTARY "C".

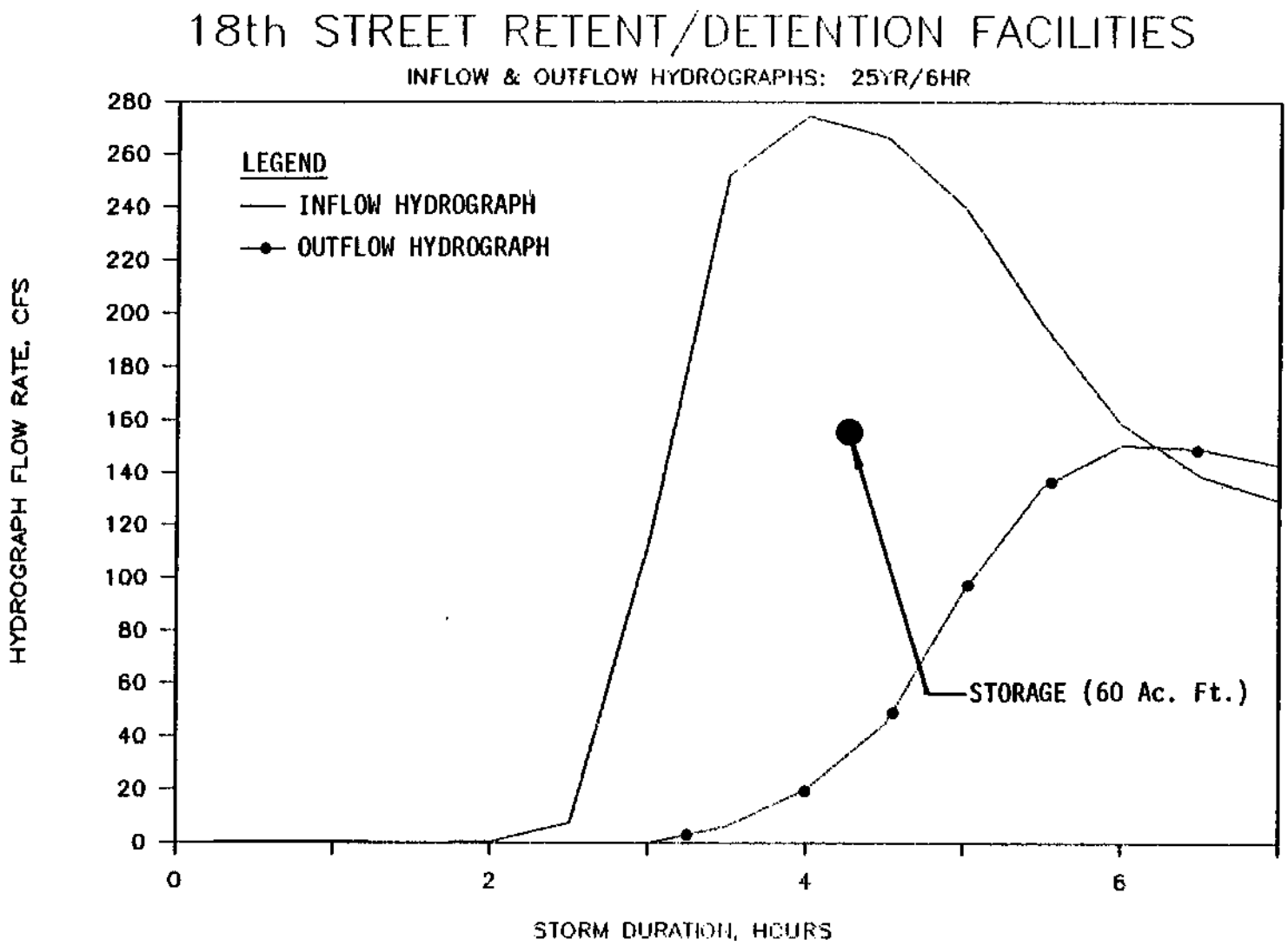


FIGURE 5-5. INFLOW AND OUTFLOW HYDROGRAPHS FOR THE 18TH STREET RETENTION/ DETENTION FACILITY (25 YR/6HR DESIGN STORM)

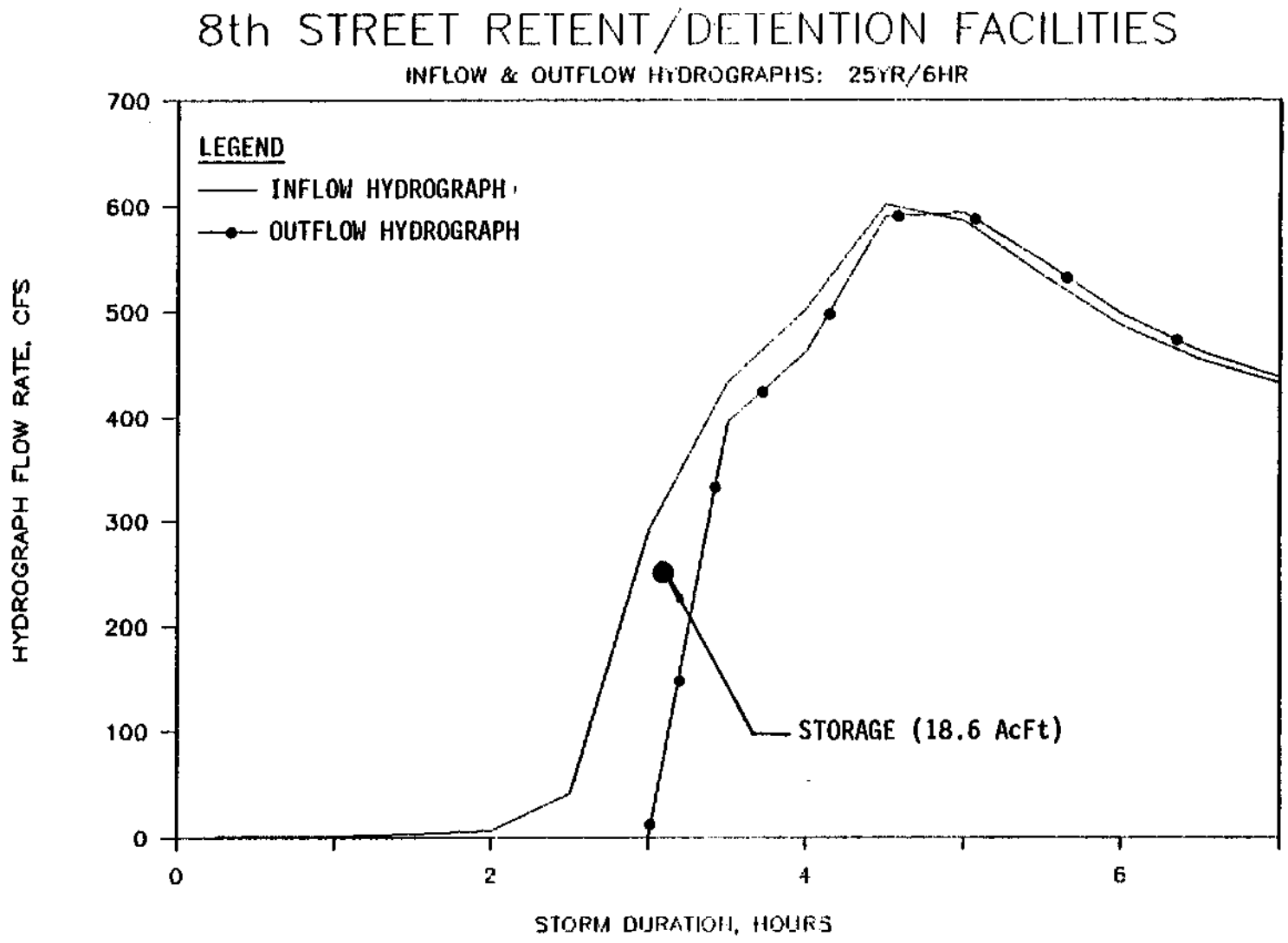


FIGURE 5-6. INFLOW AND OUTFLOW HYDROGRAPHS FOR THE 8TH STREET RETENTION/DETENTION FACILITY (25 YR/6 HR DESIGN STORM)

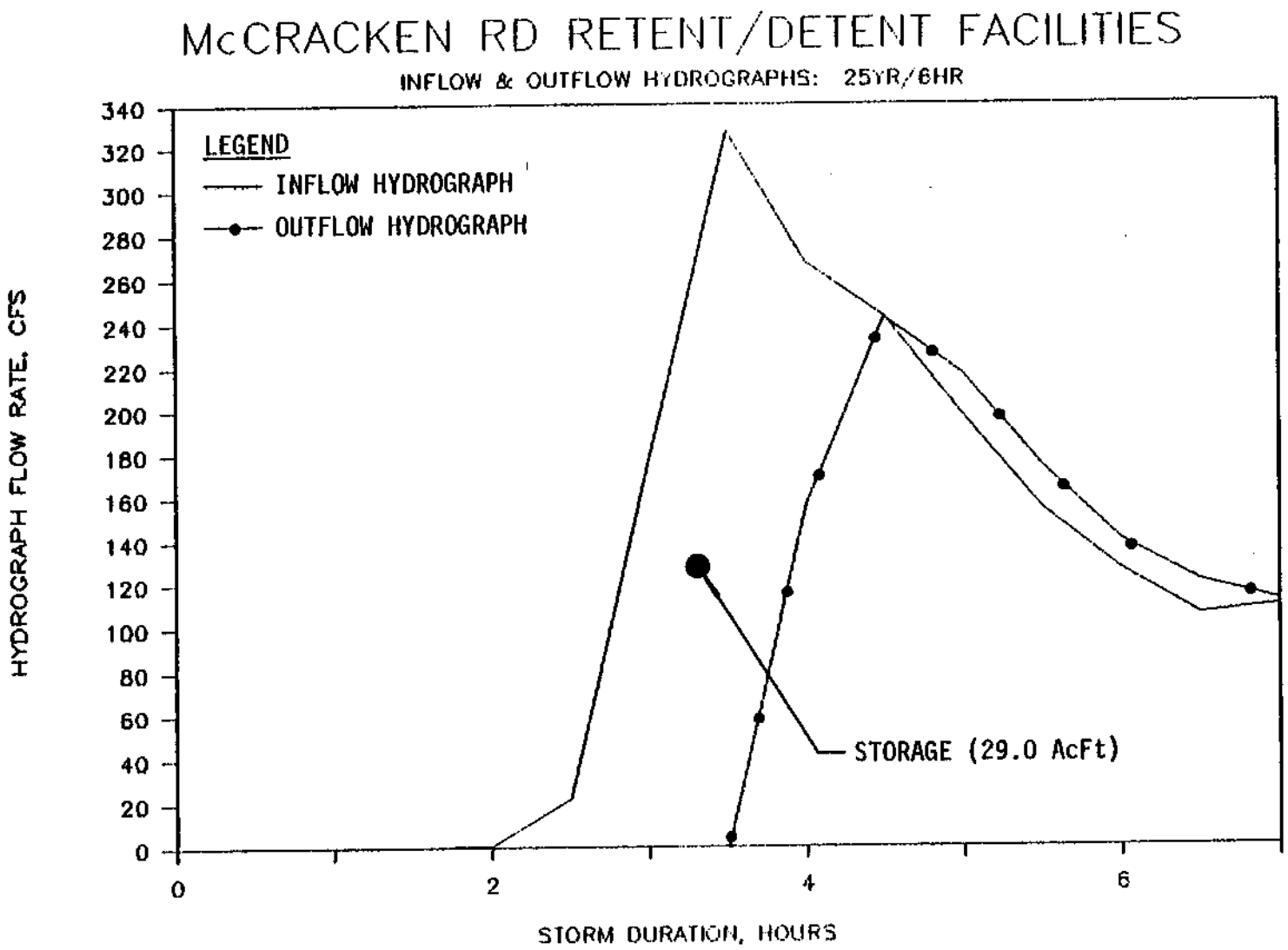


FIGURE 5-7. INFLOW AND OUTFLOW HYDROGRAPHS FOR THE McCRACKEN ROAD RETENTION/DETENTION FACILITY (25 YR/6 HR DESIGN STORM)

Table 5-6 and shown graphically in Figure F-1 (Map Pocket F). Even with the addition of this culvert the channel was unable to convey the stormwater without staging out of its banks and over the culvert crossings at 20th St, 19th St, 8th St, and the 10th St. area. Peak stormwater discharge rates at nodes varied from approximately 117 cfs at the head of the Cloud Branch system (Node 300 at t = 3.02 hrs) to 291 cfs (Node 1400 at t = 3.55 hrs.) at Hwy 46. By the end of the 6.0 hour storm duration, approximately 64 percent of the rainfall excess, or 79.9 ac-ft, had passed through the stormwater system and into Lake Monroe. Major flooding was observed in areas east of French Ave (Hwy 17/92) which drain by stormsewer to the main channel system.

Simulation No. 2, utilizing the results of the first analysis, included the addition of a 4.0 ac-ft pond just south of 16th Street, and a 12.6 ac-ft retention/detention pond at Coastline Park (10th St area) in an effort to attenuate the backwatering effect of the downstream area on the upstream culvert crossings. The results of this stormwater routing are presented in Table 5-7 and shown graphically in Figure G-1 (Map Pocket G). Peak nodal discharge rates increased 28 percent due to the improvements, from approximately 117 cfs at Pinehurst Park (Node 300 at t = 3.02 hrs.) to 372 cfs at U. S. Hwy 46 (Node 1400 at t = 4.16 hrs.). Approximately 70 percent of the rainfall excess, or 87.2 ac-ft, had passed through the stormwater basin and into Lake Monroe by the end of the design storm duration. Inflow and Outflow hydrographs from the retention/detention pond at Coastline Park are presented in Figure 5-8. Yet, even this increase in storage and conveyance within the drainage basin still led to out of channel flow and some flooding east of French

TABLE 5-6

CLOUD BRANCH DRAINAGE STUDY
HYDRAULIC SIMULATION

STORMWATER ROUTING ANALYSIS: SIMULATION No. 1

25YR/6HR STORM EVENT: CHANNEL CLEANOUT w/REHAB. BETWEEN 10th & 13th STREETS, AND ADDITION OF CULVERT @ 19th ST (48" EQ)

NODE	DESCRIPTION	INLET BASINS	DRAINAGE AREA (AC)	PEAK STAGE (FMSL)	PEAK STORAGE (AC-FT)	PEAK DISCHARGE (CFS)	DISCH. TO NODE No.
100	UPSTREAM STORAGE	100	90.00	35.39	1.64	99	300
200	UPSTREAM STORAGE	200	12.00	31.60	0.03	7	300
300	CHANNEL BETWEEN 20th & 24th STREETS	300,310	37.00	31.50	2.49	117	400
400	CHANNEL BETWEEN 19th & 20th STREETS	400	12.00	30.22	0.36	309	700
500	UPSTREAM STORAGE	700,800	49.00	31.28	1.03	54	700
600	UPSTREAM STORAGE	900	6.40	29.41	0.05	20	700
700	CHANNEL BETWEEN 13th & 19th STREETS	500,600 1000	96.00	28.99	9.06	203	1000
800	UPSTREAM STORAGE	1300	26.00	29.29	5.73	35	1000
900	UPSTREAM STORAGE	1400	105.00	30.32	8.36	47	1000
1000	CHANNEL BETWEEN 10th & 13th STREETS	1100 1200	23.10	28.50	3.18	218	1100
1100	CHANNEL BETWEEN 8th & 10th STREETS	1500	26.30	25.60	2.45	226	1200
1200	CHANNEL BETWEEN 7th & 8th STREETS	1600	42.00	22.67	1.44	251	1300
1300	CHANNEL BETWEEN 3rd & 7th STREETS	1700	47.00	14.44	1.34	278	1400
1400	CHANNEL BETWEEN 1st & 3rd STREETS	1800	23.00	8.74	0.98	291	1500
1500	CHANNEL BETWEEN HWY 17-92 & 1st ST	* 1900	0.00	3.40	2.91	291	1600
1600	LAKE MONROE	* 2000	0.00	3.08	79.87	---	---

* NULL INLET BASIN FOR STORMWATER ROUTING ANALYSIS

TABLE 5-7

CLOUD BRANCH DRAINAGE STUDY
HYDRAULIC SIMULATION

STORMWATER ROUTING ANALYSIS: SIMULATION No. 2

25YR/6HR STORM EVENT: CHANNEL CLEANOUT w/REHAB. BETWEEN 10th & 13th STREETS, AND ADDITION OF A CULVERT @ 19th ST (48" EQ), A 12 AC-FT POND @ COASTLINE PARK, AND A 4 AC-FT POND SOUTH OF 16th ST

NODE	DESCRIPTION	INLET BASINS	DRAINAGE AREA (AC)	PEAK STAGE (FMSL)	PEAK STORAGE (AC-FT)	PEAK DISCHARGE (CFS)	DISCH. TO NODE No.
100	UPSTREAM STORAGE	100	90.00	35.39	1.64	99	300
200	UPSTREAM STORAGE	200	12.00	31.60	0.03	7	300
300	CHANNEL BETWEEN 20th & 24th STREETS	300,310	37.00	31.50	2.49	117	400
400	CHANNEL BETWEEN 19th & 20th STREETS	400	12.00	27.73	0.16	125	700
500	UPSTREAM STORAGE	700,800	49.00	31.28	1.03	54	700
600	UPSTREAM STORAGE	900	6.40	27.39	0.02	4	700
700	CHANNEL BETWEEN 13th & 19th STREETS	500,600 1000	96.00	26.95	5.06	229	1000
800	UPSTREAM STORAGE	1300	26.00	26.81	1.96	50	1000
900	UPSTREAM STORAGE	1400	105.00	27.76	3.90	54	1000
1000	CHANNEL BETWEEN 10th & 13th STREETS	1100 1200	23.10	25.76	12.62	300	1100
1100	CHANNEL BETWEEN 8th & 10th STREETS	1500	26.30	26.63	2.92	310	1200
1200	CHANNEL BETWEEN 7th & 8th STREETS	1600	42.00	24.47	2.09	339	1300
1300	CHANNEL BETWEEN 3rd & 7th STREETS	1700	47.00	16.04	2.15	363	1400
1400	CHANNEL BETWEEN 1st & 3rd STREETS	1800	23.00	9.91	1.47	372	1500
1500	CHANNEL BETWEEN HWY 17-92 & 1st ST	* 1900	0.00	3.62	3.16	372	1600
1600	LAKE MONROE	* 2000	0.00	3.08	87.17	---	----

* NULL INLET BASIN FOR STORMWATER ROUTING ANALYSIS

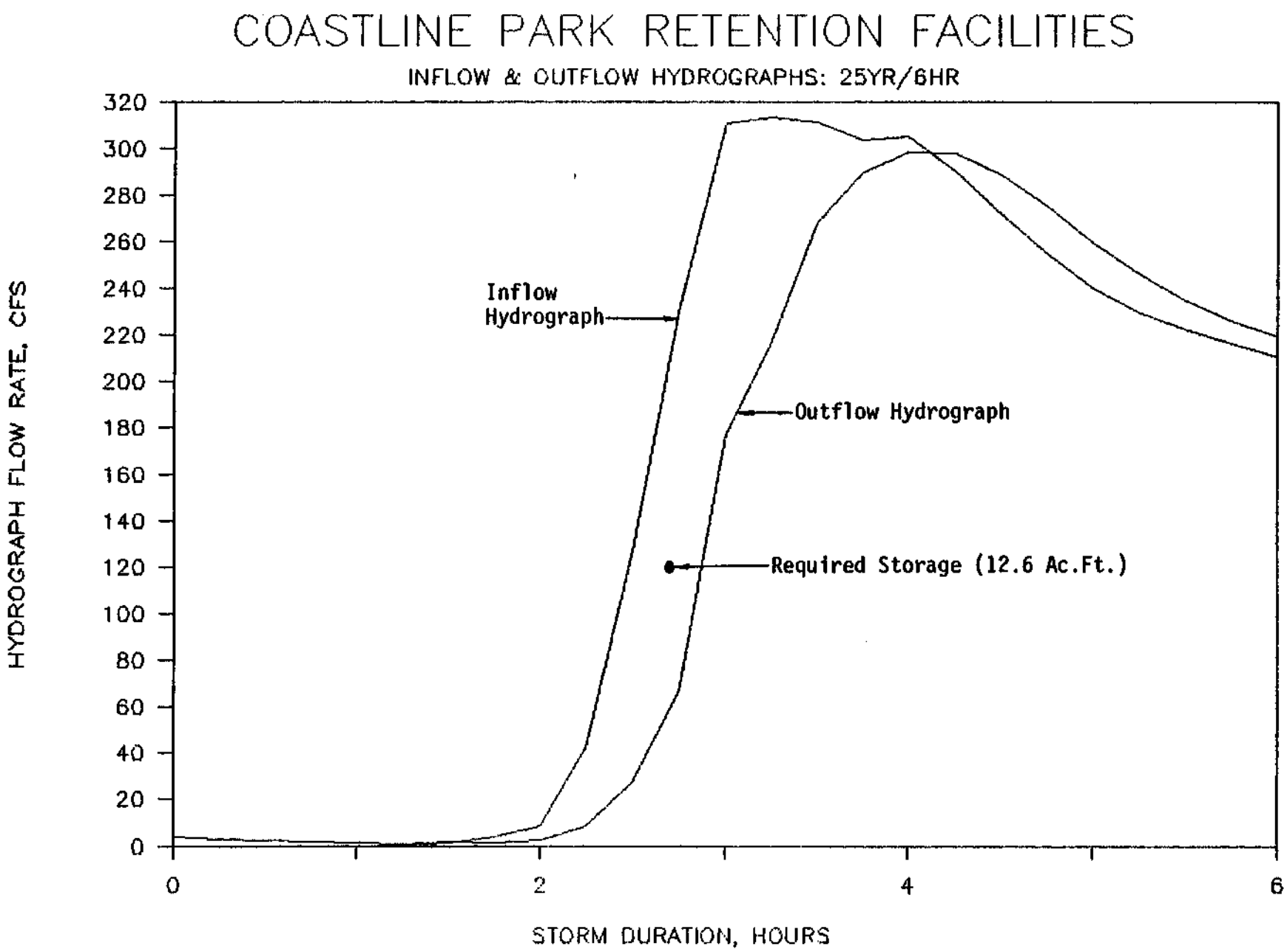


FIGURE 5-8. INFLOW AND OUTFLOW HYDROGRAPHS FOR THE COASTLINE PARK RETENTION/DETENTION FACILITY (25 YR/6 HR DESIGN STORM).

Ave. The dual 48" culverts under the railroad and the 58" arched culvert at 8th St were determined to be retricting flow and causing a backwatering problem upstream as far upstream as 20th St.

Simulation No. 3 included the addition of dual 48" circular culverts under the S.C.L. Railroad at 7th St as well as a 48" circular culvert at 8th St. in an effort to provide non-restrictive conveyance of flow through the basin culvert system. The results from the modeling process produced a stormwater management system for the Cloud Branch Drainage Basin which provides a positive, non-restrictive conveyance of stormwater flows for a design storm of 25 year freqency-6 hour duration. The results of this final hydraulic simulation are presented in Table 5-8 and graphically in Figures 5-9 and H-i (Map Pocket H). Peak stormwater discharge rates remained unchanged from the previous simulation while the addition of the new culverts led to a lowering of the stage throughout the entire channel. Approximately 72 percent of the rainfall excess, or 89.5 ac-ft, had passed through the system and into Lake Monroe by the end of the storm duration.

There was still some evidence of some minor flooding in a few areas east of French Avenue after the final simulation. The problem is mainly due to the stormsewer system in these areas and is not within the scope of this study to design and recommend any changes to said system.

TABLE 5-8

CLOUD BRANCH DRAINAGE STUDY
HYDRAULIC SIMULATION

STORMWATER ROUTING ANALYSIS: SIMULATION No. 3

25YR/6HR STORM EVENT: CHANNEL CLEANOUT w/REHAB. BETWEEN 10th & 13th STREETS, AND ADDITION OF CULVERTS @ 19th ST (48" EQ), RR (2-48"), AND 8th ST (48") WITH A 12 AC-FT POND AT COASTLINE PARK, AND A 4 AC-FT POND SOUTH OF 16th ST

NODE	DESCRIPTION	INLET BASINS	DRAINAGE AREA (AC)	PEAK STAGE (FMSL)	PEAK STORAGE (AC-FT)	PEAK DISCHARGE (CFS)	DISCH. TO NODE No.
100	UPSTREAM STORAGE	100	90.00	33.39	1.64	99	300
200	UPSTREAM STORAGE	200	12.00	31.60	0.03	7	300
300	CHANNEL BETWEEN 20th & 24th STREETS	300,310	37.00	31.50	2.49	117	400
400	CHANNEL BETWEEN 19th & 20th STREETS	400	12.00	27.73	0.16	125	700
500	UPSTREAM STORAGE	700,800	49.00	31.28	1.03	54	700
600	UPSTREAM STORAGE	900	6.40	27.39	0.02	4	700
700	CHANNEL BETWEEN 13th & 19th STREETS	500,600 1000	96.00	26.95	5.06	229	1000
800	UPSTREAM STORAGE	1300	26.00	26.81	1.96	50	1000
900	UPSTREAM STORAGE	1400	105.00	27.76	3.90	54	1000
1000	CHANNEL BETWEEN 10th & 13th STREETS	1100 1200	23.10	25.76	12.62	300	1100
1100	CHANNEL BETWEEN 8th & 10th STREETS	1500	26.30	24.13	1.77	309	1200
1200	CHANNEL BETWEEN 7th & 8th STREETS	1600	42.00	20.45	0.69	338	1300
1300	CHANNEL BETWEEN 3rd & 7th STREETS	1700	47.00	16.01	2.13	362	1400
1400	CHANNEL BETWEEN 1st & 3rd STREETS	1800	23.00	9.89	1.46	371	1500
1500	CHANNEL BETWEEN HWY 17-92 & 1st ST	* 1900	0.00	3.62	3.16	371	1600
1600	LAKE NOWRDE	* 2000	0.00	3.08	89.50	---	----

* NULL INLET BASIN FOR STORMWATER ROUTING ANALYSIS

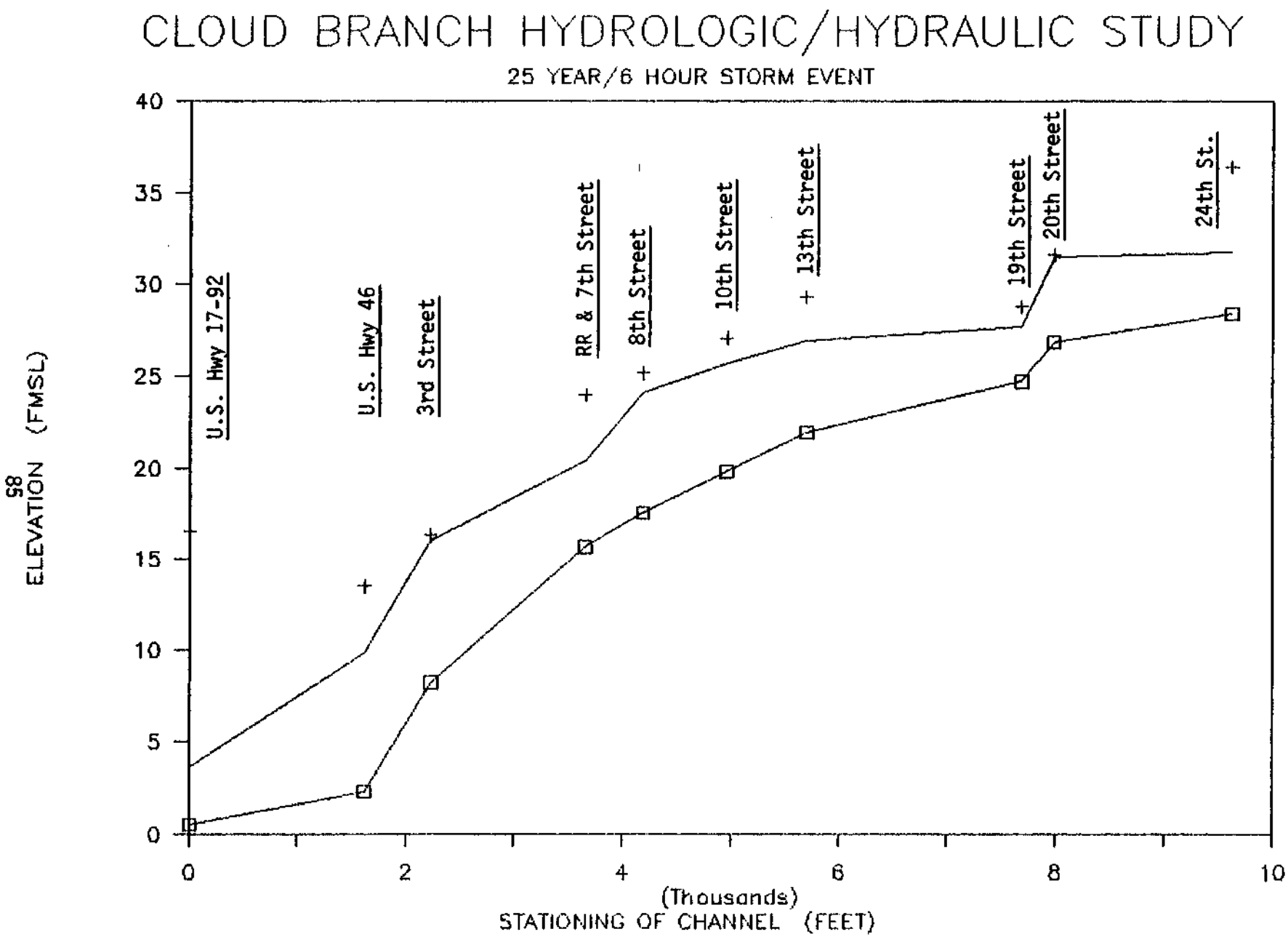


FIGURE 5-9. HYDRAULIC PROFILE OF THE CLOUD BRANCH DRAINAGE BASIN WITH THE NEW STORMWATER MANAGEMENT IMPROVEMENTS.

5.3 Mill Creek Stormwater Management System

The proposed stormwater management plan for the Mill Creek Drainage basin involves the upgrading and addition of culvert crossings in numerous locations where the existing structures are inadequate in size. In addition, the construction of three retention/detention ponds with adequate storage to "attenuate" the peak flows throughout the system will be required, thereby reducing peak stages and the potential for flood damage to adjacent properties.

One of the major restrictions to flow within the Mill Creek drainage basin is the immense growth of plants, shrubs, and bushes within the confines of the conveyance channels. Many of the areas are completely overrun with growth and trash, thereby limiting the effective flow of stormwater runoff through the basin and hence creating a potential for damage to property due to the increased stages within the creek itself. As part of the overall plan, a channel and tributary cleaning and regrading program will be instituted, involving the removal of all plant, natural, and manmade restrictions to flow within the system, as well as the redefining of the channel to appropriate grade. Beyond this initial program of channel redefinition, a maintenance program should be setup by the City in order to keep not only the main channel, but also the adjacent tributaries free from restrictions so as to not create any further backwatering effects on the system.

At the head of the Mill Creek Drainage Basin, improvements will be required to the earthen driveway culvert system along 25th St near

Georgia Avenue (north side of the road). The existing 30" culvert is partially filled with sand and debris and is incapable of conveying the design flow for this section of the channel. An additional 30" R.C.P is required at this location as is the cleanout of the existing culvert thereby providing non-restrictive flow at the head of the system.

As Mill Creek flows in a northerly direction from 25th St it receives inflow from two east-west tributary channels in the Country Club Manor area (Tributary Channels "A" and "B"). As predicted by the hydraulic modeling and on-site inspection of this area during various storm events, the local culvert systems are undersized and require upgrading. As part of the stormwater management plan, the existing culvert systems at Bradshaw and Chase Avenues, and Marshall Avenue will be replaced with 36" R.C.P. and dual 29" x 45" E.R.C.P. systems, respectively. Headwalls will be installed at both upstream and downstream ends of all culvert crossings.

As part of the overall plan, the 20th St crossing within the Mill Creek Basin will be replaced with a dual 48" R.C.P. system which will provide conveyance of the stormwater flow to the county ditch adjacent to Goldsboro Elementary School (north side of 20th St). The new stormwater facility will replace the highly inadequate existing system and will also include the installation of three stormwater inlets along 20th St as a means of relieving some of the flooding problems in this immediate area. The flow within the county ditch will then be redirected from its northerly route by means of a diversion system to a new

retention/detention facility (23 acre site) to be constructed between 18th and 20th Streets. A control structure consisting of a dual 48" R.C.P. culvert system and earthen broad crested weir will be utilized to direct the majority of the flow westward to the 18th St retention/detention facility with a high level popover to the existing drainage channel (northerly flow to 18th St). The retention/detention pond will be utilized to store stormwater runoff and attenuate peak flows to downstream channels, thereby reducing the size of new facilities in this region and decreasing the potential for property damage due to flooding.

Outflow from the 18th St Pond will be conveyed by a closed conduit system (dual 48" R.C.P. culvert and headwall system) to an area approximately 100 feet north of 13th St, thereby relieving flooding, aesthetic and safety problems within the present Mulberry St open ditch drainage system. A network of 12 stormwater inlets/junction boxes will be incorporated into the system and collect surface drainage along the 2900 linear foot stormwater interceptor.

Tributary channel "C" which transports stormwater flow from the Airport Blvd area to the main channel of Mill Creek will be shortened under the new Stormwater Management Plan. The tributary will be backfilled from the S.C.L. Railroad to an area 100 feet west of Dixie Street and accept runoff from this point eastward to the Mill Creek main channel only. As is subsequently described in this section of the report, the rainfall excess between the Airport Blvd and the S.C.L. Railroad will be

redirected to a new retention/detention facility in the McCracken Road area. The present stormwater appurtenances between Dixie St and the Mill Creek main channel are adequate to convey the stormwater without any undue restrictions to flow.

From the new 13th St outfall, the main channel of Mill Creek will continue to flow in a northerly direction along residential property lines to 8th St where an upgrade of the existing culvert system will be required. The existing 60" R.C.P. will be supplemented with an additional 48" R.C.P. culvert and headwall system, thereby relieving the last major choke point along the Mill Creek main channel.

Tributary "E", under the proposed plan, will receive the additonal stormwater runoff (Airport Blvd area) that is being diverted away from Tributary "C". This will require an upgraded culvert crossing of the S.C.L. Railroad (adjacent to Dixie St) by the addition of a 48" R.C.P. and headwall system. A new channel, approximately 500 feet in length, will then be constructed to carry the flow from the railroad crossing to the proposed retention/detention (6.1 acres) at the McCracken Road/S.C.L. Railroad Intersection (southwest quadrant). The retention/detention facility will be utilized to reduce the peak flow rates to downstream channels and appurtenances, thereby reducing the need for further upgrading. Tributary "E", just upstream of the McCracken Road Pond, will also be diverted into said pond by a 50" x 96" arch culvert. This divergence will require the berming of the tributary in order to redirect the flow to the pond. The remainder of the

tributary will be utilized to carry the discharge from the pond downstream to the main channel of Mill Creek. The outflow from the pond control structure will be directed to the existing 52" R.C.P. culvert which crosses McCracken Road and converges with the main portion of the tributary. This crossing, in addition to the system at 8th St will require the installation of additional 48" and 36" R.C.P. and headwall systems, respectively, to ensure non-restrictive flow within the tributary.

Tributary "D", the northern-most east-west collector channel, will require upgraded crossings at Meisch and Bevier Roads under the Mill Creek Stormwater Management Plan. Meisch Road will require an additional 21" R.C.P.; Bevier Road an additional 30" equivalent culvert, in order to pass future stormwater flows without creating any additional backwatering effects.

Tributaries "D" and "E" both discharge to the main channel of Mill Creek between 8th Street and the S.C.L. Railroad main track. A proposed retention/detention facility is designated for this area (3.0 acres) such that a final reduction in peak flow can be realized after the confluence of the two tributaries and the Mill Creek main channel. This facility will reduce the flow rate such that no further upgrading or replacement of culvert systems between said pond and Lake Monroe is required.

A construction phasing or prioritization schedule is listed below for the Mill Creek Drainage Basin based on alleviating the major choke points or areas which see severe flooding, without transfering the problem to another location further downstream. As noted within this drainage study, the cleanout and regrading of the Mill Creek channel and its adjacent tributaries is essential to promote a postive, non-restrictive flow regime within the confines of the system. Construction of the stormwater management facilities and their inherent appurtenances without this cleaning and subsequent maintenance program will tend to decrease the effect of the improvements by creating backwatered conditions within the channel. Therefore, since the cleaning of the channel and its tributaries is essential, its timing with respect to the other items is not significant and will not be included within the prioritization schedule. The cleaning and regrading can be done at any time during the overall construction period of the stormwater improvements with the intent that it be completed by constructions end. The construction phasing (prioritization) schedule is as follows:

PRIORITY	ITEM
1	Closed Conduit Piping of Mill Creek from the south side of 13th St to an area approximately 100 ft north of 13th St (dual 48" R.C.P.)
2	Upgrading of the 8th St culvert crossing along the main channel of Mill Creek by the addition of a 48" R.C.P. and headwall system
3	Upgrading of the 8th St culvert crossing along Tributary "E" by the addition of a 36" R.C.P. and headwall system

PRIORITY	ITEM
4	Construction of the 18th Street Retention/ Detention Facility (23 acres)
5	Construction of both the 18th Street Pond Diversion System (inlet to 18th St Pond) and the remainder of the piping (dual 48" R.C.P.) between the 18th St Pond and 13th St (south side)
6	Construction of the 20th St culvert system (dual 48" R.C.P. and headwall system)
7	Upgrading of the culvert systems at Chase Avenue (additional 18" R.C.P.), Bradshaw Avenue (additional 36" R.C.P.), Marshall Avenue (replace existing system with dual 29" x 45" E.R.C.P.) and 25th St (additional 30" R.C.P. under the earthen driveway)
8	Construction of the McCracken Rd Retention/ Detention Facility (6.1 acres), Pond Inlet and Outlet system, and the S.C.L. Railroad crossing upgrade
9	Construction of the 8th St Retention/Detention Facility (3.0 acres) and the upgrading of culverts at Meisch Rd (additional 21" R.C.P.) and Bevier Rd (additional 30" eq. R.C.P.)

5.4 Cloud Branch Stormwater Management System

The proposed stormwater management system for the Cloud Branch Drainage Basin involves the upgrading and addition of culvert crossings in numerous locations where existing structures are inadequate in size. In addition, the construction of two retention/detention ponds with adequate storage to "attenuate" the peak flows throughout the system will be required, thereby reducing peak stages and the potential for

flood damage to adjacent properties.

One of the major restrictions to flow within the Cloud Branch drainage basin is the immense growth of plants, shrubs, and bushes within the confines of the conveyance channels. Many of the areas are comoletely overrun with growth and trash, thereby limiting the effective flow of stormwater runoff through the basin and hence creating a potential for damage to property due to the increased stages within the creek itself. As part of the overall plan, a channel and tributary cleaning and regrading program will be instituted, involving the removal of all plant, natural, and manmade restrictions to flow within the system, as well as the redefining of the channel to the appropriate grade. Beyond this initial program of redefinition, a maintenance program should be setup by the City in order to keep the main channel and its tributaries free from restrictions so as to not create any further backwatering effects on the system.

At the head of the Cloud Branch Drainage Basin, improvements will be required to the culvert crossing at 19th St based on the results of the hydraulic analysis. The existing culvert system is inadequate to convey the design flow in this steep section of the channel and will have to be supplemented with a 48" R.C.P. and headwall system thereby providing a non-restrictive flow at the head of the system.

Cloud Branch follows a northerly course from 19th St and enters a region of low, wet ground between 18th and 13th streets. As part of the

overall stormwater plan for the basin, a new retention/detention facility will be constructed in the low area just south of 16th St (4.0 acres). The retention/detention facility will be utilized to store stormwater runoff and attenuate peak flows to the downstream channel and culverts, thus reducing the size of new facilities and potential flooding in this region. Outflow from the pond will be governed by the control structure at the northern end of the facility and conveyed to the existing earthen channel. The culverts at 16th and 14th Streets will need to be replaced with 32 square foot box culverts so as to adequately convey the runoff downstream without creating a backwatering effect.

The channel north of 13th St meanders through residential and commercial areas along lot lines and street right of way which has caused a limitation in the capacity of the conveyance system. Another of the major concerns in the area between 10th and 13 streets is the apparent adverse flow condition which occurs. The channel in this reach rises 2.28 feet in elevation and creates a very significant backwatering effect on the upstream regions as well as a limitation of flow through the culvert system at 13th St. In order to increase the conveyance of the system and reduce the backwater effect the main channel of the Cloud Branch Basin will be piped approximately 1000 linear feet between 13th St and Coastline Park through a 5'x 8' box culvert system. In addition, a retention/detention facility (5.0 acres) within the confines of the Park will be required to store the large amount of runoff that arrives at this point in the basin as well as to attenuate the peak flow to the downstream portion of the basin. This closed conduit system will

collect runoff from local streets through a network of 9 stormwater inlets/junction boxes located throughout the interceptors path.

Outflow from the retention/detention facility at Coastline Park will discharge into the existing ditch along Poplar Avenue and follow a northly route to 8th St. As part of the management plan, the culvert crossings at 8th St and the S.C.L. Railroad will require upgrading in order to pass the design storm flow without creating any hydraulic problems either upstream or downstream. The 8th St crossing will require the addition of a 48" R.C.P. and headwall system, whereas the railroad crossing will require an additional dual 48" R.C.P. culvert system and will have to be installed in two open-cut sections (culvert crosses a main line and a spur line). The addition of these facilities will complete the improvements required within the system to pass the rainfall excess from the 25yr/6hr design storm. The retention/detention facility at Coastline Park consumes a large quantity of the City owned property and may not be completely attainable for these purposes. Further hydraulic simulations can be run during the final engineering process in order to downsize this facility. Though, any decrease in retention/detention storage at this site will require an increase in the ability of the S.C.L. Railroad crossing to pass stormwater flows, i.e., further upgrading of the culvert system from its proposed design (4-48" R.C.P).

A construction phasing or prioritization schedule is listed below for the Cloud Branch Drainage Basin based on alleviating the major choke points or areas which see severe flooding, without transfering the problem to another location downstream. As noted within this drainage study, the cleanout and regrading of the Cloud Branch channel and its adjacent tributaries is essential to promote a positive, non-restrictive flow regime within the confines of the system. Construction of the stormwater management facilities and their inherent appurtenances without this cleaning and subsequent maintenance program will tend to decrease the effect of the improvements by creating backwatered conditions within the channel. Therefore, since the cleaning of the channel and its tributaries is essential, its timing with respect to the other items is not significant and will not be included in the prioritization schedule. The cleaning and regrading can be done at any time during the overall construction period of the stormwater improvements with the intent that it be completed by constructions end. The construction phasing (prioritization) schedule is as follows:

PRIORITY	ITEM
1	Replacement of the 16th and 14th St culvert crossings with 32 sq ft box culvert and headwall systems. Upgrading of the 19th St culvert system by the addition of a 48" R.C.P. and headwall system
2	Upgrading of the 8th St culvert system by the addition of a 48" R.C.P. and headwall system
3	Upgrading of the S.C.L. Railroad crossing by the addition of a dual 48" R.C.P. and headwall system

PRIORITY	ITEM
4	Construction of both the Coastline Park (5.0 acres) and the 16th St (2.0 acres) Retention/Detention Facilities
5	Piping of the Cloud Branch channel between 13th Street and Coastline Park

6.0 OPINION OF PROBABLE CONSTRUCTION COST

6.1 GENERAL

Probable construction costs for the proposed Mill Creek and Cloud Branch Basin stormwater management systems have been prepared and are presented below. Cost estimates were compiled based on the results of the hydrologic/hydraulic analyses and implementation of these improvements on a unit cost basis. The following is a partial list of unit costs utilized in the generation of both cost estimates:

ITEM	UNIT	UNIT COST
Channel Cleaning and Regrading	LF	$3.75
Stripping and Sodding	SY	$1.50
Seeding and Mulching	SY	$0.35
Road Crossing	LS	$2000.00
5'x 8' Box Culvert, Installed	LF	$300.00
32 Sq. Ft. Box Culvert, Installed	LF	$250.00
48" R.C.P., Installed	LF	$120.00
36" R.C.P., Installed	LF	$90.00
30" R.C.P., Installed	LF	$65.00
24" R.C.P., Installed	LF	$60.00
21" R.C.P., Installed	LF	$50.00
18"x 44" E.R.C.P., Installed	LF	$95.00
29"x 45" E.R.C.P., Installed	LF	$125.00
50"x 96" C.M.P. Arch, Installed	LF	$250.00
Headwall, Normal	LS	$2500.00

The following Opinions of Probable Construction costs are preliminary in scope and detail, and are subject to refinement resulting from final drainage calculations and design details, as well as the other qualifications identified. They are intended principally as a basis for preliminary budgeting purposes and should not be considered all inclusive in and of themselves.

6.2 MILL CREEK: OPINION OF PROBABLE CONSTRUCTION COST

The Opinion of Probable Construction Cost for the Stormwater Management Improvements within the Mill Creek Basin is based on the following results and recommendations outlined in the Mill Creek Hydrologic/Hydraulic Analyses:

1. Clearing and reshaping of approximately 33,000 linear feet of open drainage-way in the Mill Creek drainage system so as to produce no appreciable retardance to flow.

2. Many miscellaneous road crossings need to be either upgraded or added. The estimate includes pipe and installation costs, headwalls, road repairs, and/or seeding or mulching backfilled utility trenches through yards. However, right-of-way or easement acquisition costs are NOT included.

3. The recommeded retention/detention ponds (18th St, 8th St, and McCracken Rd) are to be utilized for detention/storage to lessen flooding in upstream areas by attenuating the peak flow rate. These opinions of probable construction cost do NOT include the land and/or easement acquisition costs.

4. Piping of Mill Creek from the proposed 18th St Pond to an area approximately 50 feet north of 13th St. The line will collect stormwater from areas through which it passes via stormwater inlets. The opinion of probable cost does NOT include right-of-way or easement acquisition or utility relocation, should it become necessary.

MILL CREEK DRAINAGE BASIN

OPINION OF PROBABLE CONSTRUCTION COST

ITEM	COST
CHANNEL CLEANING & REGRADING	
Mill Creek Channel & Tributaries (33,000 LF)	$123,750
Stripping & Sodding (14,700 SY)	$22,000
Seeding & Mulching (73,300 SY)	$25,500
Sub-Total	$171,250
RETENTION/DETENTION POND SYSTEMS	
(Opinions of Probable Costs do Not include land and/or easement aquisition costs)	
18th Street (23 acres)	$250,000
McCracken Road (6.1 acres)	$70,000
8th Street (3.0 acres)	$35,000
Sub-Total	$355,000
PIPING OF MILL CREEK-13TH TO 18TH ST	
(Opinions of Probable Cost do Not include right-of-way or easement aquisition or utility relocation, should it become necessary)	
Twin 48" R.C.P. (5800 LF)	$1,160,000
Storm Inlets & Junction Boxes (12)	$60,000
Headwalls (2)	$20,000
Road Crossings (5)	$20,000
Seeding & Mulching (16,500 SY)	$5,775
Sheeting & Traffic Control	$150,000
Restoration	$20,000
Sub-Total	$1,430,775

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NEW/UPGRADED CULVERT CROSSINGS

(Opinion of Probable Cost does NOT include right-of-way and/or easement aquisition costs)

Bradshaw Avenue

36" R.C.P. (60 LF)		$5,400
Road Crossing (1)		$4,000
Headwall, Normal (2)		$5,000
	Sub-Total	$14,400

Chase Avenue

18" R.C.P. (60 LF)		$4,500
Road Crossing (1)		$4,000
Headwall, Normal (2)		$5,000
	Sub-Total	$13,500

Marshall Avenue

29"x 45" E.R.C.P. (120 LF)		$15,000
Road Crossing (1)		$4,000
Headwall, Normal (2)		$5,000
	Sub-Total	$24,000

25th Street

30" R.C.P. (40 LF)		$2,600

20th Street

Twin 48" R.C.P. (840 LF)		$168,000
Storm Inlets & Junction Boxes (4)		$20,000
Headwalls, Normal (2)		$20,000
Sodding (1000 SY)		$1,500
Road Crossings (3)		$12,000
	Sub-Total	$221,500

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18th Street Pond Diversion System

Twin 48" R.C.P. (640 LF)		$128,000
Headwalls, Normal (2)		$20,000
Sodding (800 SY)		$1,200
Broad Crested Weir		$10,000
	Sub-Total	$159,200

8th Street

48" R.C.P. (60 LF)		$7,200
Road Crossing (1)		$4,000
Headwalls, Normal (2)		$10,000
	Sub-Total	$21,200

8th Street (Tributary "E")

36" R.C.P. (60 LF)		$5,400
Road Crossing (1)		$4,000
Headwalls, Normal (2)		$5,000
	Sub-Total	$14,400

Meisch Road

21" R.C.P. (60 LF)		$3,000
Road Crossing (1)		$4,000
Headwalls, Normal (2)		$5,000
	Sub-Total	$12,000

Bevier Road

30" Equivalent R.C.P. (60 LF)		$5,700
Road Crossing (1)		$4,000
Headwalls, Normal (2)		$5,000
	Sub-Total	$14,700

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McCracken Road Pond Inlet/Outlet & RR Crossing

50"x 96" Corrugated Metal Arch (100 LF)	$32,500
Road Crossing (1)	$4,000
48" R.C.P. (60 LF)	$15,000
Headwalls, Normal (2)	$20,000
Sodding (300 SY)	$2,000
48" R.C.P. (60 LF)	$15,000
Railroad Crossing (Open Cut)	$15,000
Sodding (200 SY)	$1,500
Headwalls (2)	$10,000
Dixie St Diversion	$5,000
Sub-Total	$120,000

****

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OPINION OF PROBABLE CONSTRUCTION COST:	$2,573,750
25% CONTINGENCY :	$ 643,440
7% FINAL ENGINEERING, SURVEYING & DESIGN:	$ 180,160

****

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* MILL CREEK *

* OPINION OF PROBABLE CONSTRUCTION COST: $3,397,350 *

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6.3 CLOUD BRANCH: OPINION OF PROBABLE CONSTRUCTION COST

The Opinion of Probable Construction Cost for the Stormwater Management Improvements within the Cloud Branch Basin is based on the following results and recommendations outlined in the Cloud Branch Hydrologic/Hydraulic Analyses:

1. Clearing and reshaping of approximately 11,000 linear feet of open drainage-way in the Cloud Branch drainage system so as to produce no appreciable retardance to flow.

2. Miscellaneous road crossings need to either be upgraded or added. The estimate includes pipe and installation costs, headwalls, road repairs, and/or seeding or mulching backfilled utility trenches through yards. However, right-of-way or easement acquisition costs are NOT included.

3. The recommended retention/detention ponds (Coastline Park and 16th Street) are to be utilized for detention/storage to lessen flooding in upstream areas by attenuating the peak flow rate. These opinions of probable construction cost do NOT include the land and/or easement acquisition costs.

4. Piping of Cloud Branch from the proposed Coastline Park Pond to 13th Street. The line will collect stormwater runoff from areas throughout which it passes via stormwater inlets. The opinion of probable construction cost does NOT include right-of-way or easement acquisition or utility relocation, should it become necessary.

CLOUD BRANCH DRAINAGE BASIN

OPINION OF PROBABLE CONSTRUCTION COST

ITEM	COST
CHANNEL CLEANING & REGRADING	
Cloud Branch Channel & Tributaries (10,500 LF)	$39,500
Sodding (5500 SY)	$8,250
Seeding & Mulching (27000 SY)	$9,450
Regrading & excavate new bottom profile (13th St to Coastline Pk), sheeting & shoring as necessary for culvert installation (1500 LF)	$9,000
Sub-Total	$66,200
RETENTION/DETENTION POND SYSTEMS	
(Opinions of Probable Costs do NOT include land and/or easement acquisition costs)	
Coastline Park (12.6 Ac-ft)	$140,000
16th Street (4.0 Ac-ft)	$50,000
Sub-Total	$190,000
PIPING OF CLOUD BRANCH - 13TH ST TO COASTLINE PARK	
(Opinions of Probable Cost do NOT include right-of-way or easement acquisition or utility relocation, should it become necessary)	
5'x 8' Box Culvert (1000 LF)	$300,000
Storm Inlets & Junction Boxes (9)	$45,000
Headwalls (2)	$20,000
Road Crossings (3)	$12,000
Seeding & Mulching (2860 SY)	$1,000
Sheeting & Traffic Control	$100,000
Restoration	$10,000
Sub-Total	$488,000

****

NEW/UPGRADED CULVERT CROSSINGS

(Opinion of Probable Cost does NOT include right-of-way and/or easement aquisition costs

19th Street

48" R.C.P. (60 LF)		$7,200
Road Crossing (1)		$4,000
Headwalls, Normal (2)		$10,000
	Sub-Total	$21,200

16th Street

32 Sq. Ft. Box Culvert (60 LF)		$15,000
Road Crossing (1)		$4,000
Headwalls, Normal (2)		$5,000
	Sub-Total	$24,000

14th Street

32 Sq. Ft. Box Culvert (60 LF)		$15,000
Road Crossing (1)		$4,000
Headwalls, Normal (2)		$5,000
	Sub-Total	$24,000

8th Street

48" R.C.P. (60 LF)		$7,200
Road Crossing (1)		$4,000
Headwalls, Normal (2)		$10,000
	Sub-Total	$21,200

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Railroad Crossing

Twin 48" R.C.P. (300 LF)		$90,000
Railroad Crossing (Open Cut)		$15,000
Headwalls (2)		$20,000
	Sub-Total	$125,000

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OPINION OF PROBABLE CONSTRUCTION COST : $959,600
25% CONTINGENCY : $239,900
7% FINAL ENGINEERING,SURVEYING & DESIGN: $67,172
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* CLOUD BRANCH *
* OPINION OF PROBABLE CONSTRUCTION COST : $1,266,672 *
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APPENDIX A

ICPR FLOOD ROUTING PROCEDURES

AND

STRUCTURE HYDRAULICS

HYDRAULIC COMPUTATIONS

Hydraulic computations in ICPR consist of a flood routing procedure and structure hydraulics. This section provides information on the methods used by ICPR. Input parameters for each of the reach types are also discussed.

Flood Routing Technique

A hydrologic storage routing technique is used which is based on the conservation of mass. Simply stated, the change in storage over some time interval is equal to the inflow minus the outflow. A schematic depicting this relationship is shown in Figure 4, and is expressed in differential form as:

$$dS/dt = I - O \tag{1}$$

where:

dS is the differential storage

dt is the differential time

I is the inflow rate

O is the outflow rate

Equation (1) can be expanded using a central difference formula as:

$$(S_j - S_i)/\Delta t = (I_j + I_i)/2 - (O_j + O_i)/2 \tag{2}$$

where the subscripts i and j represent the beginning and end of time interval Δt. Rearranging equation (2) yields:

$$S_j = [(I_j + I_i)/2 - (O_j + O_i)/2]\Delta t + S_i \tag{3}$$

This equation contains two unknowns; namely, S_j and O_j. However, outflow is typically a nonlinear function of storage, which reduces equation (3) to one equation and one unknown.

Solution of equation (3) can be implemented using both iterative and direct techinques. The approach used herein is to linearize equation (3) by assuming the outflow, O_j, is approximately equal to O_i. Thus,

$$S_j = [(I_j + I_i)/2 - O_i]\Delta t + S_i \tag{4}$$

Direct solution for storage, S_j is possible with the continuity

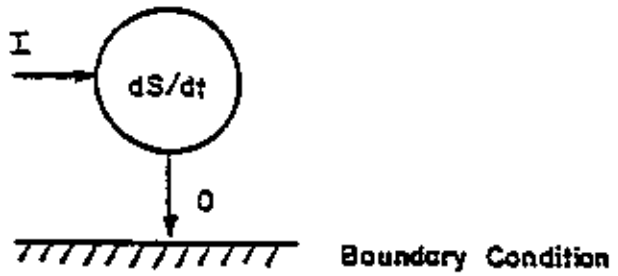
equation expressed in this form. Stage elevations at time t_j can be determined from the storage, S_j, and stage/storage characteristics of the pond being analyzed. Outflow, O_j, can be evaluated once the stage at time t_j is determined. Malcom and New have checked this method against more precise methods, and found departures of no more than two to three percent.

Flood routing through interconnected ponds is achieved by expanding on the concepts presented thus far. The continuity equation must be written for individual ponds as shown in Figure 4b and then expressed in appropriate difference form. Discharges from each outfall are approximated from respective flows obtained at the previous time, t_i. Storage volumes are then computed from known inflows and approximated outflows. Resulting stage elevations are determined from stage-storage characteristics of each pond. Updated flow rates are computed at time t_j by relating upstream and downstream stage elevations to hydraulic characteristics of respective connecting reaches. Functions describing outflow depend on outfall type and flow regime and will be discussed subsequently.

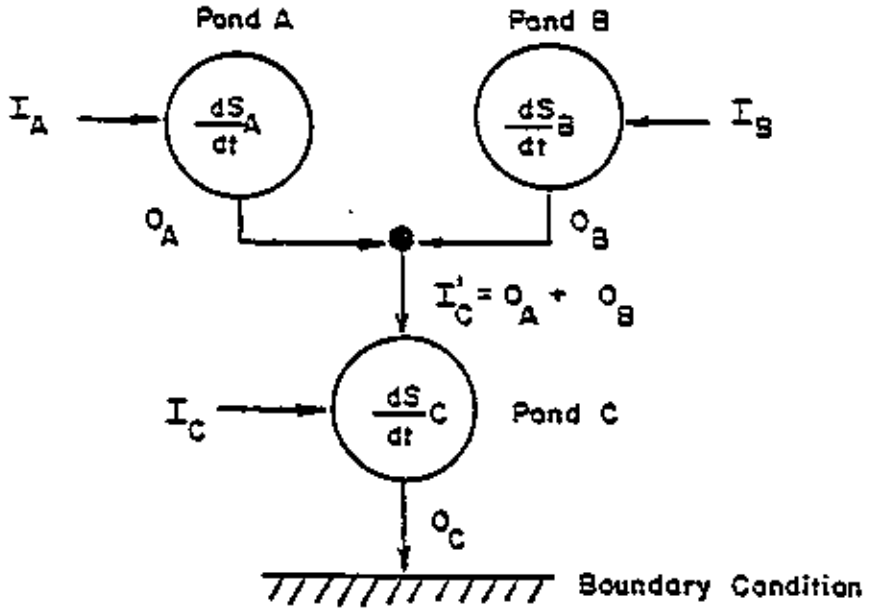
The number of outfalls leaving a particular pond does not increase the number of equations or unknowns. The continuity equation is written for each pond with a summation of inflows and outflows performed for each. A boundary condition is established when storage at a particular location is independent of flows to it. Stage-time relationships must be provided at these points.

The approach presented allows for any number of ponds (within hardware limitations) to be connected in any fashion.

Multiple boundary conditions can also be specified which allows flow to leave the system from more than one point.



4c. Single - Pond Schematic



4b. Triple - Pond Schematic

Figure 4. Pond System Schematics.

Weirs, Gates and Orifices

ICPR combines input requirements for weirs, gates and circular orifices because of similarities in hydraulic calculations. A weir is simply a special case of a gate while gates behave as either a weir or an orifice. Circular orifices, such as bleeders, are considered to be a separate outlet with discharges added to that of the weir or gate. This arrangement forms a compound structure as depicted in Figure 5. The user has the flexibility of using either an orifice or a weir/gate or both depending on how the input is specified. This will become clear in the following discussion.

Weirs can be either sharp crested or broad crested, each being affected differently by tailwater conditions. Tailwater conditions reduce flows over a sharp crested weir as soon as downstream stages exceed the weir crest. However, broad crested weirs may not be affected until the downstream head, h_2, is about 67% that of the upstream head, h_1 where, h_1 and h_2 are shown in Figure 6. The general equation for flow over a weir, assuming free tailwater, is

$$Q^* = CA(2gh_1)^{1/2} \tag{5}$$

where:

- Q^* is the flow (cfs) for free tailwater conditions
- C is a coefficient of discharge
- A is the cross-sectional area (sq ft)
- g is the gravitational constant (32.16 fps^2)
- h_1 is the head above the weir crest (ft)

The cross-sectional area for rectangular weirs is simply the

length, L, times the depth, h_1. This reduces equation (5) to the following form:

$$Q^* = C^* L h_1^{3/2} \tag{6}$$

where: $C^* = C(2g)^{1/2}$ (7)

Appropriate values for C* can be found in King and Brater.[11]

End contractions are also of concern for weir flow and can be included by adjusting the weir length, L.

$$L^* = L(1 - 0.1 n h_1) \tag{8}$$

where: n is the number of end contractions.

ICPR generalizes equation (5) as follows:

$$Q^* = C^* (L - 0.1 n h_1) h_1^e \tag{9}$$

The following parameters must be specified for weir flow:

1. Crest elevation (ft)
2. Crest length, L (ft)
3. Discharge coefficient, C*
4. Weir exponent, e
5. Number of end contractions, n

Equation (9) can be used to accommodate V-notch weirs by adjusting L and e appropriately. The cross-sectional area of flow for a triangle can be expressed as:

$$A = h_1^2 \tan(\theta/2) \tag{10}$$

where: θ is the vertex angle of the "V"

Substituting equation (10) into equation (5) yields

$$Q^* = C^* \tan(\theta/2) h_1^{5/2} \tag{11}$$

Therefore, equation (9) can be used for V-notch weirs by setting

$L = \tan(\theta/2)$

$n = 0$

$e = 2.5$

Another consideration of weir flow is the effect of submergence. King and Brater[11] present the following submergence correction for all sharp-crested weirs:

$$Q = Q^* [1 - (h_2/h_1)^e]^{0.385} \quad (12)$$

where: Q is the reduced flow in cfs.

ICPR assumes that sharp-crested weirs are affected by tailwater (i.e., flow reduced) as soon as h_2 rises above the weir crest.

Venard[12] and Fread[13] use the following correction for tailwater influenced broad-crested weirs:

$$Q = Q^* [1 - 27.8 (h_2/h_1 - P)^3] \quad (13)$$

This correction is applied only after h_2/h_1 exceeds 0.67.

Gates act hydraulically as weirs until h_1 exceeds the gate opening, D, as shown in Figure 5. Orifice flow is then assumed for this condition with the flow equation expressed as:

$$Q_g = C_g A_g (2gh)^{\frac{1}{2}} \quad (14)$$

where: Q_g is the flow (cfs)

C_g is the discharge coefficient of the gate under orifice flow

A_g is the cross-sectional area of the gate (L x D)

h is the net head ($h_1 - h_2$) in the feet on the gate, measured from the center of the gate opening.

ICPR requires two more parameters when describing a gate. Namely:

6. Gate opening, D, in feet

7. Discharge coefficient, C_g, of the gate under orifice flow

A gate opening must be specified. If the user desires to model a weir condition only, then a large gate opening (say 999 feet) is specified such that the gate opening never becomes submerged. A gate opening of zero will result in a no flow condition since the gate is literally "closed". This approach is used to model a circular orifice without weir/gate flow as will be discussed below.

The equation for flow through a circular orifice is similar to equation (14) except the cross-sectional area is geometrically different and ICPR assumes no flow occurs through the orifice(s) for stages below the orifice centerline. The input parameters include:

8. Centerline elevation, feet
9. Orifice diameter, feet
10. Circular orifice discharge coefficient
11. Number of identical orifices

The circular orifice option can be "shut off" by setting the centerline elevation well above the expected flood stage elevations (say 999 feet). Since stages remain below the centerline, flow through the orifice will be zero and the total flow will be through the weir/gate only. However, should the gate opening be set to zero and the centerline elevation be in the range of anticipated flood stages, flow will be through the circular orifice only. Otherwise, flow will be computed as the composite of weir/gate and orifice discharges.

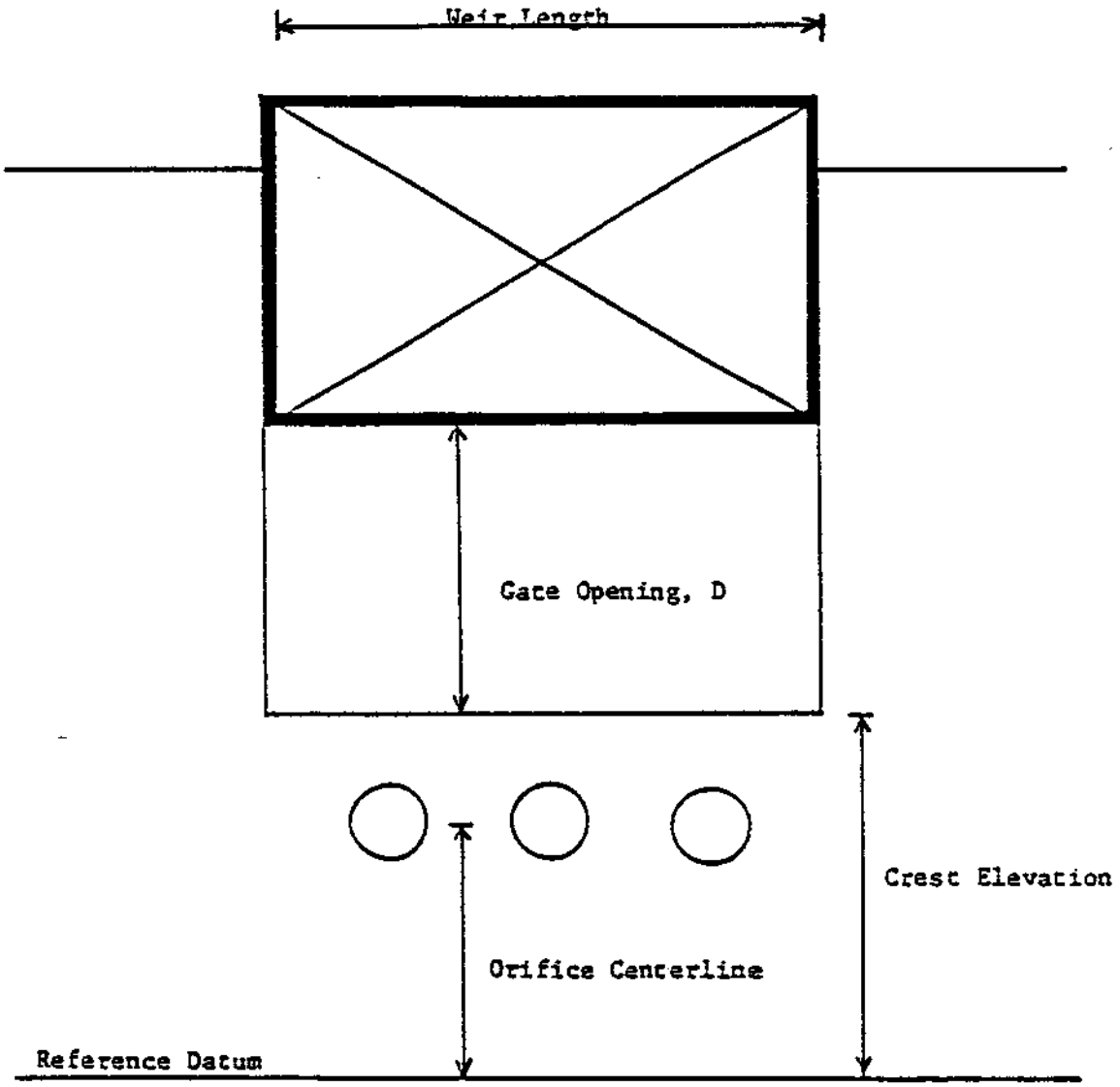
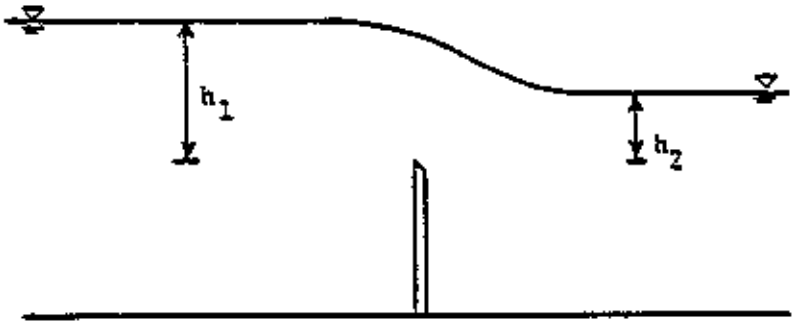
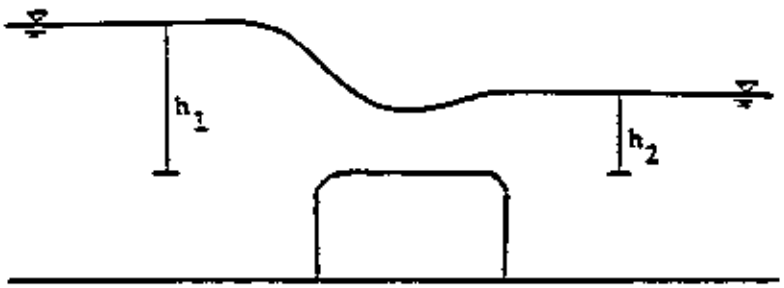


Figure 5. Typical Weir/Gate and Orifice Structure.



Sharp-Crested Weir



Broad-Crested Weir

Figure 6. Weir Structures.

Culvert Hydraulics

Culvert flow poses an interesting and challenging problem for many reasons. A wide range of flow regimes can occur depending on flow rate, bed slope and cross-sectional geometry among others. A computer program or sub-program designed to solve the hydraulics of culverts must be general enough to handle a wide range of flow conditions as well as cross-sectional configurations. ICPR addresses the following eight major conditions:

1. Sub critical flow, outlet unsubmerged and tailwater below critical depth.
2. Sub-critical flow, outlet unsubmerged and tailwater above critical depth
3. Sub-critical flow, outlet submerged and tailwater less than headwater crown
4. Sub-critical flow, outlet submerged and tailwater greater than headwater crown
5. Super-critical flow, outlet unsubmerged and tailwater less than critical depth at inlet
6. Super-critical flow, outlet unsubmerged and tailwater greater than critical depth at inlet
7. Super-critical flow, outlet submerged and tailwater less than headwater crown
8. Super-critical flow, outlet submerged and tailwater greater than headwater crown

Each of these cases are depicted in Figure 7 with corresponding hydraulic calculations presented below.

Procedures for Culvert Headwater Calculations

Case 1 1. Starting at y = dc at outlet, carry out flow

profile analysis to find y_e at entrance

2. Compute headwater from:

$$HW = y_e + \frac{v_e^2}{2g}(\alpha + C_e) + HWINV$$

<u>Case 2</u>

1. Starting at $y = y_{TW}$ at outlet, carry out flow profile to find y_e at entrance
2. Compute headwater from:

$$HW = y_e + \frac{v_e^2}{2g}(\alpha + C_e) + HWINV$$

<u>Case 3</u>

1. Determine point at which TW intersects pipe crown
2. Compute friction losses in lower portion of pipe and add to TW
3. Determine new point of intersection with friction losses added
4. Carry out flow profile to find y_e at entrance
5. Compute headwater from:

$$HW = y_e + \frac{v_e^2}{2g}(\alpha + C_e) + HWINV$$

<u>Case 4</u>

1. Assume pressure flow and compute HW using Bernoulli's equation:

$$HW = (\alpha + C_e)\frac{V^2}{2g} + (S_f - S_o)L + y_{TW} + HWINV$$

<u>Case 5</u>

1. Set $y_e = d_c$ at inlet
2. Compute headwater from:

$$HW = y_e + \frac{v_e^2}{2g}(\alpha + C_e) + HWINV$$

<u>Case 6</u> Same procedure as Case 2

<u>Case 7</u> Same procedure as Case 3

<u>Case 8</u> Same procedure as Case 4

NOTES:

1. is an energy loss coefficient which accounts for the nonlinear velocity distribution in a pipe. This is typically assumed to be 1.0.

2. C_e is an entrance loss coefficient dependent on inlet geometry.

3. S_f is the friction slope as computed by Manning's equation.

4. V is the mean velocity in a pipe flowing full and V_e is the mean entrance velocity.

5. HWINV is the headwater invert elevation.

6. Bernoulli's equation is used in Cases 1, 2 and 3 when the pipe is flowing full through a portion of its length, L.

7. Flow profiles are performed using the direct step method.[1]

ICPR requires the following input parameters for culverts:

1. Culvert Type

   1 for circular or elliptical
   2 for arch
   3 for box

Geometry for circular and elliptical pipes are based on internal data tables. Values used for arch pipes reflect CMPA 2-2/3 " x 1/2" corrugations, but appear to work well for other arch sections.

2. Culvert span and rise (inches)

3. Length (feet)

4. Manning's n

5. Headwater invert elevations (feet)

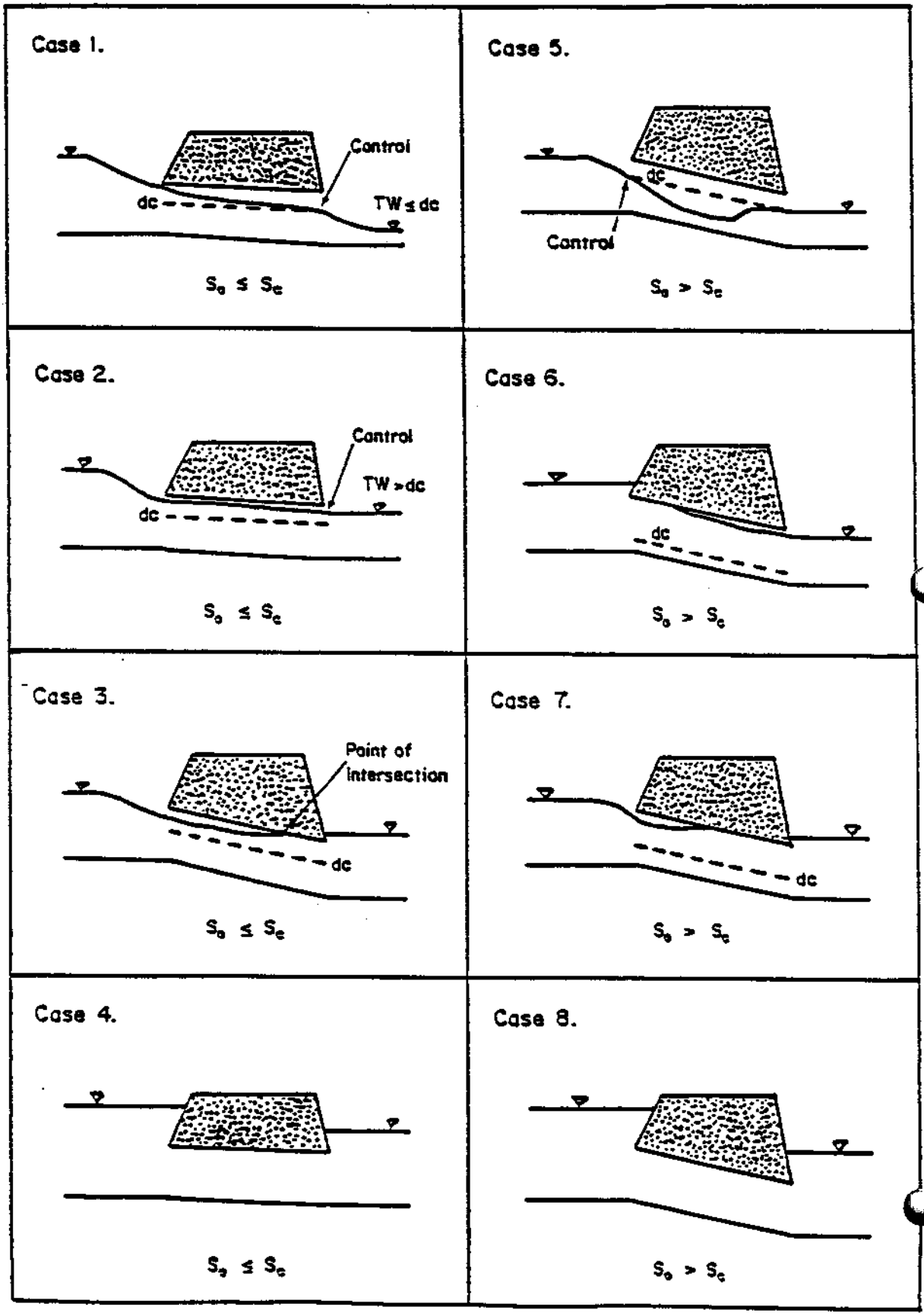
6. Tailwater invert elevations (feet)

7. Energy loss coefficient (usually 1.0)

8. Entrance loss coefficient

9. Number of idential culverts

Positive, zero and adverse slopes are accommodated as well as back flow through culverts.


Case 1.
Control
dc
TW ≤ dc
$S_o \leq S_c$
Case 5.
dc
Control
$S_o > S_c$
Case 2.
Control
TW > dc
dc
$S_o \leq S_c$
Case 6.
dc
$S_o > S_c$
Case 3.
Point of Intersection
dc
$S_o \leq S_c$
Case 7.
dc
$S_o > S_c$
Case 4.
$S_o \leq S_c$
Case 8.
$S_o > S_c$

Channels

ICPR currently allows trapezoidal and parabolic channels. Channel hydraulics are similar to open channel conditions in culverts with geometry being the primary difference. ICPR uses the direct step method to perform backwater computations through the reach. This method computes a distance upstream (for sub-critical flow) given an incremental depth. The incremental depth is implicitly specified by the user by indicating a maximum depth in the channel and backwater depth increment ratio. This ratio is multiplied (internally) by the maximum depth to obtain an incremental depth for backwater calculations. The incremental depth should typically be about 0.1 feet or less. As this increment decreases, execution time increases since more "steps" are required in backwater computations. The user is advised to experiment with this parameter to become familiar with its sensitivity and limitations.

The maximum channel depth should be specified such that it is never exceeded during a given run. The user should adjust this parameter such that the maximum depth is not exceeded since erroneous results may appear undetected in output report.

Input requirements are otherwise similar to culverts. Trapezoidal channels require a bottom width and side slopes as opposed to span and rise while parabolic channels require a top width and corresponding depth. Both trapezoidal and parabolic channels, as with culverts, are assumed to be prismatic.

Risers

Risers, as referred to herein, consist of a weir in series with either a culvert or channel as depicted in Figure 8. The weir is assumed to be at the upstream end of the culvert/channel and flow reversal is not permitted. Flow through riser systems may be either weir controlled, culvert controlled or a combination of both. ICPR checks for each of these conditions through an iterative procedure which adjusts for weir submergence caused by head losses through the culvert barrel. Weir flow uses the sharp-crested formula (Equation 12). Culvert/channel hydraulics are as discussed. This option can be used to model box inlets as well as drop inlets.

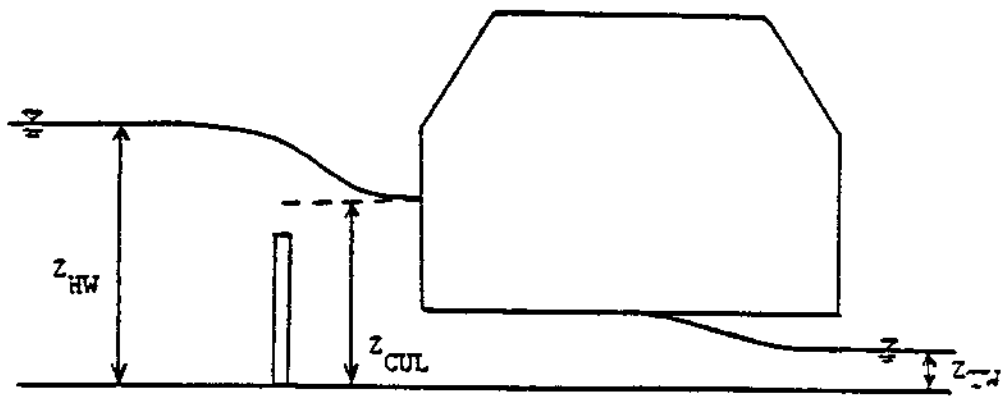


Figure 8. Schematic of Riser Structure.

Rating Curves

Rating curves are typically used in the more traditional pond routing techniques. A relationship is formed between pond stage and discharge with rating curves. ICPR treats rating curves as being totally independent of downstream effects, with flow a function of stage only and backflow not permitted. Calculations are simple and fast as opposed to culverts/channels and risers. A culvert under free or constant tailwater conditions can be rated one time, with the rating curve used for subsequent routings. This decreases run time drastically.

ICPR limits the number of points in a rating curve to eight. This limitation is easily overcome by simply using two reaches to define one curve. For instance, assume that Pond A discharges to Boundary B according to the following eleven point rating curve:

Stage (ft)	Discharge (cfs)
80	0
81	5
82	11
83	17
84	21
85	30
86	42
87	56
88	73
89	91
90	110

This curve must be broken up into two separate curves such that the composite of the two is equivalent to the original curve. This individual curve must also be defined in 8 points or less. This is done as follows:

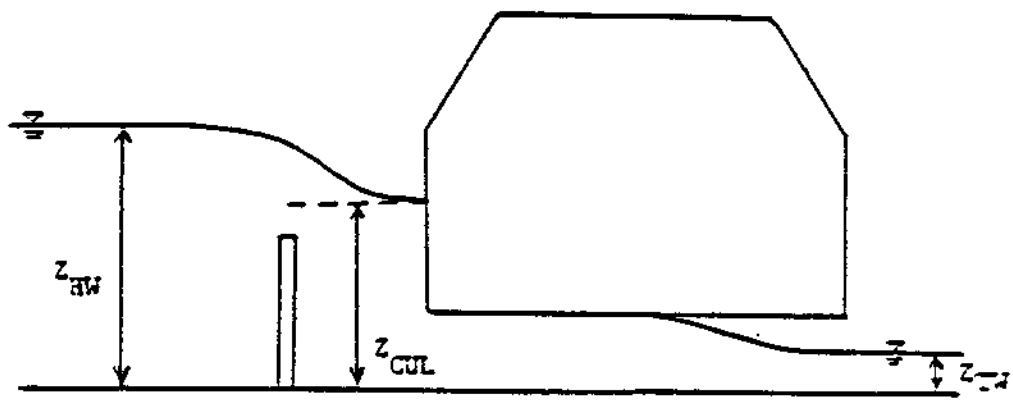


Figure 8. Schematic of Riser Structure.

Rating Curves

Rating curves are typically used in the more traditional pond routing techniques. A relationship is formed between pond stage and discharge with rating curves. ICPR treats rating curves as being totally independent of downstream effects, with flow a function of stage only and backflow not permitted. Calculations are simple and fast as opposed to culverts/channels and risers. A culvert under free or constant tailwater conditions can be rated one time, with the rating curve used for subsequent routings. This decreases run time drastically.

ICPR limits the number of points in a rating curve to eight. This limitation is easily overcome by simply using two reaches to define one curve. For instance, assume that Pond A discharges to Boundary B according to the following eleven point rating curve:

Stage (ft)	Discharge (cfs)
80	0
81	5
82	11
83	17
84	21
85	30
86	42
87	56
88	73
89	91
90	110

This curve must be broken up into two separate curves such that the composite of the two is equivalent to the original curve. This individual curve must also be defined in 8 points or less. This is done as follows:

REACH #1 (from A to B)		REACH #2 (from A to B)	
Stage (ft)	Discharge (cfs)	Stage (ft)	Discharge (cfs)
80	0	80	0
81	5	86	0
82	11	87	14
83	17	88	31
84	21	89	49
85	30	90	68
86	42		
90	42		

Flow at elevation 87 would be computed by ICPR in two parts. The first would be 42 cfs from Reach #1 and the second would be 14 cfs from Reach #2. The total discharge from A to B would be 56 cfs, which corresponds to the original 11-point rating curve. This technique could be extended to include any number of points if need be.

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APPENDIX B

NODAL CROSS SECTIONS

FOR THE

MILL CREEK & CLOUD BRANCH DRAINAGE BASINS

NODE	STAGE (FMSL)	DEPTH (FT)	STORAGE (FT^3)	(AC-FT)
	29.86	0.0	0	0.00
	30.86	1.0	4,487	0.10
100	31.86	2.0	12,589	0.29
	32.86	3.0	21,606	0.50
	33.86	4.0	32,409	0.74
	24.50	0.0	0	0.00
	25.50	1.0	7,579	0.17
	26.50	2.0	35,806	0.82
200	27.50	3.0	78,452	1.80
	28.50	4.0	134,470	3.09
	29.50	5.0	204,863	4.70
	30.50	6.0	286,363	6.57
	31.50	7.0	379,974	8.72
	26.00	0.0	0	0.00
	27.00	1.0	958	0.02
	28.00	2.0	4,356	0.10
210	29.00	3.0	11,238	0.26
	30.00	4.0	21,432	0.49
	31.00	5.0	36,721	0.84
	26.14	0.0	0	0.00
	27.14	1.0	261	0.01
	28.31	2.2	1,220	0.03
220	29.31	3.2	1,525	0.04
	30.31	4.2	6,360	0.15
	31.31	5.2	15,725	0.36
	32.31	6.2	29,621	0.68
	24.00	0.0	0	0.00
300	25.00	1.0	950,044	21.81
	26.00	2.0	1,950,181	44.77
	27.00	3.0	3,000,413	68.88
	10.99	0.0	0	0.00
	11.99	1.0	1,481	0.03
	12.99	2.0	6,621	0.15
400	13.99	3.0	15,551	0.36
	14.99	4.0	29,142	0.67
	15.99	5.0	49,179	1.13
	16.99	6.0	75,577	1.74
	17.99	7.0	110,555	2.54
	20.17	0.0	0	0.00
	21.17	1.0	4,792	0.11
410	22.17	2.0	13,678	0.31
	23.17	3.0	33,280	0.76
	24.17	4.0	60,853	1.40
	25.17	5.0	93,262	2.14

TABLE B-1. MILL CREEK HYDRAULIC SIMULATION: EXISTING NODAL GEOMETRIES

NODE	STAGE (FMSL)	DEPTH (FT)	STORAGE (FT^3)	STORAGE (AC-FT)
	8.49	0.0	0	0.00
	9.49	1.0	121,881	2.80
	10.49	2.0	250,601	5.75
600	11.49	3.0	381,411	8.76
	12.49	4.0	513,790	11.80
	13.49	5.0	648,303	14.88
	14.49	6.0	784,385	18.01
	25.32	0.0	0	0.00
	26.32	1.0	3,006	0.07
610	27.32	2.0	14,393	0.34
	28.32	3.0	32,583	0.75
	29.32	4.0	54,581	1.25
	30.32	5.0	80,586	1.85
	22.80	0.0	0	0.00
	23.80	1.0	3,006	0.07
620	24.80	2.0	10,193	0.23
	25.80	3.0	39,117	0.90
	26.80	4.0	71,395	1.64
	27.80	5.0	107,114	2.46
	21.30	0.0	0	0.00
625	22.30	1.0	217,800	5.00
	23.30	2.0	461,736	10.60
	24.30	3.0	729,630	16.75
	20.74	0.0	0	0.00
	21.74	1.0	1,263	0.03
	22.74	2.0	8,276	0.19
630	23.74	3.0	26,964	0.62
	24.74	4.0	60,984	1.40
	25.74	5.0	107,201	2.46
	26.74	6.0	160,517	3.69
	18.32	0.0	0	0.00
	19.32	1.0	2,309	0.05
	20.32	2.0	11,151	0.26
	21.32	3.0	26,136	0.60
640	22.32	4.0	44,126	1.01
	23.32	5.0	65,122	1.50
	24.32	6.0	95,963	2.20
	25.32	7.0	113,123	2.60
	26.32	8.0	141,134	3.24
	26.97	0.0	0	0.00
650	27.97	1.0	8,189	0.19
	28.97	2.0	20,343	0.47
	29.97	3.0	33,715	0.77

TABLE B-1 (Cont'd). MILL CREEK HYDRAULIC SIMULATION: EXISTING NODAL GEOMETRIES

NODE	STAGE (FMSL)	DEPTH (FT)	STORAGE (FT^3)	STORAGE (AC-FT)
	20.35	0.0	0	0.00
	21.35	1.0	1,786	0.04
	22.35	2.0	8,276	0.19
660	23.35	3.0	22,825	0.52
	24.35	4.0	46,043	1.06
	25.35	5.0	84,550	1.94
	26.35	6.0	139,044	3.19
	27.35	7.0	219,804	5.05
	11.13	0.0	0	0.00
	13.13	2.0	3,354	0.08
	15.13	4.0	22,608	0.52
670	17.13	6.0	69,348	1.59
	19.13	8.0	186,088	4.27
	21.13	10.0	294,396	6.76
	23.13	12.0	424,100	9.74
	25.13	14.0	574,600	13.19
	4.98	0.0	0	0.00
	5.98	1.0	3,703	0.09
	6.98	2.0	16,379	0.38
	7.98	3.0	38,899	0.89
700	8.98	4.0	72,745	1.67
	9.98	5.0	115,652	2.66
	10.98	6.0	160,214	3.68
	11.98	7.0	211,353	4.85
	12.98	8.0	267,458	6.14
	4.50	0.0	0	0.00
	5.50	1.0	9,148	0.21
	6.50	2.0	20,691	0.48
800	7.50	3.0	33,890	0.78
	7.50	4.0	48,177	1.11
	9.50	5.0	63,598	1.46
	10.50	6.0	80,107	1.84
	11.50	7.0	97,705	2.24
	3.02	0.0	0	0.00
	5.02	2.0	17,250	0.40
900	7.02	4.0	56,454	1.30
	9.02	6.0	106,853	2.45
	11.97	9.0	201,334	4.62
	0.50	0.0	0	0.00
	2.00	1.5	48,177	1.11
1000	4.00	3.5	172,498	3.96
	6.00	5.5	329,617	7.54
	8.00	7.5	500,722	11.50

TABLE B-1 (Cont'd). MILL CREEK HYDRAULIC SIMULATION: EXISTING NODAL GEOMETRIES.

STAGE (FMSL)	DEPTH (FT)	AREA (FT)	LENGTH (FT)	STORAGE (AC-FT)
NODE 1400				
2.26	0.00	0	0	0.000
3.26	1.00	15	100	0.017
4.26	2.00	32	290	0.085
5.26	3.00	52	310	0.185
6.26	4.00	75	410	0.353
7.26	5.00	100	500	0.574
8.93	6.67	147	610	1.029
10.26	8.00	190	610	1.631
12.26	10.00	250	610	2.471
NODE 1300				
8.25	0.00	0	0	0.000
9.25	1.00	8	210	0.019
10.25	2.00	20	400	0.092
11.25	3.00	35	550	0.221
13.25	5.00	72	900	0.744
15.25	7.00	122	1250	1.751
NODE 1200				
15.67	0.00	0	0	0.000
16.67	1.00	4	270	0.013
18.17	2.50	14	530	0.085
19.17	3.50	31	530	0.292
20.67	5.00	69	530	0.754
21.67	6.00	96	530	1.083
23.67	8.00	155	530	1.801
NODE 1100				
17.56	0.00	0	0	0.000
18.56	1.00	11	310	0.039
19.56	2.00	25	640	0.184
21.56	4.00	58	770	0.767
23.56	6.00	100	770	1.509
24.56	7.00	126	770	1.969
NODE 1000				
19.81	0.00	0	0	0.000
20.81	1.00	13	340	0.051
21.81	2.00	29	720	0.240
22.81	3.00	47	740	0.546
23.81	4.00	67	740	0.885
24.81	5.00	90	740	1.276
25.81	6.00	116	740	1.718
26.31	6.50	132	740	1.989
NODE 700				
21.95	0.00	0	0	0.000
22.95	1.00	8	290	0.026
23.95	2.00	17	1990	0.388
24.95	3.00	28	1990	0.640
25.95	4.00	39	1990	1.142
26.95	5.00	52	1990	1.736
27.95	6.00	67	1990	2.421
28.95	7.00	82	1990	8.806
NODE 400				
24.75	0.00	0	0	0.000
25.75	1.00	9	140	0.015
26.75	2.00	19	300	0.083
28.75	4.00	42	300	0.242
NODE 300				
26.88	0.00	0	0	0.000
27.88	1.00	13	800	0.120
28.88	2.00	28	1630	0.524
29.88	3.00	48	1630	1.272
30.88	4.00	68	1630	2.021

TABLE B-2. CLOUD BRANCH HYDRAULIC SIMULATION: EXISTING NODAL GEOMETRIES

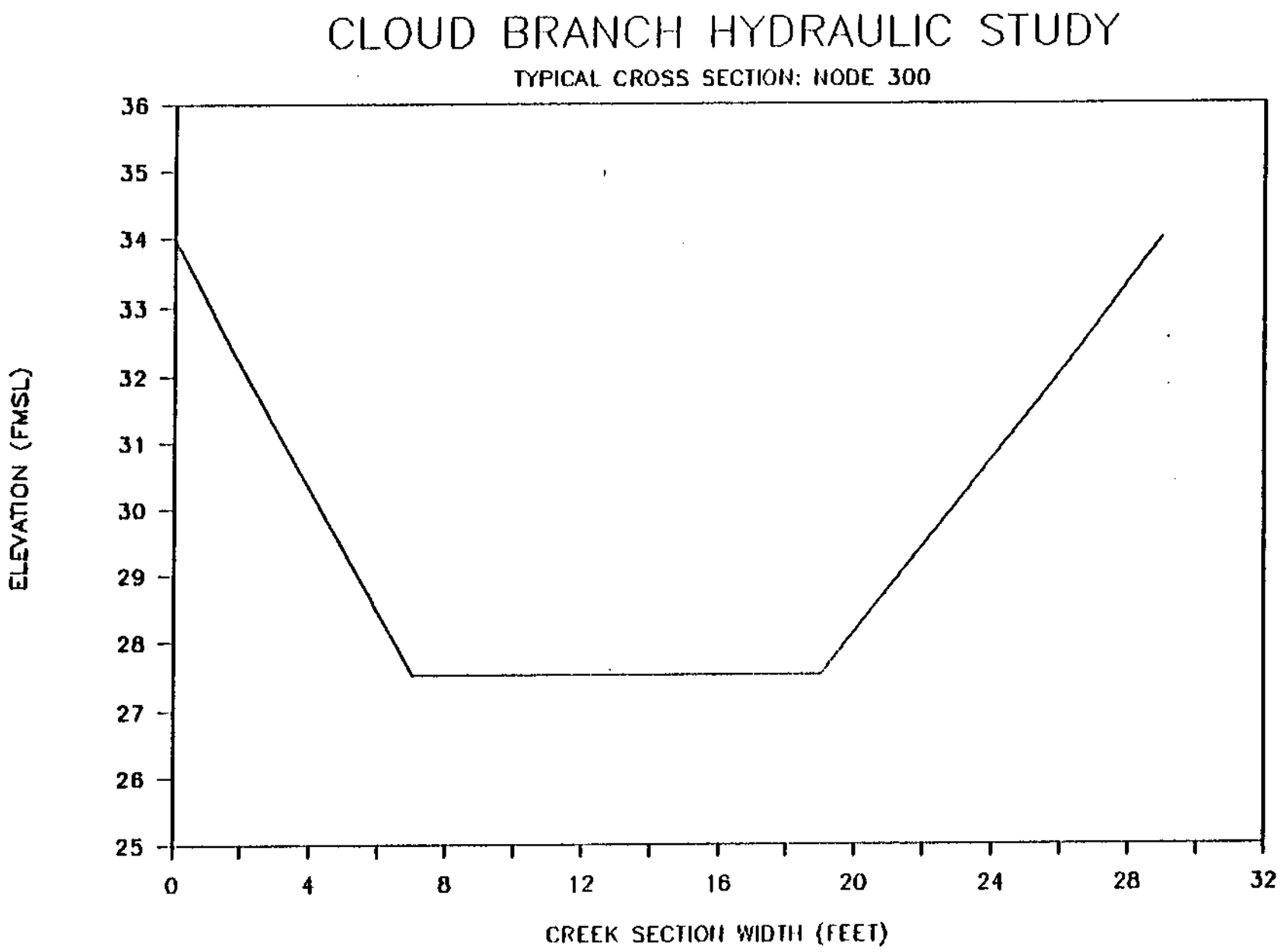


FIGURE B-1. TYPICAL CROSS SECTION IN THE CLOUD BRANCH DRAINAGE BASIN: NODE 300 (Pinehurst Park to 20th Street)

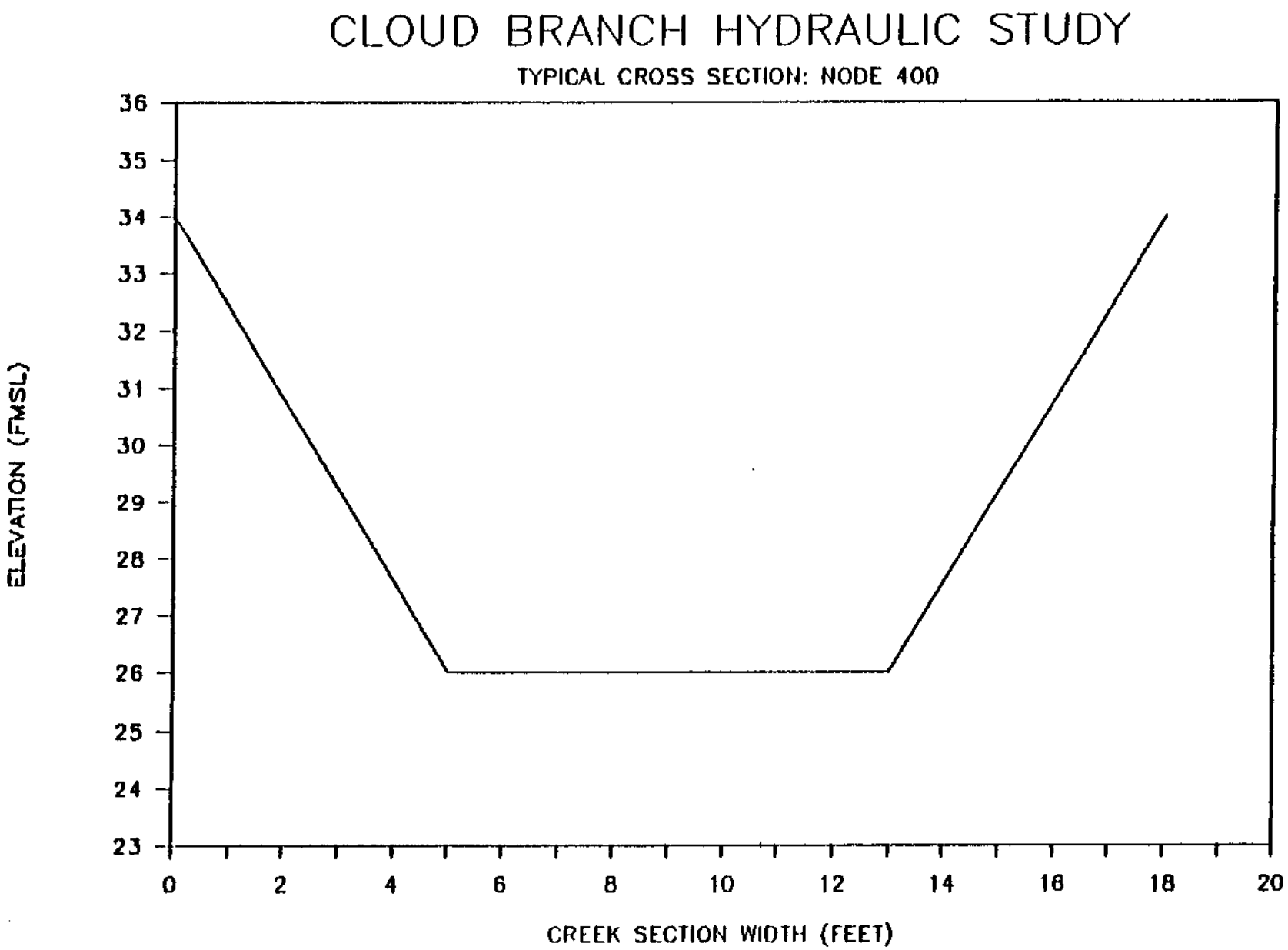


FIGURE B-2. TYPICAL CROSS SECTION IN THE CLOUD BRANCH DRAINAGE BASIN: NODE 400 (20th Street to 19th Street)

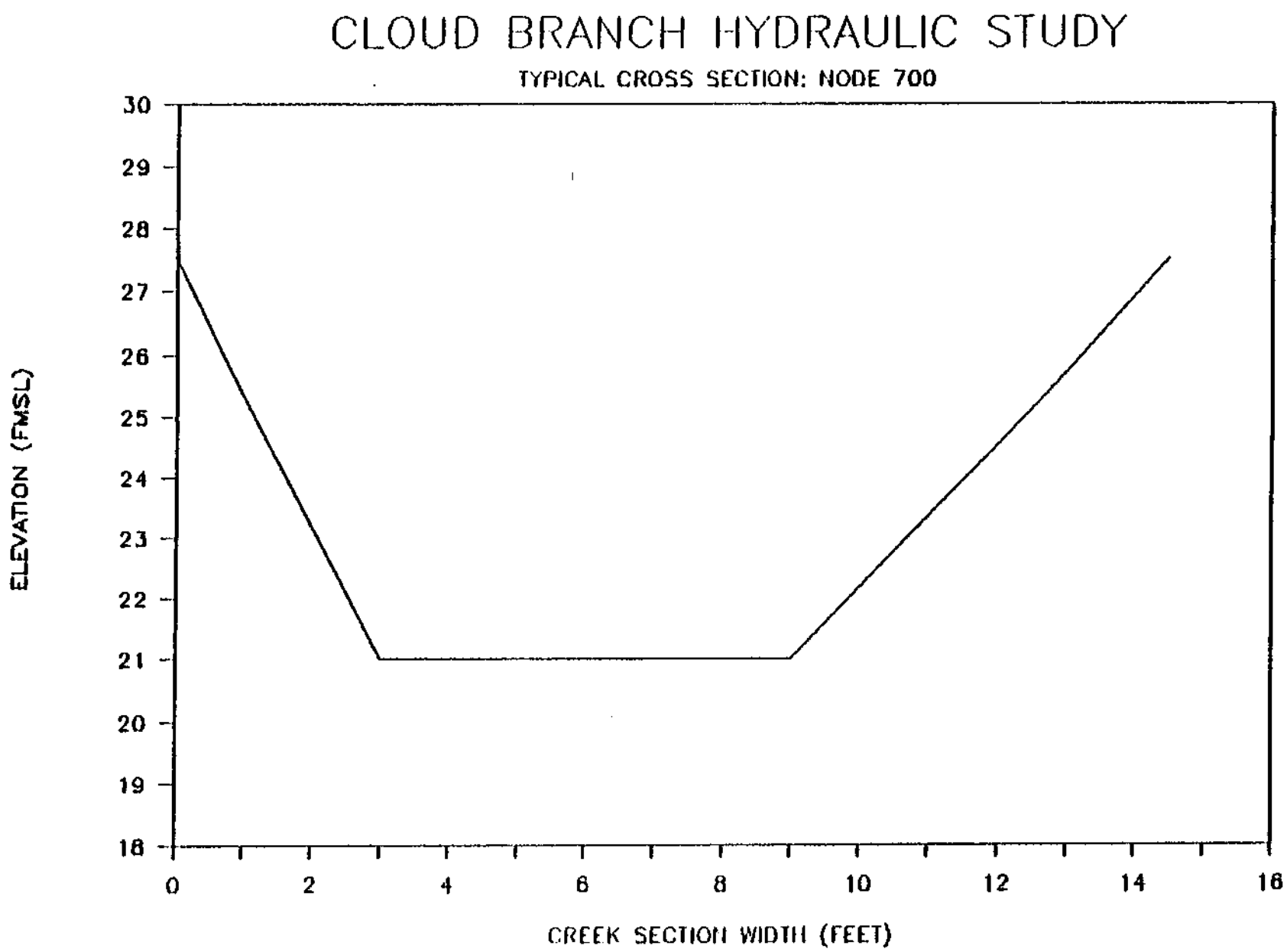
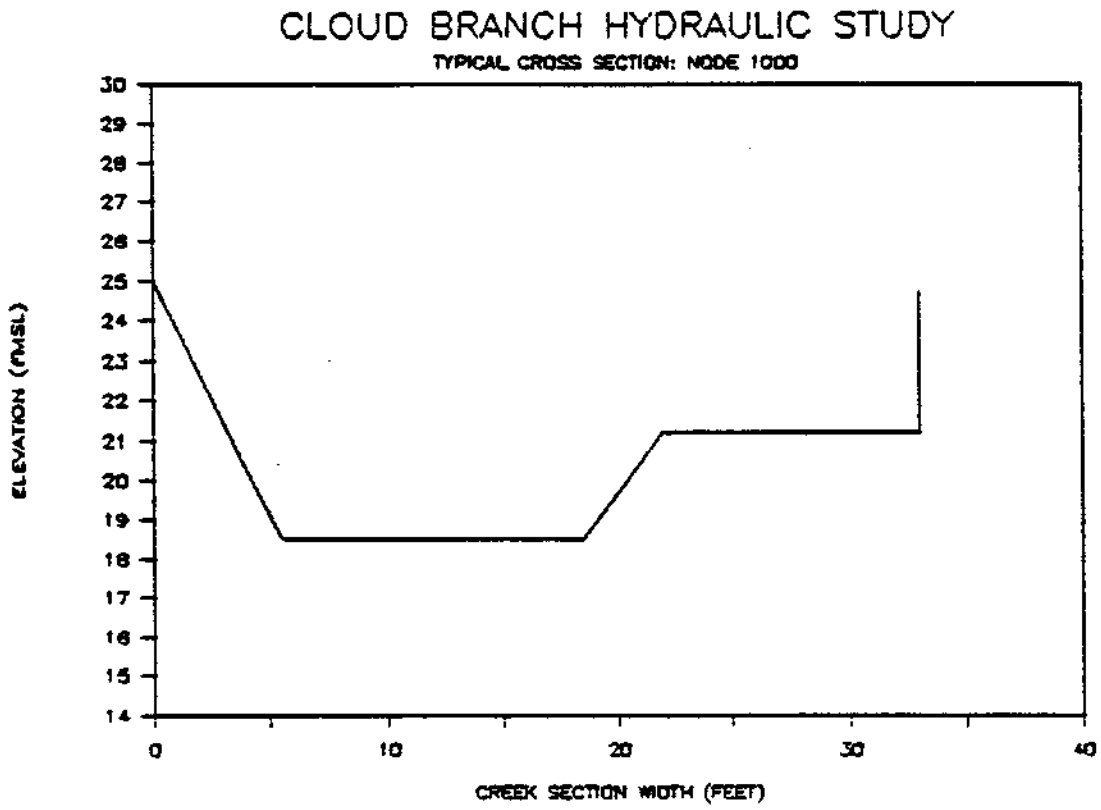


FIGURE B-3. TYPICAL CROSS SECTION IN THE CLOUD BRANCH DRAINAGE BASIN: NODE 700 (19th Street to 13th Street)



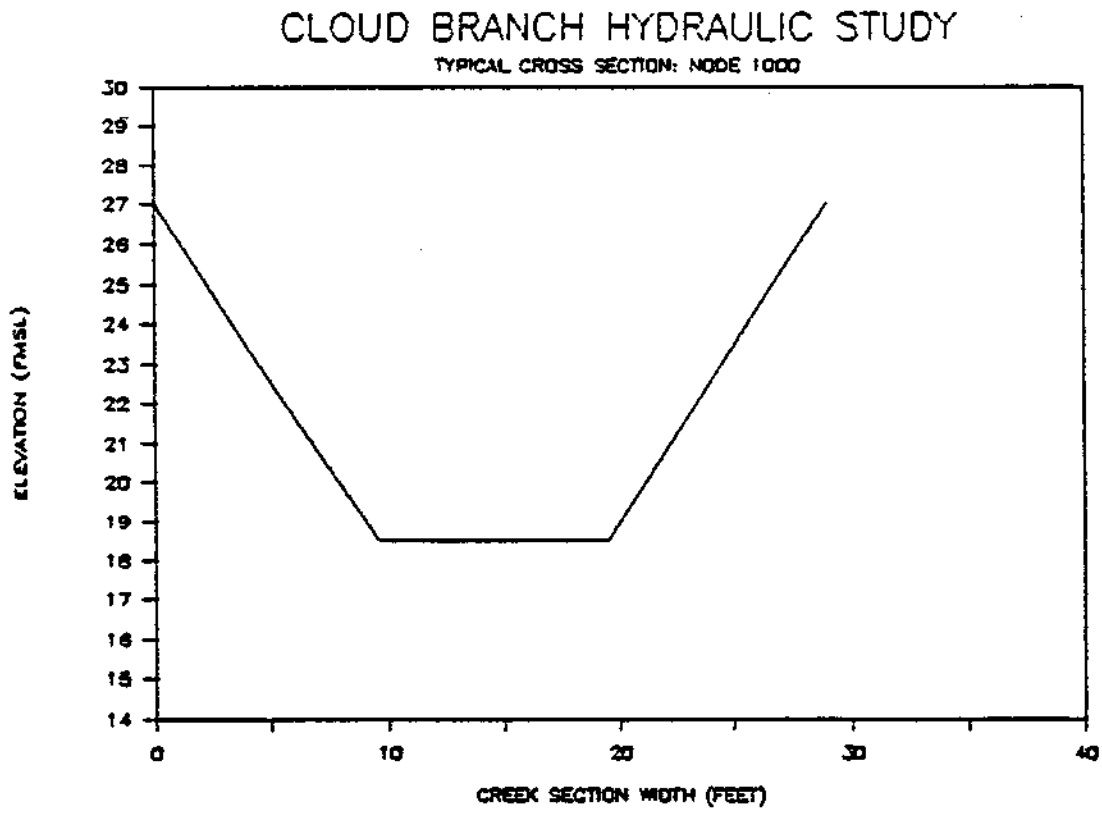


FIGURE B-4. TYPICAL CROSS SECTIONS IN THE CLOUD BRANCH DRAINAGE BASIN: NODE 1000 (13th Street to 10th Street)

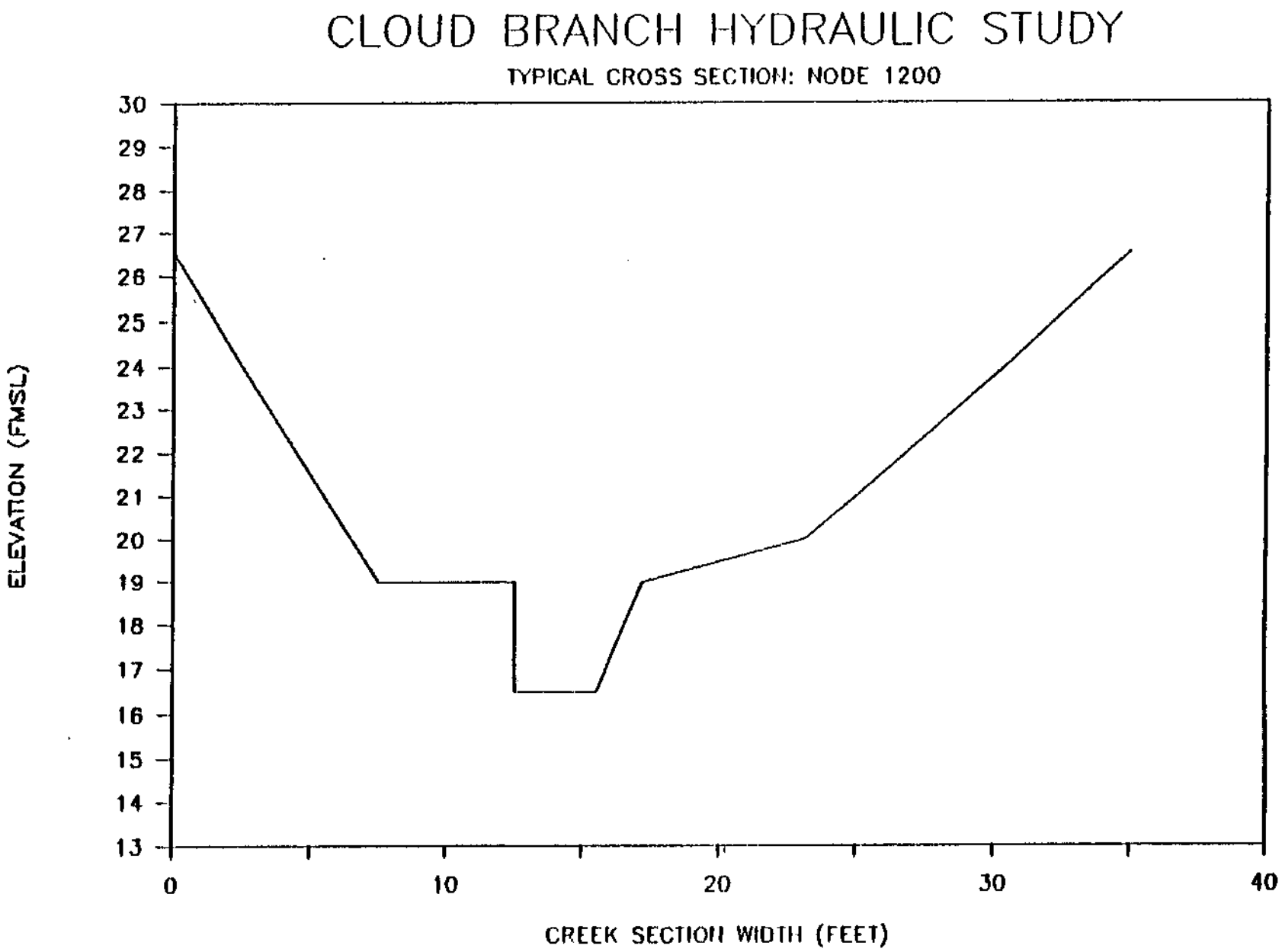


FIGURE B-6. TYPICAL CROSS SECTION IN THE CLOUD BRANCH DRAINAGE BASIN: NODE 1200 (8th Street to 6th Street)

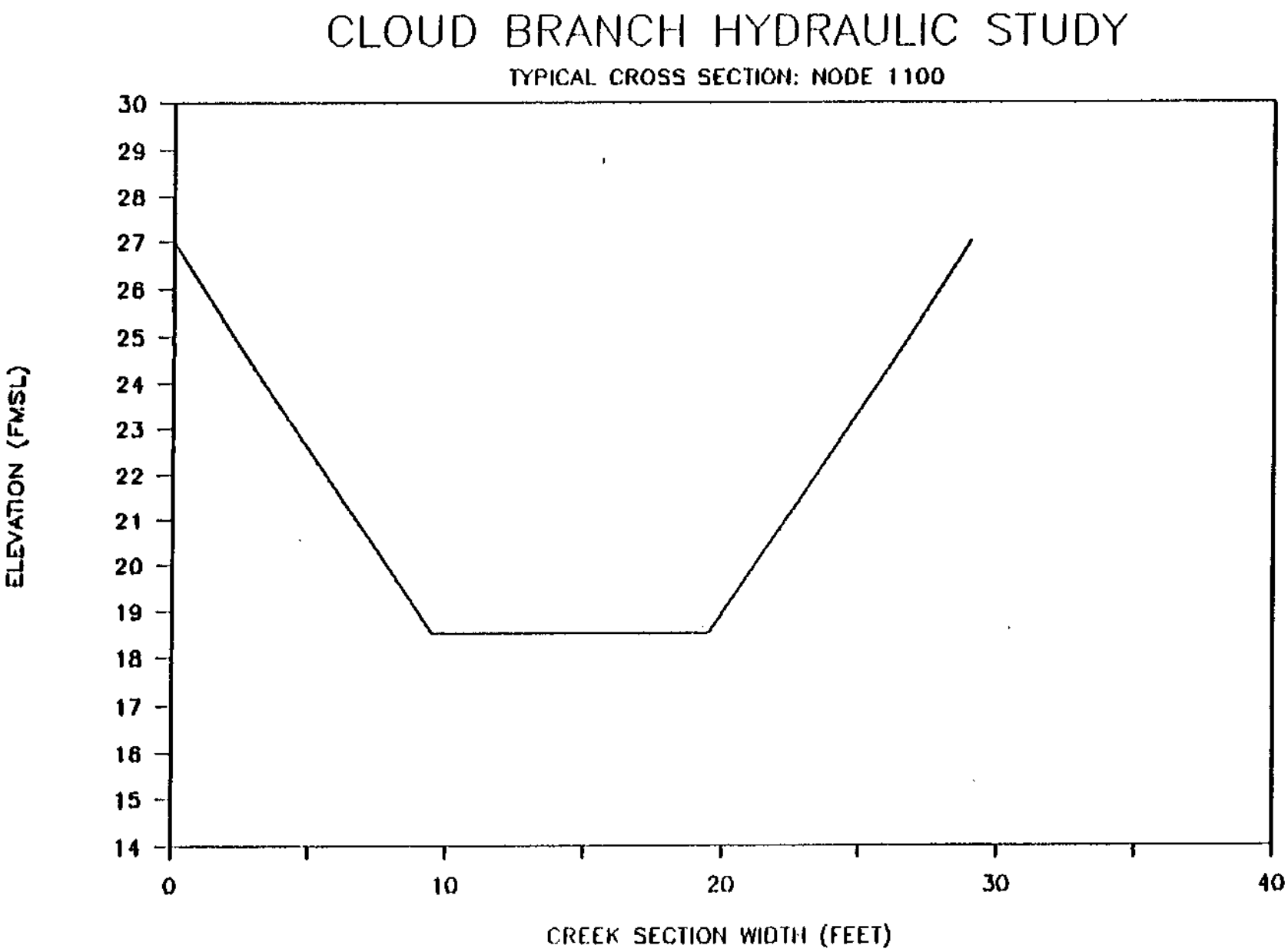


FIGURE B-5. TYPICAL CROSS SECTION IN THE CLOUD BRANCH DRAINAGE BASIN: NODE 1100 (10th Street to 8th Street)

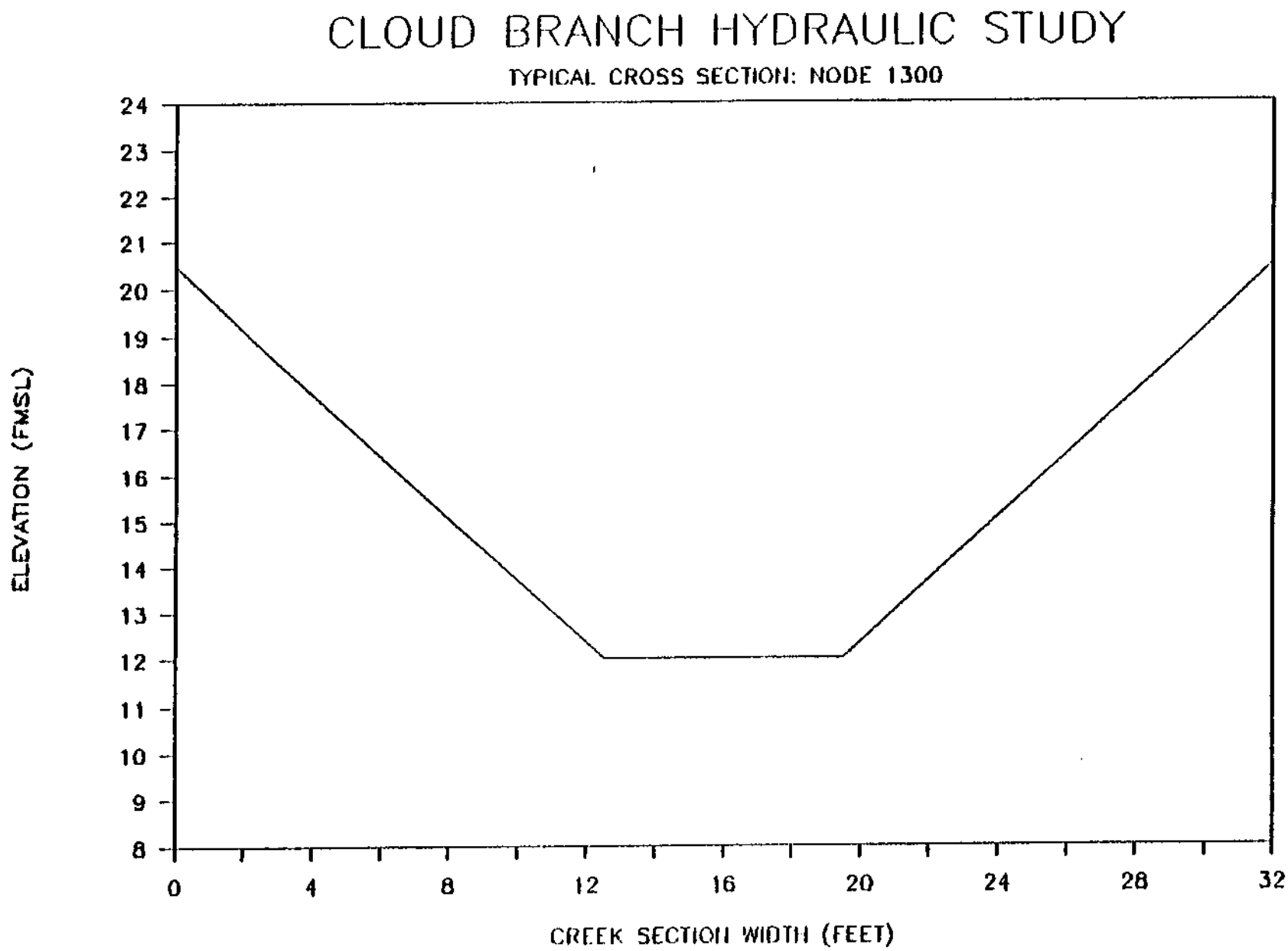


FIGURE B-7. TYPICAL CROSS SECTION IN THE CLOUD BRANCH DRAINAGE BASIN: NODE 1300 (6th Street to 3rd Street)

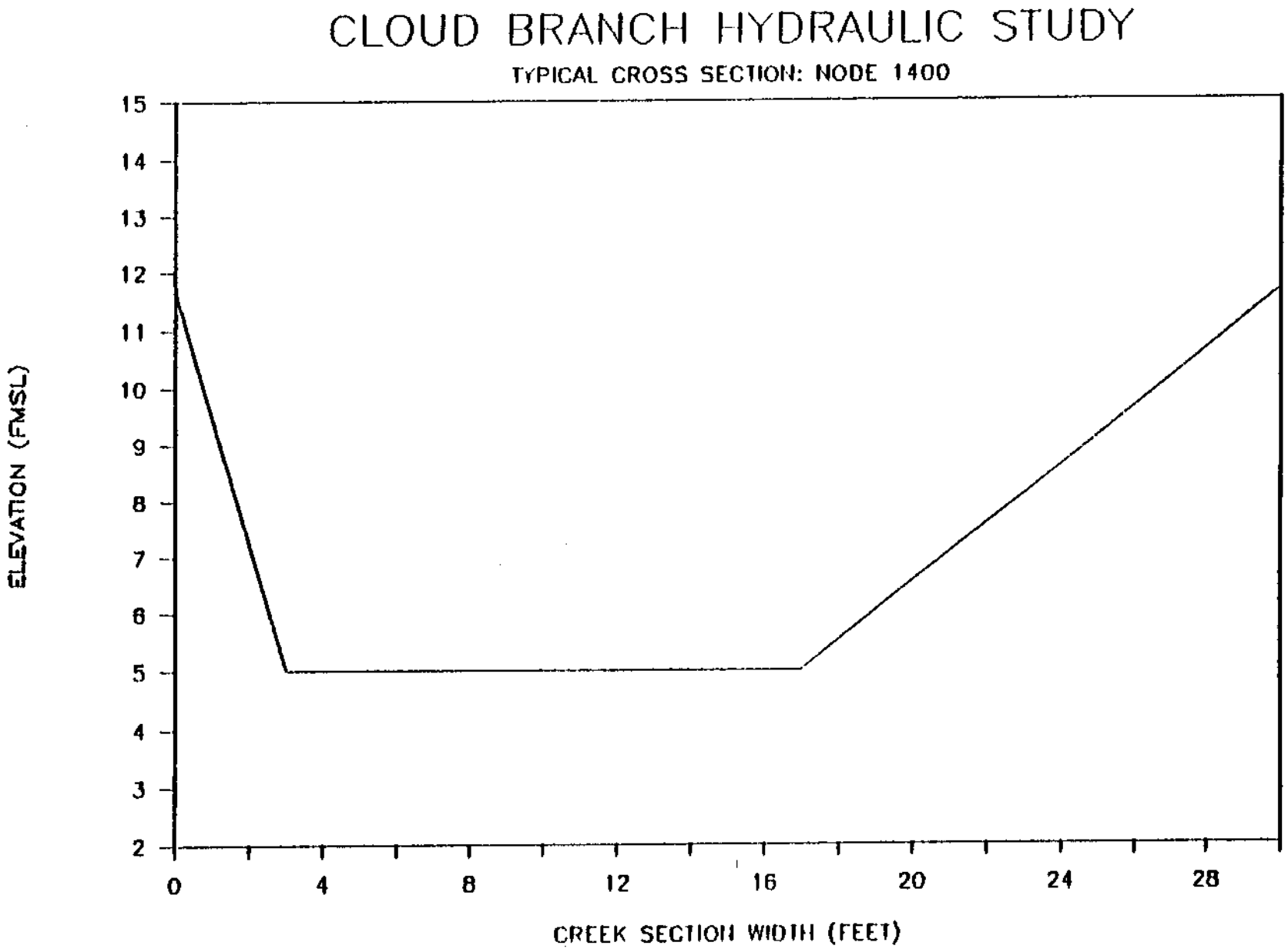


FIGURE B-8. TYPICAL CROSS SECTION IN THE CLOUD BRANCH DRAINAGE BASIN: NODE 1400 (3rd Street to Hwy. 46)

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EVENT

BASIN 100

BASIN INPUT DATA

BASIN AREA	90.00	ACRES
SCS CURVE NUMBER	74.00	
INITIAL ABSTRACTION	1.05	INCHES
TIME OF CONCENTRATION	33.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	2.77	INCHES
PEAK RUNOFF RATE	115.36	CFS
TIME OF PEAK	2.70	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE3A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

SCS UNIT HYDROGRAPH PACKAGE SC84009 VER 1.01
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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EV

BASIN 200

BASIN INPUT DATA

BASIN AREA	12.00	ACRES
SCS CURVE NUMBER	60.00	
INITIAL ABSTRACTION	2.00	INCHES
TIME OF CONCENTRATION	20.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	1.42	INCHES
PEAK RUNOFF RATE	7.01	CFS
TIME OF PEAK	2.60	HOURS
UNIT GRAPH VOLUME	0.96	INCHES

REFERENCE FILES

INPUT DATA	C:FILE5A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EVENT

BASIN 300

BASIN INPUT DATA

BASIN AREA	5.00	ACRES
SCS CURVE NUMBER	61.00	
INITIAL ABSTRACTION	1.92	INCHES
TIME OF CONCENTRATION	15.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	1.52	INCHES
PEAK RUNOFF RATE	3.69	CFS
TIME OF PEAK	2.60	HOURS
UNIT GRAPH VOLUME	0.98	INCHES

REFERENCE FILES

INPUT DATA	C:FILE3A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

SCS UNIT HYDROGRAPH PACKAGE SC84009 VER 1.01
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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EV

BASIN 310

BASIN INPUT DATA

BASIN AREA	32.00	ACRES
SCS CURVE NUMBER	61.00	
INITIAL ABSTRACTION	1.92	INCHES
TIME OF CONCENTRATION	25.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	1.51	INCHES
PEAK RUNOFF RATE	19.65	CFS
TIME OF PEAK	2.70	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE3A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

SCS UNIT HYDROGRAPH PACKAGE SC84009 VER 1.01
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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EVENT

BASIN 400

BASIN INPUT DATA

BASIN AREA	12.00	ACRES
SCS CURVE NUMBER	65.00	
INITIAL ABSTRACTION	1.62	INCHES
TIME OF CONCENTRATION	28.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	1.87	INCHES
PEAK RUNOFF RATE	9.40	CFS
TIME OF PEAK	2.70	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILEEA.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EV

BASIN 500

BASIN INPUT DATA

BASIN AREA	44.00	ACRES
SCS CURVE NUMBER	64.00	
INITIAL ABSTRACTION	1.69	INCHES
TIME OF CONCENTRATION	38.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	1.78	INCHES
PEAK RUNOFF RATE	27.31	CFS
TIME OF PEAK	2.80	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE5A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EVENT

BASIN 600

BASIN INPUT DATA

BASIN AREA	27.00	ACRES
SCS CURVE NUMBER	63.00	
INITIAL ABSTRACTION	1.76	INCHES
TIME OF CONCENTRATION	52.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	1.69	INCHES
PEAK RUNOFF RATE	13.83	CFS
TIME OF PEAK	3.60	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE3A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

SCS UNIT HYDROGRAPH PACKAGE SC84009 VER 1.01
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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EV

BASIN 700

BASIN INPUT DATA

BASIN AREA	23.00	ACRES
SCS CURVE NUMBER	82.00	
INITIAL ABSTRACTION	0.66	INCHES
TIME OF CONCENTRATION	25.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	3.62	INCHES
PEAK RUNOFF RATE	48.55	CFS
TIME OF PEAK	2.60	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILESA.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

SCS UNIT HYDROGRAPH PACKAGE SCS4009 VER 1.01
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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EVENT

BASIN 800

BASIN INPUT DATA

BASIN AREA	26.00	ACRES
SCS CURVE NUMBER	71.00	
INITIAL ABSTRACTION	1.23	INCHES
TIME OF CONCENTRATION	36.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	2.47	INCHES
PEAK RUNOFF RATE	26.94	CFS
TIME OF PEAK	2.70	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE5A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EV

BASIN 900

BASIN INPUT DATA

BASIN AREA	6.40	ACRES
SCS CURVE NUMBER	61.00	
INITIAL ABSTRACTION	1.92	INCHES
TIME OF CONCENTRATION	28.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	1.51	INCHES
PEAK RUNOFF RATE	3.55	CFS
TIME OF PEAK	2.70	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILESA.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EVENT

BASIN 1000

BASIN INPUT DATA

BASIN AREA	25.00	ACRES
SCS CURVE NUMBER	71.00	
INITIAL ABSTRACTION	1.23	INCHES
TIME OF CONCENTRATION	41.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	2.45	INCHES
PEAK RUNOFF RATE	24.01	CFS
TIME OF PEAK	2.80	HOURS
UNIT GRAPH VOLUME	0.77	INCHES

REFERENCE FILES

INPUT DATA	C:FILE5A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EVE

BASIN 1100

BASIN INPUT DATA

BASIN AREA	13.30	ACRES
SCS CURVE NUMBER	86.00	
INITIAL ABSTRACTION	0.49	INCHES
TIME OF CONCENTRATION	24.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	4.06	INCHES
PEAK RUNOFF RATE	32.58	CFS
TIME OF PEAK	2.60	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE5A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EVENT

BASIN 1200

BASIN INPUT DATA

BASIN AREA	9.80	ACRES
SCS CURVE NUMBER	62.00	
INITIAL ABSTRACTION	1.84	INCHES
TIME OF CONCENTRATION	22.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	1.60	INCHES
PEAK RUNOFF RATE	6.72	CFS
TIME OF PEAK	2.60	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE5A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EV

BASIN 1300

BASIN INPUT DATA

BASIN AREA	95.00	ACRES
SCS CURVE NUMBER	64.00	
INITIAL ABSTRACTION	1.69	INCHES
TIME OF CONCENTRATION	49.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	1.78	INCHES
PEAK RUNOFF RATE	52.68	CFS
TIME OF PEAK	3.40	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE5A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

SCS UNIT HYDROGRAPH PACKAGE SCS4009 VER 1.01
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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EVENT

BASIN 1400

BASIN INPUT DATA

BASIN AREA	105.00	ACRES
SCS CURVE NUMBER	70.00	
INITIAL ABSTRACTION	1.29	INCHES
TIME OF CONCENTRATION	86.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	2.36	INCHES
PEAK RUNOFF RATE	65.01	CFS
TIME OF PEAK	3.70	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE5A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EV

BASIN 1500

BASIN INPUT DATA

BASIN AREA	26.30	ACRES
SCS CURVE NUMBER	63.00	
INITIAL ABSTRACTION	1.76	INCHES
TIME OF CONCENTRATION	21.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	1.68	INCHES
PEAK RUNOFF RATE	20.20	CFS
TIME OF PEAK	2.60	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE3A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EVENT

BASIN 1600

BASIN INPUT DATA

BASIN AREA	42.00	ACRES
SCS CURVE NUMBER	74.00	
INITIAL ABSTRACTION	1.05	INCHES
TIME OF CONCENTRATION	43.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	2.76	INCHES
PEAK RUNOFF RATE	46.58	CFS
TIME OF PEAK	2.80	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE5A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EV

BASIN 1700

BASIN INPUT DATA

BASIN AREA	47.00	ACRES
SCS CURVE NUMBER	71.00	
INITIAL ABSTRACTION	1.23	INCHES
TIME OF CONCENTRATION	27.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	2.46	INCHES
PEAK RUNOFF RATE	56.13	CFS
TIME OF PEAK	2.60	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE5A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

SCS UNIT HYDROGRAPH PACKAGE SC84007 VER 1.01
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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EVENT
BASIN 1800

BASIN INPUT DATA

BASIN AREA	23.00	ACRES
SCS CURVE NUMBER	67.00	
INITIAL ABSTRACTION	1.48	INCHES
TIME OF CONCENTRATION	19.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	2.04	INCHES
PEAK RUNOFF RATE	24.80	CFS
TIME OF PEAK	2.60	HOURS
UNIT GRAPH VOLUME	0.96	INCHES

REFERENCE FILES

INPUT DATA	C:FILESA.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

SCS UNIT HYDROGRAPH PACKAGE SC8400? VER 1.01
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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EV

BASIN 1900

BASIN INPUT DATA

BASIN AREA	0.00	ACRES
SCS CURVE NUMBER	61.00	
INITIAL ABSTRACTION	1.92	INCHES
TIME OF CONCENTRATION	60.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	1.52	INCHES
PEAK RUNOFF RATE	0.00	CFS
TIME OF PEAK	3.80	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILE3A.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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CLOUD BRANCH SUB-BASIN HYDROGRAPHS (F) - 25YR/6HR STORM EVENT

BASIN 2000

BASIN INPUT DATA

BASIN AREA	0.00	ACRES
SCS CURVE NUMBER	61.00	
INITIAL ABSTRACTION	1.92	INCHES
TIME OF CONCENTRATION	60.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	6.00	HOURS
TOTAL RUNOFF	1.52	INCHES
PEAK RUNOFF RATE	0.00	CFS
TIME OF PEAK	3.80	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:FILESA.DAT.DAT
OUTPUT TO DISK	CBE
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 100

BASIN INPUT DATA

BASIN AREA	30.50	ACRES
SCS CURVE NUMBER	66.00	
INITIAL ABSTRACTION	1.55	INCHES
TIME OF CONCENTRATION	65.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.00	INCHES
PEAK RUNOFF RATE	16.26	CFS
TIME OF PEAK	3.57	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 105

BASIN INPUT DATA

BASIN AREA	24.50	ACRES
SCS CURVE NUMBER	71.00	
INITIAL ABSTRACTION	1.23	INCHES
TIME OF CONCENTRATION	55.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.49	INCHES
PEAK RUNOFF RATE	19.92	CFS
TIME OF PEAK	3.38	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 200

BASIN INPUT DATA

BASIN AREA	53.10	ACRES
SCS CURVE NUMBER	74.00	
INITIAL ABSTRACTION	1.05	INCHES
TIME OF CONCENTRATION	46.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.80	INCHES
PEAK RUNOFF RATE	57.05	CFS
TIME OF PEAK	3.25	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	A:FILEA.DAT
OUTPUT TO DISK	
RAINFALL DISTRIBUTION	A:RAIN25-6.RAI
UNIT HYDROGRAPH	A:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 210

BASIN INPUT DATA

BASIN AREA	46.90	ACRES
SCS CURVE NUMBER	73.00	
INITIAL ABSTRACTION	1.11	INCHES
TIME OF CONCENTRATION	46.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.70	INCHES
PEAK RUNOFF RATE	47.74	CFS
TIME OF PEAK	3.25	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	A:FILEA.DAT
OUTPUT TO DISK	
RAINFALL DISTRIBUTION	A:RAIN25-6.RAI
UNIT HYDROGRAPH	A:UNIT342.UHG

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HILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 220

BASIN INPUT DATA

BASIN AREA	92.40	ACRES
SCS CURVE NUMBER	72.00	
INITIAL ABSTRACTION	1.17	INCHES
TIME OF CONCENTRATION	43.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.60	INCHES
PEAK RUNOFF RATE	92.77	CFS
TIME OF PEAK	3.23	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	A:FILEA.DAT
OUTPUT TO DISK	
RAINFALL DISTRIBUTION	A:RAIN25-6.RAI
UNIT HYDROGRAPH	A:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 300

BASIN INPUT DATA

BASIN AREA	21.90	ACRES
SCS CURVE NUMBER	78.00	
INITIAL ABSTRACTION	0.85	INCHES
TIME OF CONCENTRATION	17.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	3.23	INCHES
PEAK RUNOFF RATE	47.80	CFS
TIME OF PEAK	2.98	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 400

BASIN INPUT DATA

BASIN AREA	108.00	ACRES
SCS CURVE NUMBER	74.00	
INITIAL ABSTRACTION	1.05	INCHES
TIME OF CONCENTRATION	90.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.80	INCHES
PEAK RUNOFF RATE	76.72	CFS
TIME OF PEAK	3.78	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 410

BASIN INPUT DATA

BASIN AREA	35.00	ACRES
SCS CURVE NUMBER	69.00	
INITIAL ABSTRACTION	1.35	INCHES
TIME OF CONCENTRATION	32.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.29	INCHES
PEAK RUNOFF RATE	35.10	CFS
TIME OF PEAK	3.13	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 420

BASIN INPUT DATA

BASIN AREA	31.00	ACRES
SCS CURVE NUMBER	69.00	
INITIAL ABSTRACTION	1.35	INCHES
TIME OF CONCENTRATION	25.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.29	INCHES
PEAK RUNOFF RATE	35.86	CFS
TIME OF PEAK	3.07	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 500

BASIN INPUT DATA

BASIN AREA	18.30	ACRES
SCS CURVE NUMBER	71.00	
INITIAL ABSTRACTION	1.23	INCHES
TIME OF CONCENTRATION	24.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.49	INCHES
PEAK RUNOFF RATE	24.43	CFS
TIME OF PEAK	3.05	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 610

BASIN INPUT DATA

BASIN AREA	23.50	ACRES
SCS CURVE NUMBER	71.00	
INITIAL ABSTRACTION	1.23	INCHES
TIME OF CONCENTRATION	27.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.49	INCHES
PEAK RUNOFF RATE	29.39	CFS
TIME OF PEAK	3.08	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 620

BASIN INPUT DATA

BASIN AREA	55.80	ACRES
SCS CURVE NUMBER	74.00	
INITIAL ABSTRACTION	1.05	INCHES
TIME OF CONCENTRATION	40.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.80	INCHES
PEAK RUNOFF RATE	65.35	CFS
TIME OF PEAK	3.18	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 625

BASIN INPUT DATA

BASIN AREA	11.70	ACRES
SCS CURVE NUMBER	71.00	
INITIAL ABSTRACTION	1.23	INCHES
TIME OF CONCENTRATION	25.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.49	INCHES
PEAK RUNOFF RATE	15.26	CFS
TIME OF PEAK	3.05	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 630

BASIN INPUT DATA

BASIN AREA	72.50	ACRES
SCS CURVE NUMBER	83.00	
INITIAL ABSTRACTION	0.61	INCHES
TIME OF CONCENTRATION	61.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	3.78	INCHES
PEAK RUNOFF RATE	97.87	CFS
TIME OF PEAK	3.37	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 640

BASIN INPUT DATA

BASIN AREA	78.90	ACRES
SCS CURVE NUMBER	80.00	
INITIAL ABSTRACTION	0.75	INCHES
TIME OF CONCENTRATION	54.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	3.45	INCHES
PEAK RUNOFF RATE	101.87	CFS
TIME OF PEAK	3.30	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 650

BASIN INPUT DATA

BASIN AREA	38.30	ACRES
SCS CURVE NUMBER	69.00	
INITIAL ABSTRACTION	1.35	INCHES
TIME OF CONCENTRATION	45.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.29	INCHES
PEAK RUNOFF RATE	31.15	CFS
TIME OF PEAK	3.27	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 700

BASIN INPUT DATA

BASIN AREA	16.00	ACRES
SCS CURVE NUMBER	69.00	
INITIAL ABSTRACTION	1.35	INCHES
TIME OF CONCENTRATION	26.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.29	INCHES
PEAK RUNOFF RATE	18.11	CFS
TIME OF PEAK	3.07	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 710

BASIN INPUT DATA

BASIN AREA	37.00	ACRES
SCS CURVE NUMBER	69.00	
INITIAL ABSTRACTION	1.35	INCHES
TIME OF CONCENTRATION	28.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.29	INCHES
PEAK RUNOFF RATE	40.14	CFS
TIME OF PEAK	3.10	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 810

BASIN INPUT DATA

BASIN AREA	29.60	ACRES
SCS CURVE NUMBER	73.00	
INITIAL ABSTRACTION	1.11	INCHES
TIME OF CONCENTRATION	29.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.70	INCHES
PEAK RUNOFF RATE	39.77	CFS
TIME OF PEAK	3.08	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 820

BASIN INPUT DATA

BASIN AREA	74.50	ACRES
SCS CURVE NUMBER	73.00	
INITIAL ABSTRACTION	1.11	INCHES
TIME OF CONCENTRATION	55.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.70	INCHES
PEAK RUNOFF RATE	67.85	CFS
TIME OF PEAK	3.37	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 830

BASIN INPUT DATA

BASIN AREA	27.30	ACRES
SCS CURVE NUMBER	73.00	
INITIAL ABSTRACTION	1.11	INCHES
TIME OF CONCENTRATION	29.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.70	INCHES
PEAK RUNOFF RATE	36.68	CFS
TIME OF PEAK	3.08	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 840

BASIN INPUT DATA

BASIN AREA	30.80	ACRES
SCS CURVE NUMBER	68.00	
INITIAL ABSTRACTION	1.41	INCHES
TIME OF CONCENTRATION	32.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.20	INCHES
PEAK RUNOFF RATE	28.92	CFS
TIME OF PEAK	3.13	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 910

BASIN INPUT DATA

BASIN AREA	31.60	ACRES
SCS CURVE NUMBER	73.00	
INITIAL ABSTRACTION	1.11	INCHES
TIME OF CONCENTRATION	33.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.70	INCHES
PEAK RUNOFF RATE	39.39	CFS
TIME OF PEAK	3.13	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 920

BASIN INPUT DATA

BASIN AREA	78.80	ACRES
SCS CURVE NUMBER	78.00	
INITIAL ABSTRACTION	0.85	INCHES
TIME OF CONCENTRATION	65.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	3.23	INCHES
PEAK RUNOFF RATE	82.90	CFS
TIME OF PEAK	3.45	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 930

BASIN INPUT DATA

BASIN AREA	10.30	ACRES
SCS CURVE NUMBER	90.00	
INITIAL ABSTRACTION	0.33	INCHES
TIME OF CONCENTRATION	3.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	4.51	INCHES
PEAK RUNOFF RATE	35.88	CFS
TIME OF PEAK	2.90	HOURS
UNIT GRAPH VOLUME	0.95	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

SCS UNIT HYDROGRAPH PACKAGE SCB4009 VER 1.01
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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 940

BASIN INPUT DATA

BASIN AREA	48.00	ACRES
SCS CURVE NUMBER	67.00	
INITIAL ABSTRACTION	1.48	INCHES
TIME OF CONCENTRATION	39.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.10	INCHES
PEAK RUNOFF RATE	37.26	CFS
TIME OF PEAK	3.22	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

SCS UNIT HYDROGRAPH PACKAGE SC84009 VER 1.01
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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 950

BASIN INPUT DATA

BASIN AREA	56.80	ACRES
SCS CURVE NUMBER	66.00	
INITIAL ABSTRACTION	1.55	INCHES
TIME OF CONCENTRATION	45.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.00	INCHES
PEAK RUNOFF RATE	37.58	CFS
TIME OF PEAK	3.30	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 960

BASIN INPUT DATA

BASIN AREA	62.20	ACRES
SCS CURVE NUMBER	64.00	
INITIAL ABSTRACTION	1.69	INCHES
TIME OF CONCENTRATION	48.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	1.81	INCHES
PEAK RUNOFF RATE	33.94	CFS
TIME OF PEAK	3.35	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 1000

BASIN INPUT DATA

BASIN AREA	69.50	ACRES
SCS CURVE NUMBER	69.00	
INITIAL ABSTRACTION	1.35	INCHES
TIME OF CONCENTRATION	38.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.29	INCHES
PEAK RUNOFF RATE	62.76	CFS
TIME OF PEAK	3.20	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 1100

BASIN INPUT DATA

BASIN AREA	23.00	ACRES
SCS CURVE NUMBER	69.00	
INITIAL ABSTRACTION	1.35	INCHES
TIME OF CONCENTRATION	26.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	2.29	INCHES
PEAK RUNOFF RATE	26.04	CFS
TIME OF PEAK	3.07	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 1200

BASIN INPUT DATA

BASIN AREA	54.00	ACRES
SCS CURVE NUMBER	80.00	
INITIAL ABSTRACTION	0.75	INCHES
TIME OF CONCENTRATION	56.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	3.45	INCHES
PEAK RUNOFF RATE	68.14	CFS
TIME OF PEAK	3.33	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 1300

BASIN INPUT DATA

BASIN AREA	0.00	ACRES
SCS CURVE NUMBER	0.00	
INITIAL ABSTRACTION	0.75	INCHES
TIME OF CONCENTRATION	3600.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	3.45	INCHES
PEAK RUNOFF RATE	68.14	CFS
TIME OF PEAK	3.33	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

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MILL CREEK HYDROGRAPH GENERATION - FUTURE COND - 25YR/6HR STORM EVENT
BASIN 1400

BASIN INPUT DATA

BASIN AREA	0.00	ACRES
SCS CURVE NUMBER	0.00	
INITIAL ABSTRACTION	0.75	INCHES
TIME OF CONCENTRATION	3600.00	MINUTES
SCS SHAPE FACTOR	342	

OUTPUT SUMMARY

STORM RAINFALL	6.00	INCHES
STORM DURATION	7.00	HOURS
TOTAL RUNOFF	3.45	INCHES
PEAK RUNOFF RATE	68.14	CFS
TIME OF PEAK	3.33	HOURS
UNIT GRAPH VOLUME	0.97	INCHES

REFERENCE FILES

INPUT DATA	C:LASTFI.DAT
OUTPUT TO DISK	MC99
RAINFALL DISTRIBUTION	C:RAIN25-6.RAI
UNIT HYDROGRAPH	C:UNIT342.UHG

BASIN / NODE RELATIONSHIPS

INDEX	NODE	SUB-BASINS					
1	100	100	0	0	0	0	0
2	200	105	200	220	300	0	0
3	210	210	0	0	0	0	0
4	220	215	0	0	0	0	0
5	300	400	0	0	0	0	0
6	400	410	420	500	610	620	0
7	410	625	650	0	0	0	0
8	600	700	930	0	0	0	0
9	610	830	840	0	0	0	0
10	620	630	640	0	0	0	0
11	625	810	0	0	0	0	0
12	630	820	0	0	0	0	0
13	640	710	0	0	0	0	0
14	650	950	960	0	0	0	0
15	660	920	940	0	0	0	0
16	670	910	0	0	0	0	0
17	700	1000	0	0	0	0	0
18	800	1100	0	0	0	0	0
19	900	1200	0	0	0	0	0
20	1000	1300	0	0	0	0	0
21	1100	1400	0	0	0	0	0

*** INTER-CONNECTED POND ROUTING PROGRAM *** ICS4032 VER 2.83
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MILL CREEK HYDR SIMULATION - 25YR/6 HR STORM EVENT - FUTURE CONDITION
AUG 1988

****
*** CONTROL DATA ***
****

Simulation time increment (mins)	-->	.5
Simulation duration (hrs)	-->	7
Starting time (hrs)	-->	0
Print interval	-->	60

****
*** NODE AND INITIALIZATION DATA ***
****

NODE #	NODE TYPE	INITIAL STAGE
100	1	30.360
200	1	25.000
210	1	26.500
220	1	26.640
300	1	24.750
400	1	11.490
410	1	20.670
600	1	8.990
610	1	25.820
620	1	23.000
625	1	21.750
630	1	21.240
640	1	18.820
650	1	27.470
660	1	20.850
670	1	11.630
700	1	5.480
800	1	5.000
900	1	3.250
1000	1	3.000
1100	2	3.000

*** INTER-CONNECTED POND ROUTING PROGRAM *** IC84032 VER 2.83
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MILL CREEK HYDR SIMULATION - 25YR/6 HR STORM EVENT - FUTURE CONDITION
AUG 1988

****
*** REACH DATA ***
****

NOTE: Type 1 for sharp crested weir/gate and orifice
Type 2 for broad crested weir/gate and orifice
* Type 3 for culvert
* Type 4 for trapezoidal channel
* Type 5 for parabolic channel
Type 6 for rating curve

* (Negative type indicates riser)

REACH #	FROM NODE	TO NODE	REACH TYPE
1	100	200	3
2	220	200	3
3	210	200	3
4	200	300	3
5	300	400	6
6	410	400	3
7	400	600	3
8	610	630	3
9	630	625	3
10	620	625	3
11	625	640	2
12	640	600	3
13	650	660	3
14	660	670	3
15	670	600	3
16	600	700	6
17	700	800	3
18	800	900	3
19	900	1000	3
20	1000	1100	3

REACH # 1 from node # 100 — to node # 200

-> Circular Culvert <-

Span (inches)	—>	36
Rise (inches)	—>	36
Length (feet)	—>	75
Manning's n	—>	.013
Headwater invert (feet)	—>	30.15
Tailwater invert (feet)	—>	30
Energy loss coefficient	—>	1
Entrnc loss coefficient	—>	.5
# of culverts/channels	—>	1

REACH # 2 from node # 220 — to node # 200

-> Elliptical Culvert <-

Span (inches) —> 60
Rise (inches) —> 44
Length (feet) —> 65
Manning's n —> .013
Headwater invert (feet) —> 28.31
Tailwater invert (feet) —> 28.26
Energy loss coefficient —> 1
Entrnc loss coefficient —> .5
# of culverts/channels —> 1

REACH # 3 from node # 210 — to node # 200

-> Elliptical Culvert <-

Span (inches) —> 29
Rise (inches) —> 45
Length (feet) —> 60
Manning's n —> .013
Headwater invert (feet) —> 28.97
Tailwater invert (feet) —> 28.7
Energy loss coefficient —> 1
Entrnc loss coefficient —> .5
# of culverts/channels —> 2

REACH # 4 from node # 200 — to node # 300

-> Circular Culvert <-

Span (inches) —> 48
Rise (inches) —> 48
Length (feet) —> 320
Manning's n —> .013
Headwater invert (feet) —> 24.5
Tailwater invert (feet) —> 24
Energy loss coefficient —> 1
Entrnc loss coefficient —> .5
# of culverts/channels —> 2

REACH # 5 from node # 300 — to node # 400

-> Rating Curve <-

STAGE (feet)	FLOW (cfs)
24.000	0.000
25.000	0.000
26.000	30.000
26.500	110.000
27.000	255.000

REACH # 6 from node # 410 — to node # 400

-> Circular Culvert <-

Span (inches) —> 30
Rise (inches) —> 30
Length (feet) —> 330
Manning's n —> .013
Headwater invert (feet) —> 20.17
Tailwater invert (feet) —> 20.1
Energy loss coefficient —> 1
Entrnc loss coefficient —> .5
# of culverts/channels —> 1

-> Circular Culvert <-

Span (inches)	-->	72
Rise (inches)	-->	72
Length (feet)	-->	50
Manning's n	-->	.013
Headwater invert (feet)	-->	10.99
Tailwater invert (feet)	-->	10.3
Energy loss coefficient	-->	1
Entrnc loss coefficient	-->	.5
# of culverts/channels	-->	1

REACH # 8 from node # 610 -- to node # 630

-> Box Culvert <-

Span (inches)	-->	45
Rise (inches)	-->	48
Length (feet)	-->	60
Manning's n	-->	.014
Headwater invert (feet)	-->	25.32
Tailwater invert (feet)	-->	24.88
Energy loss coefficient	-->	1
Entrnc loss coefficient	-->	.5
# of culverts/channels	-->	1

REACH # 9 from node # 630 -- to node # 625

-> Arch Culvert <-

Span (inches)	-->	96
Rise (inches)	-->	50
Length (feet)	-->	100
Manning's n	-->	.013
Headwater invert (feet)	-->	22
Tailwater invert (feet)	-->	21.5
Energy loss coefficient	-->	1
Entrnc loss coefficient	-->	.5
# of culverts/channels	-->	1

REACH # 10 from node # 620 -- to node # 625

-> Box Culvert <-

Span (inches)	-->	84
Rise (inches)	-->	48
Length (feet)	-->	60
Manning's n	-->	.013
Headwater invert (feet)	-->	22.8
Tailwater invert (feet)	-->	22.6
Energy loss coefficient	-->	1
Entrnc loss coefficient	-->	.5
# of culverts/channels	-->	1

REACH # 11 from node # 625 -- to node # 640

Broad Crested Weir/Gate and Orifice <-

Crest elevation (feet)	-->	25.25
Crest length (feet)	-->	75
Weir discharge coefficient	-->	3
Weir exponent	-->	1.5
% to effective submergence	-->	67
Gate opening (feet)	-->	99

Discharge coef for gate under ori TIW -> 0
Circular orifice centerline (feet) —> 99
Orifice diameter (feet) —> 0
Orifice discharge coefficient —> 0
identical orifices —> 0

REACH # 12 from node # 640 — to node # 600

-> Circular Culvert <-

Span (inches) —> 78
Rise (inches) —> 78
Length (feet) —> 60
Manning's n —> .013
Headwater invert (feet) —> 18.32
Tailwater invert (feet) —> 18.29
Energy loss coefficient —> 1
Entrnc loss coefficient —> .5
# of culverts/channels —> 1

REACH # 13 from node # 650 — to node # 660

-> Elliptical Culvert <-

Span (inches) —> 44
Rise (inches) —> 18
Length (feet) —> 60
Manning's n —> .013
Headwater invert (feet) —> 26.97
Tailwater invert (feet) —> 26.25
Energy loss coefficient —> 1
Entrnc loss coefficient —> .5
# of culverts/channels —> 3

REACH # 14 from node # 660 — to node # 670

-> Circular Culvert <-

Span (inches) —> 44
Rise (inches) —> 44
Length (feet) —> 375
Manning's n —> .013
Headwater invert (feet) —> 20.35
Tailwater invert (feet) —> 18.14
Energy loss coefficient —> 1
Entrnc loss coefficient —> .5
# of culverts/channels —> 2

REACH # 15 from node # 670 — to node # 600

-> Arch Culvert <-

Span (inches) —> 56
Rise (inches) —> 57.5
Length (feet) —> 85
Manning's n —> .014
Headwater invert (feet) —> 12
Tailwater invert (feet) —> 11.13
Energy loss coefficient —> 1
Entrnc loss coefficient —> .5
# of culverts/channels —> 2

REACH # 16 from node # 600 — to node # 700

-> Rating Curve <-

STAGE (feet)	FLOW (cfs)
8.490	0.000
11.490	0.000
12.490	30.000
12.990	110.000
13.490	255.000

REACH # 17 from node # 700 — to node # 800

-> Box Culvert <-

Span (inches)	-->	300
Rise (inches)	-->	60
Length (feet)	-->	80
Manning's n	-->	.014
Headwater invert (feet)	-->	4.98
Tailwater invert (feet)	-->	4.52
Energy loss coefficient	-->	1
Entrnc loss coefficient	-->	.5
# of culverts/channels	-->	1

REACH # 18 from node # 800 — to node # 900

-> Box Culvert <-

Span (inches)	-->	300
Rise (inches)	-->	60
Length (feet)	-->	60
Manning's n	-->	.014
Headwater invert (feet)	-->	4.5
Tailwater invert (feet)	-->	4.5
Energy loss coefficient	-->	1
Entrnc loss coefficient	-->	.5
# of culverts/channels	-->	1

REACH # 19 from node # 900 — to node # 1000

-> Box Culvert <-

Span (inches)	-->	84
Rise (inches)	-->	96
Length (feet)	-->	100
Manning's n	-->	.014
Headwater invert (feet)	-->	3.02
Tailwater invert (feet)	-->	2.99
Energy loss coefficient	-->	1
Entrnc loss coefficient	-->	.5
# of culverts/channels	-->	3

REACH # 20 from node # 1000 — to node # 1100

-> Box Culvert <-

Span (inches)	-->	360
Rise (inches)	-->	108
Length (feet)	-->	45
Manning's n	-->	.017
Headwater invert (feet)	-->	.5
Tailwater invert (feet)	-->	.4
Energy loss coefficient	-->	1
Entrnc loss coefficient	-->	.5
# of culverts/channels	-->	1

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****
*** STAGE/STORAGE/TIME DATA ***
****

NODE # 100

STAGE	29.860	30.860	31.860	32.860	33.860
STORAGE	0.000	0.103	0.289	0.496	0.744
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 200

STAGE	24.500	25.500	26.500	27.500	28.500
STORAGE	0.000	0.174	0.822	1.801	3.087
STAGE	29.500	30.500	31.500	0.000	0.000
STORAGE	4.703	6.574	8.723	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 210

STAGE	26.000	27.000	28.000	29.000	30.000
STORAGE	0.000	0.022	0.100	0.258	0.492
STAGE	31.000	0.000	0.000	0.000	0.000
STORAGE	0.843	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 220

STAGE	26.140	27.140	28.310	29.310	30.310
STORAGE	0.000	0.006	0.028	0.035	0.146
STAGE	31.310	32.310	0.000	0.000	0.000
STORAGE	0.361	0.680	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 300

STAGE	24.000	25.000	26.000	27.000	0.000
STORAGE	0.000	21.810	44.770	68.880	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 400

STAGE	10.990	11.990	12.990	13.990	14.990
STORAGE	0.000	0.034	0.152	0.357	0.669
STAGE	15.990	16.990	17.990	0.000	0.000
STORAGE	1.129	1.735	2.538	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 410

STAGE	20.170	21.170	22.170	23.170	24.170
STORAGE	0.000	0.110	0.314	0.764	1.397
STAGE	25.170	0.000	0.000	0.000	0.000
STORAGE	2.141	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 600

STAGE	8.490	9.490	10.490	11.490	12.490
STORAGE	0.000	2.798	5.753	8.756	11.795
STAGE	13.490	14.490	0.000	0.000	0.000
STORAGE	14.883	18.007	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 610

STAGE	25.320	26.320	27.320	28.320	29.320
STORAGE	0.000	0.069	0.335	0.748	1.253
STAGE	30.320	0.000	0.000	0.000	0.000
STORAGE	1.850	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 620

STAGE	22.800	23.800	24.800	25.800	26.800
STORAGE	0.000	0.069	0.234	0.898	1.639

STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 625

STAGE	21.300	22.300	23.300	24.300	0.000
STORAGE	0.000	5.000	10.600	16.750	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 630

STAGE	20.740	21.740	22.740	23.740	24.740
STORAGE	0.000	0.029	0.190	0.619	1.400
STAGE	25.740	26.740	0.000	0.000	0.000
STORAGE	2.461	3.685	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 640

STAGE	18.320	19.320	20.320	21.320	22.320
STORAGE	0.000	0.053	0.256	0.600	1.013
STAGE	23.320	24.320	25.320	26.320	0.000
STORAGE	1.495	2.023	2.597	3.240	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 650

STAGE	26.970	27.970	28.970	29.970	0.000
STORAGE	0.000	0.188	0.467	0.774	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 660

STAGE	20.350	21.350	22.350	23.350	24.350
STORAGE	0.000	0.041	0.190	0.524	1.057
STAGE	25.350	26.350	27.350	0.000	0.000
STORAGE	1.941	3.192	5.046	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 670

STAGE	11.130	13.130	15.130	17.130	19.130
STORAGE	0.000	0.077	0.519	1.592	4.272
STAGE	21.130	23.130	25.130	0.000	0.000
STORAGE	6.763	9.736	13.191	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 700

STAGE	4.980	5.980	6.980	7.980	8.980
STORAGE	0.000	0.085	0.376	0.893	1.670
STAGE	9.980	10.980	11.980	12.980	0.000
STORAGE	2.655	3.678	4.852	6.140	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 800

STAGE	4.500	5.500	6.500	7.500	8.500
STORAGE	0.000	0.210	0.475	0.778	1.106
STAGE	9.500	10.500	11.500	0.000	0.000
STORAGE	1.460	1.839	2.243	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 900

STAGE	3.020	4.020	5.020	6.020	7.020
STORAGE	0.000	0.093	0.396	0.814	1.296
STAGE	8.020	9.020	10.020	11.020	11.970
STORAGE	1.842	2.453	3.128	3.867	4.622
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 1000

STAGE	0.500	2.000	4.000	6.000	8.000
STORAGE	0.000	1.106	3.960	7.544	11.495
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 1100

STAGE	3.000	3.100	3.300	3.500	0.000
TIME	0.000	12.000	24.000	100.000	0.000

STAGE	0.000	0.000	0.000	0.000	0.000
TIME	0.000	0.000	0.000	0.000	0.000

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MILL CREEK HYDR SIMULATION - 25YR/6 HR STORM EVENT - FUTURE CONDITION
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****
*** INFLOW HYDROGRAPHS ***
****

INFLOW HYDROGRAPHS TO BE READ FROM DISK FILE

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MILL CREEK HYDR SIMULATION - 25YR/6 HR STORM EVENT - FUTURE CONDITION
AUG 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	TOTAL
100	0.00	30.36	0.05	0.00	1.49	1.49
200	0.00	25.00	0.09	1.49	3.41	3.41
210	0.00	26.50	0.01	0.00	0.00	0.00
220	0.00	26.64	0.00	0.00	0.00	0.00
300	0.00	24.75	16.36	3.41	0.00	0.00
400	0.00	11.49	0.02	2.05	3.80	3.80
410	0.00	20.67	0.06	0.00	2.05	2.05
600	0.00	8.99	1.40	6.73	0.00	0.00
610	0.00	25.82	0.03	0.00	4.25	4.25
620	0.00	23.00	0.01	0.00	3.16	3.16
625	0.00	21.75	2.25	3.16	0.00	0.00
630	0.00	21.24	0.01	4.25	0.00	0.00
640	0.00	18.32	0.03	0.00	2.93	2.93
650	0.00	27.47	0.09	0.00	11.90	11.90
660	0.00	20.85	0.02	11.90	8.42	8.42
670	0.00	11.63	0.02	8.42	0.00	0.00
700	0.00	5.48	0.04	0.00	21.69	21.69
800	0.00	5.00	0.10	21.69	18.51	18.51
900	0.00	3.25	0.02	18.51	7.14	7.14
1000	0.00	3.00	2.53	7.14	0.00	0.00
1100	0.00	3.00	0.00	0.00	———	0.00
100	0.50	30.29	0.04	0.00	0.09	0.09
200	0.50	24.77	0.05	0.09	0.35	0.35
210	0.50	26.50	0.01	0.00	0.00	0.00
220	0.50	26.64	0.00	0.00	0.00	0.00
300	0.50	24.75	16.41	0.35	0.00	0.00
400	0.50	11.20	0.01	0.26	0.31	0.31
410	0.50	20.50	0.04	0.00	0.26	0.26
600	0.50	9.03	1.52	0.87	0.00	0.00
610	0.50	25.35	0.00	0.00	0.10	0.10
620	0.50	22.81	0.00	0.00	0.03	0.03
625	0.50	21.75	2.26	0.03	0.00	0.00
630	0.50	21.35	0.05	0.10	0.00	0.00
640	0.50	18.48	0.01	0.00	0.12	0.12
650	0.50	27.06	0.02	0.00	0.31	0.31
660	0.50	20.48	0.01	0.31	0.37	0.37
670	0.50	12.07	0.04	0.37	0.44	0.44
700	0.50	4.98	-0.00	0.00	0.00	0.00
800	0.50	4.60	0.02	0.00	0.04	0.04
900	0.50	3.06	0.00	0.04	0.23	0.23
1000	0.50	2.99	2.52	0.23	-54.98	-54.98
1100	0.50	3.00	0.16	-54.98	———	0.00

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NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	TOTAL
100	1.00	30.26	0.04	0.00	0.06	0.06
200	1.00	24.75	0.04	0.06	0.08	0.08
210	1.00	26.50	0.01	0.00	0.00	0.00
220	1.00	26.64	0.00	0.00	0.00	0.00
300	1.00	24.75	16.41	0.08	0.00	0.00
400	1.00	11.14	0.01	0.15	0.17	0.17
410	1.00	20.43	0.03	0.00	0.15	0.15
600	1.00	9.04	1.55	0.69	0.00	0.00
610	1.00	25.32	0.00	0.00	0.02	0.02
620	1.00	22.80	-0.00	0.00	0.00	0.00
625	1.00	21.75	2.26	0.00	0.00	0.00
630	1.00	21.86	0.05	0.02	0.00	0.00
640	1.00	18.42	0.01	0.00	0.05	0.05
650	1.00	27.02	0.01	0.00	0.10	0.10
660	1.00	20.43	0.00	0.10	0.13	0.13
670	1.00	12.04	0.03	0.13	0.15	0.15
700	1.00	4.98	-0.00	0.00	0.00	0.00
800	1.00	4.60	0.02	0.00	0.00	0.00
900	1.00	3.03	0.00	0.00	0.02	0.02
1000	1.00	2.99	2.52	0.02	-54.77	-54.77
1100	1.00	3.01	0.16	-54.77	------	0.00
100	1.50	30.24	0.04	0.00	0.04	0.04
200	1.50	24.75	0.04	0.04	0.06	0.06
210	1.50	26.50	0.01	0.00	0.00	0.00
220	1.50	26.64	0.00	0.00	0.00	0.00
300	1.50	24.75	16.41	0.06	0.00	0.00
400	1.50	11.11	0.00	0.10	0.12	0.12
410	1.50	20.39	0.02	0.00	0.10	0.10
600	1.50	9.07	1.61	2.37	0.00	0.00
610	1.50	25.32	0.00	0.00	0.00	0.00
620	1.50	22.80	-0.00	0.00	0.00	0.00
625	1.50	21.75	2.26	0.00	0.00	0.00
630	1.50	21.86	0.05	0.00	0.00	0.00
640	1.50	18.39	0.00	0.00	0.03	0.03
650	1.50	27.01	0.01	0.00	0.05	0.05
660	1.50	20.40	0.00	0.05	0.07	0.07
670	1.50	12.02	0.03	0.07	0.08	0.08
700	1.50	4.98	-0.00	0.00	0.00	0.00
800	1.50	4.60	0.02	0.00	0.00	0.00
900	1.50	3.02	0.00	0.00	0.03	0.03
1000	1.50	3.00	2.53	0.03	-56.58	-56.58
1100	1.50	3.01	0.15	-56.58	------	0.00

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NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	TOTAL
100	2.00	30.23	0.04	0.00	0.03	0.03
200	2.00	24.76	0.05	0.43	0.21	0.21
210	2.00	26.50	0.01	0.00	0.00	0.00
220	2.00	26.64	0.00	0.00	0.00	0.00
300	2.00	24.75	16.41	0.21	0.00	0.00
400	2.00	11.09	0.00	0.07	0.09	0.09
410	2.00	20.36	0.02	0.00	0.07	0.07
600	2.00	9.12	1.77	5.71	0.00	0.00
610	2.00	25.32	-0.00	0.00	0.00	0.00
620	2.00	22.88	0.01	1.69	0.12	0.12
625	2.00	21.75	2.27	0.12	0.00	0.00
630	2.00	21.86	0.05	0.00	0.00	0.00
640	2.00	18.38	0.00	0.00	0.02	0.02
650	2.00	27.00	0.01	0.00	0.03	0.03
660	2.00	20.40	0.00	0.10	0.04	0.04
670	2.00	12.02	0.03	0.04	0.05	0.05
700	2.00	4.98	-0.00	0.00	0.00	0.00
800	2.00	4.60	0.02	0.00	0.00	0.00
900	2.00	3.03	0.00	0.26	0.26	0.26
1000	2.00	3.00	2.54	0.26	-55.85	-55.85
1100	2.00	3.02	0.15	-55.85	------	0.00
100	2.50	30.22	0.04	0.05	0.02	0.02
200	2.50	25.27	0.13	14.95	6.27	6.27
210	2.50	27.00	0.02	1.70	0.00	0.00
220	2.50	27.98	0.02	2.53	0.00	0.00
300	2.50	24.76	16.49	7.39	0.00	0.00
400	2.50	11.94	0.03	9.26	5.96	5.96
410	2.50	20.39	0.02	1.40	0.11	0.11
600	2.50	9.32	2.31	41.25	0.00	0.00
610	2.50	25.44	0.01	3.25	0.45	0.45
620	2.50	23.82	0.07	20.77	17.78	17.78
625	2.50	21.81	2.57	22.07	0.00	0.00
630	2.50	22.00	0.07	2.26	1.34	1.34
640	2.50	18.45	0.01	1.26	0.07	0.07
650	2.50	27.00	0.00	0.27	0.02	0.02
660	2.50	20.95	0.02	4.96	3.78	3.78
670	2.50	12.46	0.05	6.17	4.87	4.87
700	2.50	4.98	-0.00	1.14	0.00	0.00
800	2.50	4.63	0.03	0.94	0.65	0.65
900	2.50	3.34	0.03	6.77	5.15	5.15
1000	2.50	3.01	2.55	5.15	-51.27	-51.27
1100	2.50	3.02	0.20	-51.27	------	0.00

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MILL CREEK HYDR SIMULATION - 25YR/6 HR STORM EVENT - FUTURE CONDITION
AUG 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	TOTAL
100	3.00	30.84	0.10	6.34	2.27	2.27
200	3.00	27.71	2.07	178.74	89.96	89.96
210	3.00	30.27	0.59	35.48	11.52	11.52
220	3.00	30.62	0.21	43.09	34.23	34.23
300	3.00	24.84	18.38	114.76	0.00	0.00
400	3.00	16.09	1.19	185.25	138.13	138.13
410	3.00	22.51	0.47	36.56	14.31	14.31
600	3.00	11.30	8.19	292.79	0.00	0.00
610	3.00	27.81	0.54	59.56	36.16	36.16
620	3.00	25.90	0.98	142.20	94.48	94.48
625	3.00	22.48	6.00	177.18	0.00	0.00
630	3.00	23.93	0.77	79.06	45.36	45.36
640	3.00	20.38	0.28	37.20	27.91	27.91
650	3.00	28.23	0.26	43.29	31.84	31.84
660	3.00	23.39	0.54	108.88	77.16	77.16
670	3.00	14.79	0.44	112.55	94.57	94.57
700	3.00	5.84	0.07	50.07	49.77	49.77
800	3.00	5.60	0.24	74.47	68.12	68.12
900	3.00	4.68	0.29	116.55	105.76	105.76
1000	3.00	3.07	2.63	105.76	101.17	101.17
1100	3.00	3.03	1.84	101.17	------	0.00
100	3.50	31.94	0.31	16.18	13.44	13.44
200	3.50	29.88	5.41	235.35	182.44	182.44
210	3.50	31.68	1.08	43.82	43.82	43.82
220	3.50	31.31	0.36	52.06	54.03	54.03
300	3.50	25.20	26.39	252.33	5.98	5.98
400	3.50	17.07	1.80	179.36	185.03	185.03
410	3.50	24.06	1.33	39.57	25.48	25.48
600	3.50	13.97	16.40	432.96	395.54	395.54
610	3.50	28.58	0.88	50.94	54.00	54.00
620	3.50	27.68	2.36	191.49	187.81	187.81
625	3.50	24.36	17.11	327.54	0.00	0.00
630	3.50	25.33	2.02	119.94	110.36	110.36
640	3.50	20.56	0.34	30.52	32.77	32.77
650	3.50	29.05	0.49	69.02	69.70	69.70
660	3.50	25.37	1.97	186.04	171.45	171.45
670	3.50	16.42	1.21	202.71	192.44	192.44
700	3.50	8.80	1.53	450.70	419.27	419.27
800	3.50	8.22	1.02	438.18	424.96	424.96
900	3.50	7.36	1.48	490.09	467.13	467.13
1000	3.50	3.79	3.66	467.13	427.80	427.80
1100	3.50	3.03	11.19	427.80	------	0.00

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MILL CREEK HYDR SIMULATION - 25YR/6 HR STORM EVENT - FUTURE CONDITION
AUG 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	TOTAL
100	4.00	32.13	0.34	16.13	16.02	16.02
200	4.00	30.45	6.48	203.62	198.76	198.76
210	4.00	31.52	1.03	37.50	39.47	39.47
220	4.00	31.08	0.31	44.14	44.87	44.87
300	4.00	25.66	36.95	274.43	19.78	19.78
400	4.00	16.67	1.54	160.98	165.74	165.74
410	4.00	24.58	1.70	33.08	28.33	28.33
600	4.00	14.20	17.12	502.55	462.25	462.25
610	4.00	28.15	0.68	38.46	43.72	43.72
620	4.00	27.34	2.08	160.75	169.08	169.08
625	4.00	26.03	27.41	267.22	156.02	156.02
630	4.00	26.28	3.13	102.28	77.21	77.21
640	4.00	22.77	1.23	178.62	118.83	118.83
650	4.00	28.96	0.47	64.98	65.74	65.74
660	4.00	25.42	2.03	168.31	174.17	174.17
670	4.00	16.55	1.28	198.06	200.71	200.71
700	4.00	9.35	2.04	509.01	495.17	495.17
800	4.00	8.75	1.19	508.78	504.77	504.77
900	4.00	7.88	1.76	559.70	555.13	555.13
1000	4.00	4.25	4.41	555.13	548.09	548.09
1100	4.00	3.03	32.34	548.09	------	0.00
100	4.50	32.12	0.34	15.58	15.86	15.86
200	4.50	30.27	6.14	172.42	193.71	193.71
210	4.50	31.30	0.95	31.10	33.44	33.44
220	4.50	30.84	0.26	36.30	38.39	38.39
300	4.50	26.09	47.04	266.42	45.05	45.05
400	4.50	16.49	1.43	161.35	156.88	156.88
410	4.50	24.68	1.78	27.65	28.90	28.90
600	4.50	14.65	18.49	601.56	589.96	589.96
610	4.50	27.69	0.49	29.19	33.51	33.51
620	4.50	27.08	1.87	135.79	140.71	140.71
625	4.50	26.30	29.04	242.73	241.80	241.80
630	4.50	26.61	3.53	85.23	86.36	86.36
640	4.50	25.28	2.57	259.24	251.95	251.95
650	4.50	28.84	0.43	58.56	60.03	60.03
660	4.50	25.11	1.73	148.89	157.76	157.76
670	4.50	16.23	1.11	175.40	180.36	180.36
700	4.50	10.12	2.79	627.12	617.28	617.28
800	4.50	9.44	1.44	627.93	624.65	624.65
900	4.50	8.49	2.13	671.18	665.71	665.71
1000	4.50	4.69	5.20	665.71	647.07	647.07
1100	4.50	3.04	56.73	647.07	------	0.00

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MILL CREEK HYDR SIMULATION - 25YR/6 HR STORM EVENT - FUTURE CONDITION
AUG 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	TOTAL
100	5.00	32.02	0.32	13.98	14.56	14.56
200	5.00	29.57	4.83	134.73	172.92	172.92
210	5.00	31.00	0.84	23.49	25.84	25.84
220	5.00	30.41	0.17	27.26	28.90	28.90
300	5.00	26.41	54.61	239.84	95.31	95.31
400	5.00	17.01	1.75	191.11	182.18	182.18
410	5.00	24.46	1.61	21.57	27.69	27.69
600	5.00	14.66	18.52	584.99	593.09	593.09
610	5.00	27.31	0.33	23.25	25.87	25.87
620	5.00	26.74	1.59	105.22	111.73	111.73
625	5.00	26.22	28.58	197.55	216.34	216.34
630	5.00	26.45	3.33	66.95	73.34	73.34
640	5.00	25.06	2.45	230.43	239.73	239.73
650	5.00	28.59	0.36	46.92	48.24	48.24
660	5.00	24.59	1.27	121.22	132.79	132.79
670	5.00	15.79	0.87	146.51	152.65	152.65
700	5.00	10.17	2.85	621.59	625.19	625.19
800	5.00	9.49	1.46	633.82	635.06	635.06
900	5.00	8.53	2.15	670.84	673.09	673.09
1000	5.00	4.82	5.43	673.09	677.56	677.56
1100	5.00	3.04	84.53	677.56	———	0.00
100	5.50	31.88	0.29	11.85	12.59	12.59
200	5.50	28.69	3.39	107.62	136.36	136.36
210	5.50	30.75	0.75	18.54	20.35	20.35
220	5.50	30.12	0.12	21.44	21.98	21.98
300	5.50	26.59	58.89	196.14	134.88	134.88
400	5.50	17.50	2.14	215.97	206.17	206.17
410	5.50	24.03	1.31	17.43	25.34	25.34
600	5.50	14.50	18.03	533.68	547.51	547.51
610	5.50	27.02	0.26	19.10	20.45	20.45
620	5.50	26.42	1.36	80.93	85.73	85.73
625	5.50	26.09	27.77	154.72	173.94	173.94
630	5.50	26.24	3.07	53.06	58.79	58.79
640	5.50	24.28	2.00	185.55	196.29	196.29
650	5.50	28.40	0.31	38.31	39.42	39.42
660	5.50	23.99	0.86	98.01	104.46	104.46
670	5.50	15.23	0.57	115.68	122.32	122.32
700	5.50	9.87	2.55	570.93	579.33	579.33
800	5.50	9.21	1.36	586.47	590.44	590.44
900	5.50	8.26	1.99	618.04	622.66	622.66
1000	5.50	4.63	5.09	622.66	634.36	634.36
1100	5.50	3.05	111.78	634.36	———	0.00

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MILL CREEK HYDR SIMULATION - 25YR/6 HR STORM EVENT - FUTURE CONDITION
AUG 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	TOTAL
100	6.00	31.73	0.27	10.13	10.68	10.68
200	6.00	28.08	2.54	93.51	106.02	106.02
210	6.00	30.59	0.70	16.18	17.08	17.08
220	6.00	29.97	0.11	18.67	18.89	18.89
300	6.00	26.64	60.21	158.76	150.71	150.71
400	6.00	17.82	2.40	224.57	222.16	222.16
410	6.00	23.54	1.00	15.64	22.40	22.40
600	6.00	14.33	17.50	487.46	498.05	498.05
610	6.00	26.90	0.22	17.78	18.17	18.17
620	6.00	26.20	1.20	65.49	68.19	68.19
625	6.00	25.98	27.08	126.47	140.10	140.10
630	6.00	26.08	2.88	45.39	48.75	48.75
640	6.00	23.57	1.63	151.04	158.40	158.40
650	6.00	28.29	0.28	33.90	34.33	34.33
660	6.00	23.60	0.66	83.24	86.72	86.72
670	6.00	14.85	0.46	97.01	98.23	98.23
700	6.00	9.51	2.20	519.22	526.48	526.48
800	6.00	8.87	1.24	533.26	535.74	535.74
900	6.00	7.92	1.78	558.24	562.05	562.05
1000	6.00	4.36	4.61	562.05	572.58	572.58
1100	6.00	3.05	136.72	572.58	———	0.00
100	6.50	31.63	0.25	9.15	9.48	9.48
200	6.50	27.81	2.20	87.93	92.72	92.72
210	6.50	30.31	0.67	15.34	15.70	15.70
220	6.50	29.92	0.10	17.69	17.76	17.76
300	6.50	26.64	60.09	139.08	149.22	149.22
400	6.50	17.81	2.39	219.96	221.88	221.88
410	6.50	23.16	0.76	15.14	19.89	19.89
600	6.50	14.21	17.12	455.19	462.86	462.86
610	6.50	26.87	0.21	17.68	17.70	17.70
620	6.50	26.09	1.11	58.82	60.10	60.10
625	6.50	25.91	26.66	105.45	120.98	120.98
630	6.50	25.99	2.77	42.78	35.85	35.85
640	6.50	23.12	1.40	131.95	135.59	135.59
650	6.50	28.25	0.27	32.51	32.64	32.64
660	6.50	23.41	0.56	76.74	78.24	78.24
670	6.50	14.68	0.42	88.38	89.01	89.01
700	6.50	9.26	1.94	483.54	488.66	488.66
800	6.50	8.63	1.15	495.49	497.22	497.22
900	6.50	7.67	1.65	517.66	520.31	520.31
1000	6.50	4.17	4.26	520.31	525.59	525.59
1100	6.50	3.05	159.39	525.59	———	0.00

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MILL CREEK HYDR SIMULATION - 25YR/6 HR STORM EVENT - FUTURE CONDITION
AUG 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	TOTAL
100	7.00	31.58	0.24	8.76	8.89	8.89
200	7.00	27.71	2.08	86.30	87.47	87.47
210	7.00	30.49	0.66	15.17	15.25	15.25
220	7.00	29.91	0.10	17.47	17.49	17.49
300	7.00	26.61	59.58	129.54	143.16	143.16
400	7.00	17.67	2.28	211.83	214.97	214.97
410	7.00	22.84	0.62	15.12	17.44	17.44
600	7.00	14.12	16.86	432.72	438.29	438.29
610	7.00	26.88	0.22	17.89	17.83	17.83
620	7.00	26.04	1.08	56.25	56.79	56.79
625	7.00	25.88	26.45	109.19	111.78	111.78
630	7.00	25.99	2.77	42.16	42.82	42.82
640	7.00	22.89	1.29	122.90	124.35	124.35
650	7.00	28.24	0.26	32.42	32.39	32.39
660	7.00	23.34	0.52	74.74	75.03	75.03
670	7.00	14.60	0.40	85.24	85.46	85.46
700	7.00	9.08	1.77	459.09	462.31	462.31
800	7.00	8.46	1.09	469.23	470.63	470.63
900	7.00	7.50	1.56	490.27	491.82	491.82
1000	7.00	4.05	4.05	491.82	495.91	495.91
1100	7.00	3.06	180.48	495.91	------	0.00

*** INTER-CONNECTED POND ROUTING PROGRAM *** IC84032 VER 2.83

MILL CREEK HYDR SIMULATION - 25YR/6 HR STORM EVENT - FUTURE CONDITION
AUG 1988

*** PEAK CONDITIONS SUMMARY ***

NODE #	PEAK STAGE (feet)	PEAK STORAGE (acft)	TIME TO PEAK (hrs)	PEAK OUTFLOW (cfs)	TIME TO PEAK (hrs)
100	32.13	0.35	4.16	16.07	4.09
200	30.46	6.50	4.08	199.00	4.06
210	31.68	1.08	3.50	43.82	3.48
220	31.36	0.38	3.37	55.44	3.35
300	26.64	60.26	6.15	151.29	6.15
400	17.84	2.42	6.22	223.41	6.18
410	24.69	1.78	4.42	28.93	4.40
600	14.68	18.61	4.76	600.80	4.76
610	28.62	0.90	3.36	55.13	3.35
620	27.69	2.37	3.54	188.26	3.54
625	26.30	29.05	4.52	241.84	4.52
630	26.61	3.53	4.46	110.36	3.50
640	25.34	2.61	4.64	255.76	4.62
650	29.06	0.50	3.41	70.25	3.41
660	25.47	2.10	3.76	177.02	3.73
670	16.60	1.31	3.78	204.07	3.76
700	10.21	2.89	4.77	638.19	4.65
800	9.54	1.48	4.77	643.69	4.66
900	8.58	2.19	4.75	682.71	4.72
1000	4.83	5.46	4.86	681.17	4.86
1100	3.06	180.33	7.01	0.00	0.01

FROM NODE	TO NODE	PEAK OUTFLOW (cfs)	TIME TO PEAK (hrs)
100	200	16.07	4.09
220	200	55.44	3.35
210	200	43.82	3.48
200	300	199.00	4.06
300	400	151.29	6.15
410	400	28.93	4.40
400	600	223.41	6.18
610	630	55.13	3.35
630	625	110.36	3.50
620	625	188.26	3.54
625	640	241.84	4.52
640	600	255.76	4.62
650	660	70.25	3.41
660	670	177.02	3.73
670	600	204.07	3.76
600	700	600.80	4.76
700	800	638.19	4.65
800	900	643.69	4.66
900	1000	682.71	4.72
1000	1100	681.17	4.86

APPENDIX D

MILL CREEK/CLOUD BRANCH

HYDROLOGIC/HYDRAULIC STUDY:

DESIGN STORM HYDRAULICS (25 YR/6 HR)

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CLOUD BRANCH HYDR SIMUL (F) - 25YR/6HR - CH C\O & 2PONDS & 19TH-RR-8TH CULVS
APRIL 1988

****
*** CONTROL DATA ***
****

Simulation time increment (mins) --> .5
Simulation duration (hrs) --> 6
Starting time (hrs) --> 0
Print interval --> 30

****
*** NODE AND INITIALIZATION DATA ***
****

NODE #	NODE TYPE	INITIAL STAGE
100	1	30.220
200	1	30.220
300	1	26.980
400	1	24.850
500	1	27.000
600	1	26.500
700	1	22.050
800	1	21.810
900	1	21.810
1000	1	19.910
1100	1	17.660
1200	1	15.770
1300	1	3.350
1400	1	3.050
1500	1	3.035
1600	2	3.000

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CLOUD BRANCH HYDR SIMUL (F) - 25YR/6HR - CH C\O & 2PONDS & 19TH-RR-8TH CULVS
APRIL 1988

****
*** STAGE/STORAGE/TIME DATA ***
****

NODE # 100

STAGE	30.220	34.220	35.220	0.000	0.000
STORAGE	0.000	0.730	1.510	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 200

STAGE	30.220	34.220	35.220	0.000	0.000
STORAGE	0.000	0.080	0.160	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 300

STAGE	26.380	27.380	28.380	29.380	30.330
STORAGE	0.000	0.120	0.524	1.272	2.021
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 400

STAGE	24.750	25.750	26.750	28.750	0.000
STORAGE	0.000	0.015	0.083	0.242	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 500

STAGE	27.000	31.000	32.000	0.000	0.000
STORAGE	0.000	0.300	2.380	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 600

STAGE	26.500	30.500	31.500	0.000	0.000
STORAGE	0.000	0.070	0.200	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 700

STAGE	21.950	22.950	23.950	24.950	25.950
STORAGE	0.000	0.026	0.390	1.709	3.336
STAGE	26.950	27.950	28.950	0.000	0.000
STORAGE	5.059	6.330	12.750	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 800

STAGE	21.310	25.210	26.310	0.000	0.000
STORAGE	0.000	0.440	1.960	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 900

STAGE	21.310	25.310	26.310	0.000	0.000
STORAGE	0.000	0.500	2.240	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 1000

STAGE	19.310	21.310	24.310	26.310	0.000
STORAGE	0.000	5.240	10.276	13.989	0.000

STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 1100

STAGE	17.560	18.560	19.560	21.560	23.560
STORAGE	0.000	0.039	0.184	0.767	1.509
STAGE	24.560	0.000	0.000	0.000	0.000
STORAGE	1.969	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 1200

STAGE	15.670	16.670	18.170	19.170	20.670
STORAGE	0.000	0.013	0.085	0.292	0.754
STAGE	21.670	23.670	0.000	0.000	0.000
STORAGE	1.083	1.801	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 1300

STAGE	8.250	9.250	10.250	11.250	13.250
STORAGE	0.000	0.019	0.092	0.221	0.744
STAGE	15.250	0.000	0.000	0.000	0.000
STORAGE	1.751	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 1400

STAGE	2.260	3.260	4.260	5.260	6.260
STORAGE	0.000	0.017	0.085	0.185	0.353
STAGE	7.260	8.930	10.260	12.260	0.000
STORAGE	0.574	1.029	1.631	2.471	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 1500

STAGE	0.500	2.000	3.000	4.000	6.000
STORAGE	0.000	0.980	2.460	3.590	6.570
STAGE	8.000	9.000	0.000	0.000	0.000
STORAGE	10.190	12.110	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
STORAGE	0.000	0.000	0.000	0.000	0.000

NODE # 1600

STAGE	3.000	3.150	3.300	3.500	0.000
TIME	0.000	12.000	24.000	100.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
TIME	0.000	0.000	0.000	0.000	0.000
STAGE	0.000	0.000	0.000	0.000	0.000
TIME	0.000	0.000	0.000	0.000	0.000

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CLOUD BRANCH HYDR SIMUL (F) - 25YR/6HR - CH C\O & 2PONDS & 19TH-RR-8TH CULVS
APRIL 1988

****
*** REACH DATA ***
****

NOTE: Type 1 for sharp crested weir/gate and orifice
Type 2 for broad crested weir/gate and orifice
* Type 3 for culvert
* Type 4 for trapezoidal channel
* Type 5 for parabolic channel
Type 6 for rating curve

* (Negative type indicates riser)

REACH #	FROM NODE	TO NODE	REACH TYPE
1	100	300	3
2	200	300	3
3	300	400	3
4	300	400	6
5	400	700	3
6	400	700	3
7	400	700	6
8	500	700	3
9	600	700	3
10	700	1000	3
11	800	1000	3
12	900	1000	3
13	1000	1100	6
14	1100	1200	3
15	1100	1200	3
16	1100	1200	6
17	1200	1300	3
18	1200	1300	6
19	1300	1400	3
20	1300	1400	6
21	1400	1500	3
22	1400	1500	6
23	1500	1600	3

REACH # 1 from node # 100 -- to node # 300

-) Circular Culvert (-

Span (inches)	--)	48
Rise (inches)	--)	48
Length (feet)	--)	200
Manning's n	--)	.013
Headwater invert (feet)	--)	30.22
Tailwater invert (feet)	--)	29.22
Energy loss coefficient	--)	1
Entrnc loss coefficient	--)	.5
# of culverts/channels	--)	1

-) Circular Culvert (-

Span (inches)	--)	48
Rise (inches)	--)	48
Length (feet)	--)	600
Manning's n	--)	.013
Headwater invert (feet)	--)	30.22
Tailwater invert (feet)	--)	29.22
Energy loss coefficient	--)	1
Entrnc loss coefficient	--)	.5
# of culverts/channels	--)	1

REACH # 3 from node # 300 -- to node # 400

-) Circular Culvert (-

Span (inches)	--)	36
Rise (inches)	--)	36
Length (feet)	--)	60
Manning's n	--)	.013
Headwater invert (feet)	--)	26.88
Tailwater invert (feet)	--)	26.7
Energy loss coefficient	--)	1
Entrnc loss coefficient	--)	.5
# of culverts/channels	--)	2

REACH # 4 from node # 300 -- to node # 400

-) Rating Curve (-

STAGE (feet)	FLOW (cfs)
31.600	0.000
31.700	4.000
31.800	10.000
31.900	13.000
32.000	27.000
32.100	33.000

REACH # 5 from node # 400 -- to node # 700

-) Elliptical Culvert (-

Span (inches)	--)	43
Rise (inches)	--)	27
Length (feet)	--)	60
Manning's n	--)	.014
Headwater invert (feet)	--)	24.75
Tailwater invert (feet)	--)	24.6
Energy loss coefficient	--)	1
Entrnc loss coefficient	--)	.5
# of culverts/channels	--)	2

REACH # 6 from node # 400 -- to node # 700

-) Elliptical Culvert (-

Span (inches)	--)	60
Rise (inches)	--)	38
Length (feet)	--)	60
Manning's n	--)	.013
Headwater invert (feet)	--)	24.75
Tailwater invert (feet)	--)	24.6

Entrnc loss coefficient --> .5
# of culverts/channels --> 1

REACH # 7 from node # 400 -- to node # 700

-> Rating Curve <-

STAGE (feet)	FLOW (cfs)
28.800	0.000
28.900	4.000
29.000	10.000
29.100	18.000
29.200	27.000
29.300	38.000

REACH # 8 from node # 500 -- to node # 700

-> Circular Culvert <-

Span (inches) --> 36
Rise (inches) --> 36
Length (feet) --> 200
Manning's n --> .013
Headwater invert (feet) --> 27
Tailwater invert (feet) --> 25
Energy loss coefficient --> 1
Entrnc loss coefficient --> .5
# of culverts/channels --> 1

REACH # 9 from node # 600 -- to node # 700

-> Circular Culvert <-

Span (inches) --> 36
Rise (inches) --> 36
Length (feet) --> 200
Manning's n --> .013
Headwater invert (feet) --> 26.5
Tailwater invert (feet) --> 24.5
Energy loss coefficient --> 1
Entrnc loss coefficient --> .5
# of culverts/channels --> 1

REACH # 10 from node # 700 -- to node # 1000

-> Box Culvert <-

Span (inches) --> 108
Rise (inches) --> 48
Length (feet) --> 160
Manning's n --> .014
Headwater invert (feet) --> 22.05
Tailwater invert (feet) --> 21.7
Energy loss coefficient --> 1
Entrnc loss coefficient --> .5
# of culverts/channels --> 1

REACH # 11 from node # 800 -- to node # 1000

-> Circular Culvert <-

Span (inches) --> 36
Rise (inches) --> 36
Length (feet) --> 100

Headwater invert (feet) --> 21.81

Tailwater invert (feet) --> 20.81
Energy loss coefficient --> 1
Entrnc loss coefficient --> .5
# of culverts/channels --> 1

REACH # 12 from node # 900 -- to node # 1000

-> Circular Culvert <-

Span (inches) --> 36
Rise (inches) --> 36
Length (feet) --> 200
Manning's n --> .013
Headwater invert (feet) --> 21.81
Tailwater invert (feet) --> 20.81
Energy loss coefficient --> 1
Entrnc loss coefficient --> .5
# of culverts/channels --> 1

REACH # 13 from node # 1000 -- to node # 1100

-> Rating Curve <-

STAGE (feet)	FLOW (cfs)
19.810	0.000
21.810	75.000
23.310	175.000
24.810	213.000
26.310	350.000

REACH # 14 from node # 1100 -- to node # 1200

-> Arch Culvert <-

Span (inches) --> 58
Rise (inches) --> 58
Length (feet) --> 40
Manning's n --> .014
Headwater invert (feet) --> 17.56
Tailwater invert (feet) --> 17.4
Energy loss coefficient --> 1
Entrnc loss coefficient --> .5
# of culverts/channels --> 1

REACH # 15 from node # 1100 -- to node # 1200

-> Circular Culvert <-

Span (inches) --> 48
Rise (inches) --> 48
Length (feet) --> 40
Manning's n --> .013
Headwater invert (feet) --> 17.56
Tailwater invert (feet) --> 17.4
Energy loss coefficient --> 1
Entrnc loss coefficient --> .5
# of culverts/channels --> 1

REACH # 16 from node # 1100 -- to node # 1200

-> Rating Curve <-

STAGE (feet)	FLOW (cfs)
25.200	0.000
25.300	4.000
25.400	10.000
25.500	18.000
25.600	27.000
25.700	38.000

REACH # 17 from node # 1200 -- to node # 1300

-> Circular Culvert <-

Span (inches)	-->	48
Rise (inches)	-->	48
Length (feet)	-->	150
Manning's n	-->	.013
Headwater invert (feet)	-->	15.67
Tailwater invert (feet)	-->	15.5
Energy loss coefficient	-->	1
Entrnc loss coefficient	-->	.5
# of culverts/channels	-->	4

REACH # 18 from node # 1200 -- to node # 1300

-> Rating Curve <-

STAGE (feet)	FLOW (cfs)
24.000	0.000
24.100	4.000
24.200	10.000
24.300	18.000
24.400	27.000
24.500	38.000

REACH # 19 from node # 1300 -- to node # 1400

-> Arch Culvert <-

Span (inches)	-->	100
Rise (inches)	-->	56
Length (feet)	-->	40
Manning's n	-->	.014
Headwater invert (feet)	-->	9.25
Tailwater invert (feet)	-->	8.1
Energy loss coefficient	-->	1
Entrnc loss coefficient	-->	.5
# of culverts/channels	-->	1

REACH # 20 from node # 1300 -- to node # 1400

-> Rating Curve <-

STAGE (feet)	FLOW (cfs)
16.310	0.000
16.410	4.000
16.510	10.000

16.710	27.000
16.810	38.000

REACH # 21 from node # 1400 -- to node # 1500

-) Box Culvert (-

Span (inches)	--)	84
Rise (inches)	--)	84
Length (feet)	--)	90
Manning's n	--)	.013
Headwater invert (feet)	--)	2.26
Tailwater invert (feet)	--)	2
Energy loss coefficient	--)	1
Entrnc loss coefficient	--)	.5
# of culverts/channels	--)	1

REACH # 22 from node # 1400 -- to node # 1500

-) Rating Curve (-

STAGE (feet)	FLOW (cfs)
13.500	0.000
13.600	4.000
13.700	10.000
13.800	18.000
13.900	27.000
14.000	38.000

REACH # 23 from node # 1500 -- to node # 1600

-) Box Culvert (-

Span (inches)	--)	360
Rise (inches)	--)	108
Length (feet)	--)	45
Manning's n	--)	.017
Headwater invert (feet)	--)	.5
Tailwater invert (feet)	--)	.4
Energy loss coefficient	--)	1
Entrnc loss coefficient	--)	.5
# of culverts/channels	--)	1

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CLOUD BRANCH HYDR SIMUL (F) - 25YR/6HR - CH C\O & 2PONDS & 19TH-RR-8TH CULVS
APRIL 1988

****
*** INFLOW HYDROGRAPHS ***
****

INFLOW HYDROGRAPHS TO BE READ FROM DISK FILE

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APRIL 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	# 2	# 3	TOTAL
100	0.00	30.22	0.00	0.00	0.00	------	------	0.00
200	0.00	30.22	0.00	0.00	0.00	------	------	0.00
300	0.00	26.98	0.01	0.00	2.27	0.00	------	2.27
400	0.00	24.85	0.00	2.27	2.43	1.33	0.00	3.77
500	0.00	27.00	0.00	0.00	0.00	------	------	0.00
600	0.00	26.50	0.00	0.00	0.00	------	------	0.00
700	0.00	22.05	0.00	3.77	0.00	------	------	0.00
800	0.00	21.81	0.00	0.00	0.00	------	------	0.00
900	0.00	21.81	0.00	0.00	0.00	------	------	0.00
1000	0.00	19.91	0.26	0.00	3.75	------	------	3.75
1100	0.00	17.66	0.00	3.75	1.50	1.14	0.00	2.64
1200	0.00	15.77	0.00	2.64	4.64	0.00	------	4.64
1300	0.00	8.35	0.00	4.64	1.91	0.00	------	1.91
1400	0.00	3.05	0.01	1.91	3.52	0.00	------	3.52
1500	0.00	3.04	2.50	3.52	90.00	------	------	90.00
1600	0.00	3.00	0.00	90.00	------	------	------	0.00
100	0.25	30.22	0.00	0.00	0.00	------	------	0.00
200	0.25	30.22	0.00	0.00	0.00	------	------	0.00
300	0.25	26.95	0.01	0.00	0.04	0.00	------	0.04
400	0.25	-24.79	0.00	0.04	0.02	0.02	0.00	0.04
500	0.25	27.00	0.00	0.00	0.00	------	------	0.00
600	0.25	26.50	0.00	0.00	0.00	------	------	0.00
700	0.25	22.01	0.00	0.04	0.00	------	------	0.00
800	0.25	21.81	0.00	0.00	0.00	------	------	0.00
900	0.25	21.81	0.00	0.00	0.00	------	------	0.00
1000	0.25	19.39	0.20	0.00	2.85	------	------	2.85
1100	0.25	17.97	0.02	2.85	2.05	0.93	0.00	2.98
1200	0.25	16.06	0.01	2.98	3.00	0.00	------	3.00
1300	0.25	8.62	0.01	3.00	3.10	0.00	------	3.10
1400	0.25	3.27	0.02	3.10	16.96	0.00	------	16.96
1500	0.25	3.01	2.47	16.96	45.00	------	------	45.00
1600	0.25	3.00	0.07	45.00	------	------	------	0.00
100	0.50	30.22	0.00	0.00	0.00	------	------	0.00
200	0.50	30.22	0.00	0.00	0.00	------	------	0.00
300	0.50	26.94	0.01	0.00	0.04	0.00	------	0.04
400	0.50	24.79	0.00	0.04	0.02	0.02	0.00	0.04
500	0.50	27.00	0.00	0.00	0.00	------	------	0.00
600	0.50	26.50	0.00	0.00	0.00	------	------	0.00
700	0.50	22.04	0.00	0.04	0.00	------	------	0.00
800	0.50	21.81	0.00	0.00	0.00	------	------	0.00
900	0.50	21.81	0.00	0.00	0.00	------	------	0.00
1000	0.50	19.37	0.15	0.00	2.12	------	------	2.12
1100	0.50	17.90	0.01	2.12	1.59	0.64	0.00	2.24
1200	0.50	16.01	0.00	2.24	2.29	0.00	------	2.29
1300	0.50	3.56	0.01	2.29	2.34	0.00	------	2.34
1400	0.50	3.23	0.02	2.34	15.66	0.00	------	15.66
1500	0.50	3.02	2.43	15.66	52.30	------	------	52.30
1600	0.50	3.01	0.07	52.30	------	------	------	0.00

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APRIL 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	# 2	# 3	TOTAL
100	0.75	30.22	0.00	0.00	0.00	------	------	0.00
200	0.75	30.22	0.00	0.00	0.00	------	------	0.00
300	0.75	26.93	0.01	0.00	0.03	0.00	------	0.03
400	0.75	24.79	0.00	0.03	0.02	0.01	0.00	0.03
500	0.75	27.00	0.00	0.00	0.00	------	------	0.00
600	0.75	26.50	0.00	0.00	0.00	------	------	0.00
700	0.75	22.00	0.00	0.03	0.00	------	------	0.00
800	0.75	21.81	0.00	0.00	0.00	------	------	0.00
900	0.75	21.81	0.00	0.00	0.00	------	------	0.00
1000	0.75	19.35	0.11	0.00	1.60	------	------	1.60
1100	0.75	17.85	0.01	1.60	1.21	0.48	0.00	1.69
1200	0.75	15.96	0.00	1.69	1.72	0.00	------	1.72
1300	0.75	8.51	0.00	1.72	1.76	0.00	------	1.76
1400	0.75	3.21	0.02	1.76	14.54	0.00	------	14.54
1500	0.75	3.02	2.49	14.54	54.94	------	------	54.94
1600	0.75	3.01	0.16	54.94	------	------	------	0.00
100	1.00	30.22	0.00	0.00	0.00	------	------	0.00
200	1.00	30.22	0.00	0.00	0.00	------	------	0.00
300	1.00	26.93	0.01	0.00	0.03	0.00	------	0.03
400	1.00	24.79	0.00	0.03	0.02	0.01	0.00	0.03
500	1.00	27.00	0.00	0.00	0.00	------	------	0.00
600	1.00	26.50	0.00	0.00	0.00	------	------	0.00
700	1.00	22.03	0.00	0.03	0.00	------	------	0.00
800	1.00	21.81	0.00	0.00	0.00	------	------	0.00
900	1.00	21.81	0.00	0.00	0.00	------	------	0.00
1000	1.00	19.34	0.08	0.01	1.19	------	------	1.19
1100	1.00	17.81	0.01	1.19	0.92	0.35	0.00	1.26
1200	1.00	15.92	0.00	1.26	1.29	0.00	------	1.29
1300	1.00	8.47	0.00	1.29	1.32	0.00	------	1.32
1400	1.00	3.19	0.02	1.32	13.71	0.00	------	13.71
1500	1.00	3.02	2.49	13.71	52.10	------	------	52.10
1600	1.00	3.01	0.19	52.10	------	------	------	0.00
100	1.25	30.22	0.00	0.00	0.00	------	------	0.00
200	1.25	30.22	0.00	0.00	0.00	------	------	0.00
300	1.25	26.92	0.01	0.00	0.02	0.00	------	0.02
400	1.25	24.78	0.00	0.02	0.01	0.01	0.00	0.03
500	1.25	27.00	-0.00	0.01	0.00	------	------	0.00
600	1.25	26.50	0.00	0.00	0.00	------	------	0.00
700	1.25	21.99	0.00	0.03	0.00	------	------	0.00
800	1.25	21.81	0.00	0.00	0.00	------	------	0.00
900	1.25	21.81	0.00	0.00	0.00	------	------	0.00
1000	1.25	19.84	0.07	0.26	0.95	------	------	0.95
1100	1.25	17.78	0.01	0.95	0.74	0.26	0.00	1.00
1200	1.25	15.90	0.00	1.00	1.01	0.00	------	1.01
1300	1.25	8.44	0.00	1.01	1.02	0.00	------	1.02
1400	1.25	3.13	0.02	1.02	13.20	0.00	------	13.20
1500	1.25	3.03	2.49	13.20	52.34	------	------	52.34

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CLOUD BRANCH HYDR SIMUL (F) - 25YR/6HR - CH C\O & 2PONDS & 19TH-RR-8TH CULVS
APRIL 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	# 2	# 3	TOTAL
100	1.50	30.22	0.00	0.00	0.00	------	------	0.00
200	1.50	30.22	0.00	0.00	0.00	------	------	0.00
300	1.50	26.92	0.00	0.00	0.02	0.00	------	0.02
400	1.50	24.78	0.00	0.02	0.01	0.01	0.00	0.02
500	1.50	27.00	0.00	0.34	3.26	------	------	3.26
600	1.50	26.50	0.00	0.00	0.00	------	------	0.00
700	1.50	22.01	0.00	3.28	0.00	------	------	0.00
800	1.50	21.81	0.00	0.00	0.00	------	------	0.00
900	1.50	21.81	0.00	0.00	0.00	------	------	0.00
1000	1.50	19.53	0.06	1.05	0.37	------	------	0.37
1100	1.50	17.76	0.01	0.37	0.65	0.23	0.00	0.37
1200	1.50	15.38	0.00	0.37	0.33	0.00	------	0.38
1300	1.50	3.42	0.00	0.38	0.38	0.00	------	0.38
1400	1.50	3.13	0.02	0.38	12.87	0.00	------	12.87
1500	1.50	3.03	2.50	12.87	57.55	------	------	57.55
1600	1.50	3.02	0.22	57.55	------	------	------	0.00
100	1.75	30.22	-0.00	0.12	0.00	------	------	0.00
200	1.75	30.22	0.00	0.00	0.00	------	------	0.00
300	1.75	26.93	0.01	0.00	0.03	0.00	------	0.03
400	1.75	24.79	0.00	0.03	0.02	0.01	0.00	0.03
500	1.75	27.00	0.00	2.21	1.70	------	------	1.70
600	1.75	26.50	0.00	0.00	0.00	------	------	0.00
700	1.75	22.14	0.01	1.73	0.92	------	------	0.92
800	1.75	21.81	0.00	0.00	0.00	------	------	0.00
900	1.75	21.81	0.00	0.00	0.00	------	------	0.00
1000	1.75	19.85	0.10	3.77	1.41	------	------	1.41
1100	1.75	17.80	0.01	1.41	0.90	0.34	0.00	1.24
1200	1.75	15.91	0.00	1.27	1.20	0.00	------	1.20
1300	1.75	3.45	0.00	1.21	1.14	0.00	------	1.14
1400	1.75	3.19	0.02	1.14	13.35	0.00	------	13.35
1500	1.75	3.04	2.50	13.35	57.52	------	------	57.52
1600	1.75	3.02	0.24	57.52	------	------	------	0.00
100	2.00	30.27	0.01	3.16	0.20	------	------	0.20
200	2.00	30.22	0.00	0.00	0.00	------	------	0.00
300	2.00	27.00	0.01	0.20	0.14	0.00	------	0.14
400	2.00	24.82	0.00	0.16	0.07	0.04	0.00	0.11
500	2.00	27.80	0.06	6.67	2.91	------	------	2.91
600	2.00	26.50	0.00	0.00	0.00	------	------	0.00
700	2.00	22.29	0.01	3.22	2.65	------	------	2.65
800	2.00	21.81	-0.00	0.01	0.00	------	------	0.00
900	2.00	21.81	-0.00	0.13	0.00	------	------	0.00
1000	2.00	19.87	0.17	3.51	2.42	------	------	2.42
1100	2.00	17.90	0.01	2.42	1.55	0.64	0.00	2.19
1200	2.00	16.06	0.01	3.03	3.00	0.00	------	3.00
1300	2.00	3.64	0.01	3.35	3.28	0.00	------	3.28
1400	2.00	3.23	0.02	3.48	17.12	0.00	------	17.13
1500	2.00	3.04	2.50	17.18	54.80	------	------	54.80

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CLOUD BRANCH HYDR SIMUL (F) - 25YR/6HR - CH C\0 & 2PONDS & 19TH-RR-8TH CULVS
APRIL 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	# 2	# 3	TOTAL
100	2.25	31.70	0.27	33.99	11.09	------	------	11.09
200	2.25	30.22	-0.00	0.96	0.00	------	------	0.00
300	2.25	27.49	0.07	14.18	3.76	0.00	------	3.76
400	2.25	25.19	0.01	5.41	2.91	1.74	0.00	4.65
500	2.25	29.47	0.19	30.65	23.20	------	------	23.20
600	2.25	26.58	-0.00	0.37	0.00	------	------	0.00
700	2.25	23.04	0.06	35.52	22.29	------	------	22.29
800	2.25	21.87	0.01	3.24	0.31	------	------	0.31
900	2.25	21.87	0.01	3.03	0.26	------	------	0.26
1000	2.25	20.03	0.52	42.63	3.34	------	------	3.34
1100	2.25	18.41	0.03	13.24	6.65	3.85	0.00	10.51
1200	2.25	16.67	0.01	20.19	20.59	0.00	------	20.59
1300	2.25	9.77	0.06	37.66	30.97	0.00	------	30.97
1400	2.25	3.75	0.05	32.79	32.02	0.00	------	32.02
1500	2.25	3.06	2.53	32.02	88.84	------	------	88.84
1600	2.25	3.03	0.54	88.34	------	------	------	0.00
100	2.50	34.29	0.79	94.60	67.74	------	------	67.74
200	2.50	31.25	0.02	6.01	5.54	------	------	5.54
300	2.50	29.15	0.73	91.44	41.14	0.00	------	41.14
400	2.50	25.29	0.05	43.54	27.74	17.57	0.00	45.31
500	2.50	31.03	0.37	66.48	50.07	------	------	50.07
600	2.50	26.67	0.00	2.52	0.82	------	------	0.82
700	2.50	24.25	0.75	132.25	73.67	------	------	73.67
800	2.50	23.38	0.17	21.57	10.38	------	------	10.38
900	2.50	22.90	0.14	14.05	5.26	------	------	5.26
1000	2.50	20.54	1.92	127.01	27.53	------	------	27.53
1100	2.50	19.30	0.15	45.30	22.53	15.01	0.00	37.54
1200	2.50	17.53	0.05	69.00	67.07	0.00	------	67.07
1300	2.50	11.36	0.25	116.39	100.45	0.00	------	100.45
1400	2.50	5.67	0.25	124.06	110.51	0.00	------	110.51
1500	2.50	3.08	2.55	110.51	106.26	------	------	106.26
1600	2.50	3.03	1.93	106.26	------	------	------	0.00
100	2.75	35.10	1.42	113.05	90.38	------	------	90.38
200	2.75	31.36	0.02	6.67	6.73	------	------	6.73
300	2.75	30.37	1.64	118.66	82.82	0.00	------	82.82
400	2.75	27.06	0.11	92.05	54.24	35.71	0.00	89.95
500	2.75	31.19	0.78	69.73	52.80	------	------	52.80
600	2.75	27.39	0.02	3.52	3.52	------	------	3.52
700	2.75	25.30	2.27	207.58	132.56	------	------	132.56
800	2.75	25.24	0.38	45.71	39.53	------	------	39.53
900	2.75	24.45	0.33	34.26	25.88	------	------	25.88
1000	2.75	21.60	4.62	232.49	67.02	------	------	67.02
1100	2.75	20.12	0.35	85.83	42.73	30.52	0.00	73.25
1200	2.75	13.17	0.09	119.09	116.69	0.00	------	116.69
1300	2.75	12.49	0.54	170.34	162.58	0.00	------	162.58
1400	2.75	6.91	0.50	134.47	175.68	0.00	------	175.68
1500	2.75	3.16	2.64	175.68	171.79	------	------	171.79

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CLOUD BRANCH HYDR SIMUL (F) - 25YR/6HR - CH C\O & 2PONDS & 19TH-RR-8TH CULVS
APRIL 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	# 2	# 3	TOTAL
100	3.00	35.39	1.64	100.42	98.88	------	------	98.86
200	3.00	31.38	0.02	6.36	6.20	------	------	6.20
300	3.00	31.12	2.20	125.68	107.05	0.00	------	107.05
400	3.00	27.44	0.16	115.60	68.20	46.49	0.00	114.69
500	3.00	31.27	1.00	59.44	54.25	------	------	54.25
600	3.00	27.38	0.02	3.44	3.45	------	------	3.45
700	3.00	26.10	3.60	235.34	184.97	------	------	184.97
800	3.00	25.82	0.45	52.01	49.74	------	------	49.74
900	3.00	25.67	0.48	53.77	47.97	------	------	47.97
1000	3.00	23.39	7.89	310.73	177.04	------	------	177.04
1100	3.00	21.60	0.86	194.24	93.74	73.24	0.00	166.98
1200	3.00	19.08	0.27	211.33	200.38	0.00	------	200.38
1300	3.00	13.42	0.83	247.76	218.47	0.00	------	218.47
1400	3.00	7.69	0.69	237.28	222.46	0.00	------	222.46
1500	3.00	3.23	2.72	222.46	215.70	------	------	215.70
1600	3.00	3.04	3.79	215.70	------	------	------	0.00
100	3.25	35.31	1.58	90.63	96.67	------	------	96.67
200	3.25	31.56	0.03	5.87	5.79	------	------	5.79
300	3.25	31.45	2.45	121.25	116.07	0.00	------	116.07
400	3.25	27.60	0.15	124.37	72.43	51.22	0.00	123.64
500	3.25	31.23	1.02	51.29	54.37	------	------	54.37
600	3.25	27.37	0.02	3.35	3.36	------	------	3.36
700	3.25	26.56	4.39	243.08	216.09	------	------	216.09
800	3.25	25.39	0.57	52.35	38.71	------	------	38.71
900	3.25	25.99	0.82	62.81	35.20	------	------	35.20
1000	3.25	24.36	10.39	313.81	217.23	------	------	217.23
1100	3.25	22.65	1.17	232.68	123.71	97.12	0.00	220.83
1200	3.25	19.64	0.44	261.37	256.66	0.00	------	256.66
1300	3.25	14.47	1.36	298.21	279.77	0.00	------	279.77
1400	3.25	3.68	0.96	295.53	286.13	0.00	------	286.13
1500	3.25	3.37	2.87	286.14	279.51	------	------	279.51
1600	3.25	3.04	13.91	279.51	------	------	------	0.00
100	3.50	35.10	1.42	81.77	90.39	------	------	90.39
200	3.50	31.58	0.03	5.46	5.54	------	------	5.54
300	3.50	31.49	2.48	114.19	116.93	0.00	------	116.93
400	3.50	27.71	0.16	124.38	69.90	54.14	0.00	124.04
500	3.50	31.23	0.89	44.47	53.52	------	------	53.52
600	3.50	27.35	0.01	3.24	3.25	------	------	3.25
700	3.50	26.79	4.79	240.61	227.64	------	------	227.64
800	3.50	26.14	0.94	52.66	32.35	------	------	32.35
900	3.50	26.36	1.66	64.54	32.15	------	------	32.15
1000	3.50	25.41	11.77	311.14	267.99	------	------	267.99
1100	3.50	23.46	1.47	281.96	152.06	118.05	0.00	270.11
1200	3.50	20.09	0.58	308.39	302.33	0.00	------	302.33
1300	3.50	15.21	1.73	338.96	320.57	0.00	------	320.57
1400	3.50	9.21	1.15	334.36	322.45	0.00	------	322.45
1500	3.50	3.46	2.98	322.45	317.24	------	------	317.24

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CLOUD BRANCH HYDR SIMUL (F) - 25YR/6HR - CH C\O & 2PONDS & 19TH-RR-8TH CULVS
APRIL 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	# 2	# 3	TOTAL
100	3.75	34.84	1.21	70.78	82.48	------	------	82.48
200	3.75	31.43	0.02	4.79	4.92	------	------	4.92
300	3.75	31.32	2.35	103.61	112.69	0.00	------	112.69
400	3.75	27.72	0.16	119.22	65.38	53.83	0.00	119.20
500	3.75	31.14	0.65	37.91	51.95	------	------	51.95
600	3.75	27.31	0.01	2.92	2.96	------	------	2.96
700	3.75	26.92	5.00	231.14	220.42	------	------	220.42
800	3.75	26.41	1.35	51.53	33.11	------	------	33.11
900	3.75	26.74	2.12	64.93	34.46	------	------	34.46
1000	3.75	25.65	12.35	303.52	289.67	------	------	289.67
1100	3.75	23.90	1.66	301.72	167.35	128.42	0.00	295.77
1200	3.75	20.36	0.66	331.13	328.73	0.00	------	328.73
1300	3.75	15.78	2.02	359.71	350.47	0.00	------	350.47
1400	3.75	9.67	1.36	362.24	355.14	0.00	------	355.14
1500	3.75	3.56	3.09	355.14	350.94	------	------	350.94
1600	3.75	3.05	27.01	350.94	------	------	------	0.00
100	4.00	34.49	0.94	59.16	72.96	------	------	72.96
200	4.00	31.22	0.02	4.21	4.41	------	------	4.41
300	4.00	31.02	2.12	91.43	103.98	0.00	------	103.98
400	4.00	27.62	0.15	109.55	60.21	49.98	0.00	110.19
500	4.00	31.02	0.32	31.66	49.69	------	------	49.69
600	4.00	27.26	0.91	2.34	2.58	------	------	2.58
700	4.00	26.94	5.04	213.97	218.20	------	------	218.20
800	4.00	26.62	1.63	43.94	35.64	------	------	35.64
900	4.00	27.08	2.70	64.13	38.08	------	------	38.08
1000	4.00	25.75	12.59	304.34	298.49	------	------	298.49
1100	4.00	24.09	1.75	309.00	173.73	132.58	0.00	306.31
1200	4.00	20.45	0.69	337.36	336.97	0.00	------	336.97
1300	4.00	15.99	2.12	362.78	360.90	0.00	------	360.90
1400	4.00	9.36	1.45	371.11	369.32	0.00	------	369.32
1500	4.00	3.61	3.15	369.32	367.67	------	------	367.67
1600	4.00	3.05	34.46	367.67	------	------	------	0.00
100	4.25	33.91	0.67	50.46	57.57	------	------	57.57
200	4.25	31.09	0.02	3.87	3.93	------	------	3.93
300	4.25	30.64	1.84	74.34	92.03	0.00	------	92.03
400	4.25	27.32	0.13	96.98	56.69	41.63	0.00	98.33
500	4.25	29.79	0.21	27.62	28.50	------	------	28.50
600	4.25	27.22	0.01	2.29	2.31	------	------	2.31
700	4.25	26.72	4.67	175.53	198.07	------	------	198.07
800	4.25	26.76	1.39	45.19	38.49	------	------	38.49
900	4.25	27.35	3.19	62.48	41.98	------	------	41.98
1000	4.25	25.74	12.57	290.10	297.80	------	------	297.80
1100	4.25	24.13	1.77	307.38	175.11	133.46	0.00	308.57
1200	4.25	20.64	0.68	335.63	336.34	0.00	------	336.34
1300	4.25	15.99	2.12	359.13	360.92	0.00	------	360.92
1400	4.25	9.89	1.46	370.18	370.88	0.00	------	370.88
1500	4.25	3.62	3.16	370.88	371.17			

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CLOUD BRANCH HYDR SIMUL (F) - 25YR/6HR - CH C\0 & 2PONDS & 19TH-RR-8TH CULVS
APRIL 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	# 2	# 3	TOTAL
100	4.50	33.46	0.59	43.92	46.30	------	------	46.30
200	4.50	31.04	0.02	3.47	3.45	------	------	3.45
300	4.50	30.17	1.49	61.29	75.91	0.00	------	75.91
400	4.50	26.98	0.10	80.36	48.33	33.17	0.00	81.50
500	4.50	29.58	0.19	24.18	24.88	------	------	24.88
600	4.50	27.18	0.01	2.07	2.10	------	------	2.10
700	4.50	26.43	4.16	149.98	174.95	------	------	174.95
800	4.50	26.81	1.96	41.23	41.15	------	------	41.15
900	4.50	27.56	3.55	59.88	45.80	------	------	45.80
1000	4.50	25.64	12.32	272.07	288.60	------	------	288.60
1100	4.50	24.00	1.71	297.16	170.86	130.69	0.00	301.55
1200	4.50	20.34	0.65	325.20	327.19	0.00	------	327.19
1300	4.50	15.84	2.05	347.44	353.26	0.00	------	353.26
1400	4.50	9.80	1.42	361.43	364.64	0.00	------	364.64
1500	4.50	3.60	3.14	364.64	366.21	------	------	366.21
1600	4.50	3.06	49.73	366.21	------	------	------	0.00
100	4.75	33.24	0.55	39.46	40.94	------	------	40.94
200	4.75	31.01	0.02	3.25	3.27	------	------	3.27
300	4.75	29.34	1.24	54.91	64.35	0.00	------	64.35
400	4.75	26.73	0.08	62.61	41.61	27.40	0.00	69.01
500	4.75	29.41	0.18	21.69	22.12	------	------	22.12
600	4.75	27.15	0.01	1.90	1.91	------	------	1.91
700	4.75	26.11	3.62	130.24	153.55	------	------	153.55
800	4.75	26.77	1.90	37.46	43.00	------	------	43.00
900	4.75	27.69	3.77	56.84	48.97	------	------	48.97
1000	4.75	25.49	11.97	254.31	275.37	------	------	275.37
1100	4.75	23.78	1.61	283.33	163.27	125.76	0.00	289.02
1200	4.75	20.19	0.61	309.61	312.08	0.00	------	312.08
1300	4.75	15.54	1.90	330.47	338.41	0.00	------	338.41
1400	4.75	9.61	1.34	346.07	351.01	0.00	------	351.01
1500	4.75	3.57	3.10	351.01	353.35	------	------	353.35
1600	4.75	3.06	57.12	353.35	------	------	------	0.00
100	5.00	33.10	0.53	36.76	37.67	------	------	37.67
200	5.00	31.01	0.02	3.13	3.13	------	------	3.13
300	5.00	29.63	1.09	51.20	57.07	0.00	------	57.07
400	5.00	26.59	0.07	60.92	37.31	23.95	0.00	61.26
500	5.00	29.31	0.17	20.34	20.59	------	------	20.59
600	5.00	27.13	0.01	1.82	1.82	------	------	1.82
700	5.00	25.86	3.19	118.00	135.69	------	------	135.69
800	5.00	26.67	1.74	34.34	44.07	------	------	44.07
900	5.00	27.75	3.88	54.16	51.49	------	------	51.49
1000	5.00	25.32	11.54	240.13	259.80	------	------	259.80
1100	5.00	23.50	1.49	267.54	153.71	119.22	0.00	272.93
1200	5.00	20.01	0.55	291.45	294.32	0.00	------	294.32
1300	5.00	15.29	1.73	311.76	320.36	0.00	------	320.36
1400	5.00	9.37	1.23	327.35	333.57	0.00	------	333.57
1500	5.00	3.52	3.05	333.57	336.19	------	------	336.19

*** INTER-CONNECTED POND ROUTING PROGRAM *** IC84032 VER 2.83
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CLOUD BRANCH HYDR SIMUL (F) - 25YR/6HR - CH C\0 & 2PONDS & 19TH-RR-8TH CULVS
APRIL 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	# 2	# 3	TOTAL
100	5.25	33.02	0.51	35.36	35.84	------	------	35.84
200	5.25	31.01	0.02	3.19	3.18	------	------	3.18
300	5.25	29.51	0.99	49.31	52.75	0.00	------	52.75
400	5.25	26.51	0.07	56.53	34.61	22.11	0.00	56.72
500	5.25	29.26	0.17	19.66	19.78	------	------	19.78
600	5.25	27.13	0.01	1.79	1.79	------	------	1.79
700	5.25	25.67	2.87	110.95	123.93	------	------	123.93
800	5.25	26.52	1.51	32.22	44.10	------	------	44.10
900	5.25	27.76	3.90	52.12	53.16	------	------	53.16
1000	5.25	25.17	11.17	229.91	246.04	------	------	246.04
1100	5.25	23.25	1.39	253.76	144.80	112.89	0.00	257.69
1200	5.25	19.34	0.50	275.07	277.25	0.00	------	277.25
1300	5.25	14.86	1.55	294.29	301.75	0.00	------	301.75
1400	5.25	9.10	1.10	309.19	314.89	0.00	------	314.89
1500	5.25	3.48	3.00	314.89	317.37	------	------	317.37
1600	5.25	3.07	71.97	317.37	------	------	------	0.00
100	5.50	32.98	0.50	34.65	34.89	------	------	34.89
200	5.50	31.01	0.02	3.23	3.22	------	------	3.22
300	5.50	29.43	0.94	48.47	50.31	0.00	------	50.31
400	5.50	26.46	0.06	54.02	33.09	21.09	0.00	54.19
500	5.50	29.22	0.17	19.35	19.40	------	------	19.40
600	5.50	27.13	0.01	1.79	1.79	------	------	1.79
700	5.50	25.52	2.64	107.03	116.41	------	------	116.41
800	5.50	26.35	1.26	30.32	43.32	------	------	43.32
900	5.50	27.73	3.34	49.71	54.06	------	------	54.06
1000	5.50	25.05	10.37	222.43	235.08	------	------	235.08
1100	5.50	23.06	1.32	242.86	137.87	107.98	0.00	245.84
1200	5.50	19.71	0.46	262.57	264.22	0.00	------	264.22
1300	5.50	14.59	1.42	281.15	286.70	0.00	------	286.70
1400	5.50	3.34	1.00	294.20	297.16	0.00	------	297.16
1500	5.50	3.43	2.95	297.16	299.40	------	------	299.40
1600	5.50	3.07	77.45	299.40	------	------	------	0.00
100	5.75	32.97	0.50	34.46	34.53	------	------	34.53
200	5.75	31.02	0.02	3.28	3.27	------	------	3.27
300	5.75	29.40	0.91	48.28	49.12	0.00	------	49.12
400	5.75	26.44	0.06	52.91	32.34	20.60	0.00	52.95
500	5.75	29.22	0.17	19.26	19.26	------	------	19.26
600	5.75	27.13	0.01	1.81	1.80	------	------	1.80
700	5.75	25.42	2.48	105.19	111.76	------	------	111.76
800	5.75	26.18	1.01	30.18	42.07	------	------	42.07
900	5.75	27.66	3.72	47.25	54.30	------	------	54.30
1000	5.75	24.96	10.64	216.35	226.59	------	------	226.59
1100	5.75	22.91	1.27	234.47	132.64	104.12	0.00	236.76
1200	5.75	19.62	0.43	253.13	254.37	0.00	------	254.37
1300	5.75	14.40	1.32	271.36	275.45	0.00	------	275.45
1400	5.75	3.66	0.96	283.03	285.02	0.00	------	285.02
1500	5.75	3.40	2.92	285.02	286.05	------	------	286.05

*** INTER-CONNECTED POND ROUTING PROGRAM *** IC24032 VER 2.23
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CLOUD BRANCH HYDR SIMUL (F) - 25YR/6HR - CH C\O & 2PONDS & 19TH-RR-8TH CULVS
APRIL 1988

NODE #	TIME (hrs)	STAGE (feet)	STORAGE (acft)	INFLOW (cfs)	OUTFLOW (cfs) # 1	# 2	# 3	TOTAL
100	6.00	32.92	0.49	32.15	33.40	------	------	33.40
200	6.00	30.95	0.31	2.71	2.92	------	------	2.92
300	6.00	29.37	0.89	45.45	48.05	0.00	------	48.05
400	6.00	26.42	0.06	51.51	51.59	20.08	0.00	51.67
500	6.00	29.16	0.16	17.60	18.25	------	------	18.25
600	6.00	27.10	0.01	1.65	1.71	------	------	1.71
700	6.00	25.34	2.35	101.43	108.43	------	------	108.43
800	6.00	26.02	0.77	29.07	40.62	------	------	40.62
900	6.00	27.57	3.55	45.05	54.09	------	------	54.09
1000	6.00	24.33	10.46	210.73	219.76	------	------	219.76
1100	6.00	22.79	1.22	226.45	128.65	100.78	0.00	229.43
1200	6.00	19.53	0.40	245.03	245.95	0.00	------	245.95
1300	6.00	14.23	1.24	261.29	265.95	0.00	------	265.95
1400	6.00	8.51	0.98	272.12	274.61	0.00	------	274.61
1500	6.00	3.38	2.89	274.61	275.77	------	------	275.77
[illegible]	6.00	3.08	39.31	275.77	------	------	------	0.00

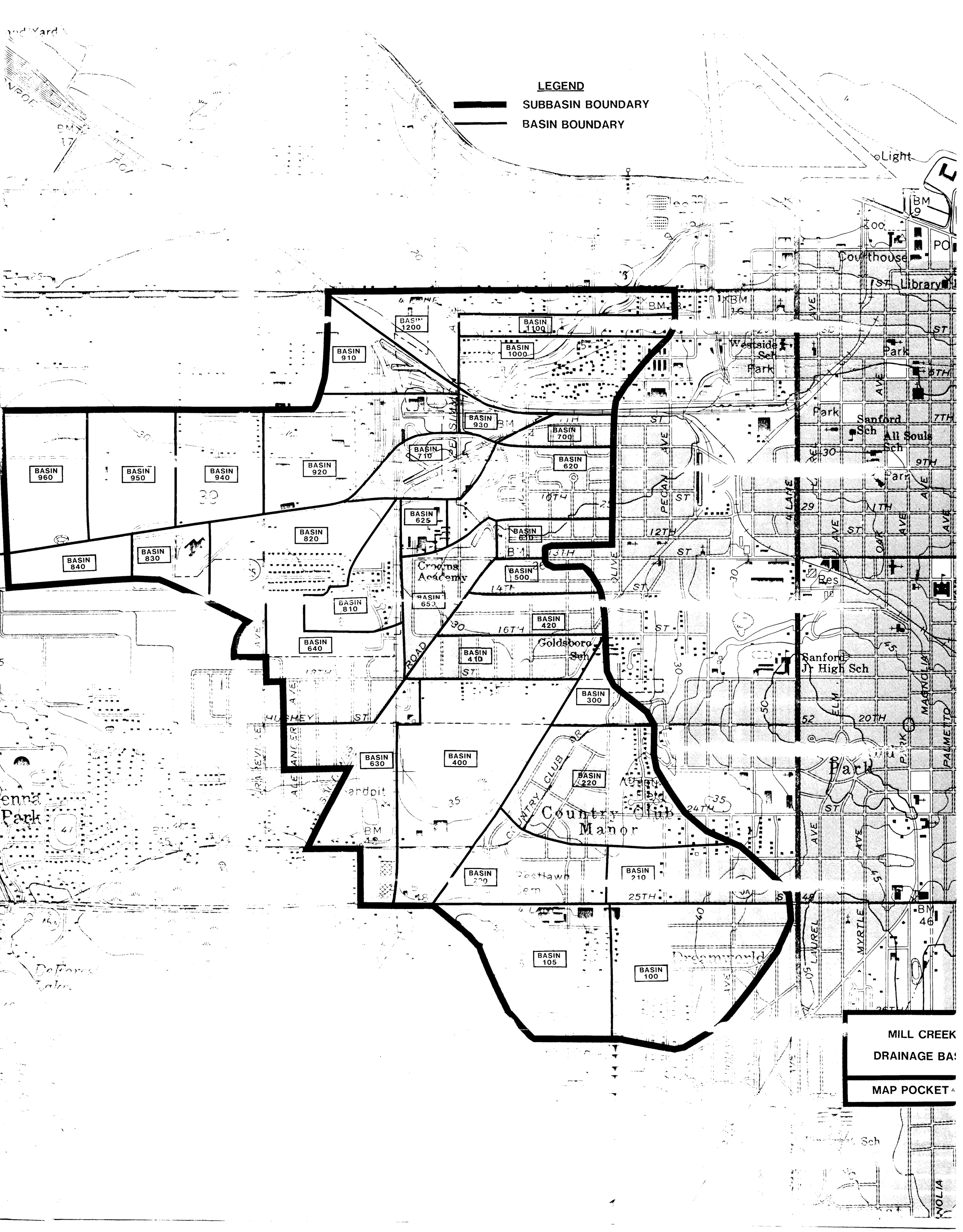
*** INTER-CONNECTED POND ROUTING PROGRAM *** IC84032 VER 2.23

CLOUD BRANCH HYDR SIMUL (F) - 25YR/6HR - CH C\D & 2PONDS & 19TH-RR-8TH CULVS
APRIL 1988

*** PEAK CONDITIONS SUMMARY ***

NODE #	PEAK STAGE (feet)	PEAK STORAGE (acft)	TIME TO PEAK (hrs)	PEAK OUTFLOW (cfs)	TIME TO PEAK (hrs)
100	35.39	1.64*	3.03	98.96	3.02
200	31.60	0.03	3.39	6.94	2.62
300	31.50	2.49	3.41	117.24	3.39
400	27.73	0.16	3.61	124.56	3.39
500	31.28	1.03	3.15	54.44	3.12
600	27.39	0.02	2.74	3.52	2.73
700	26.95	5.06	3.90	229.43	3.64
800	26.81	1.96	4.51	49.97	3.11
900	27.76	3.90	5.17	54.30	5.69
1000	25.76	12.62	4.11	299.65	4.11
1100	24.13	1.77	4.18	308.96	4.18
1200	20.65	0.69	4.10	337.74	4.10
1300	16.01	2.13	4.12	361.79	4.12
1400	9.89	1.46	4.17	371.24	4.16
1500	3.62	3.16	4.22	371.17	4.18
1600	3.08	89.50	6.01	0.00	0.01

FROM NODE	TO NODE	PEAK OUTFLOW (cfs)	TIME TO PEAK (hrs)
100	300	98.96	3.02
200	300	6.94	2.62
300	400	117.24	3.39
300	400	0.00	0.01
400	700	72.43	3.25
400	700	54.52	3.57
400	700	0.00	0.01
500	700	54.44	3.12
600	700	3.52	2.73
700	1000	229.43	3.64
800	1000	49.97	3.11
900	1000	54.30	5.69
1000	1100	299.65	4.11
1100	1200	175.35	4.18
1100	1200	133.60	4.17
1100	1200	0.00	0.01
1200	1300	337.74	4.10
1200	1300	0.00	0.01
1300	1400	361.79	4.12
1300	1400	0.00	0.01
1400	1500	371.24	4.16
1400	1500	0.00	0.01
1500	1600	371.17	4.18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BASIN BOUNDARY
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BASIN 1000
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BASIN 960
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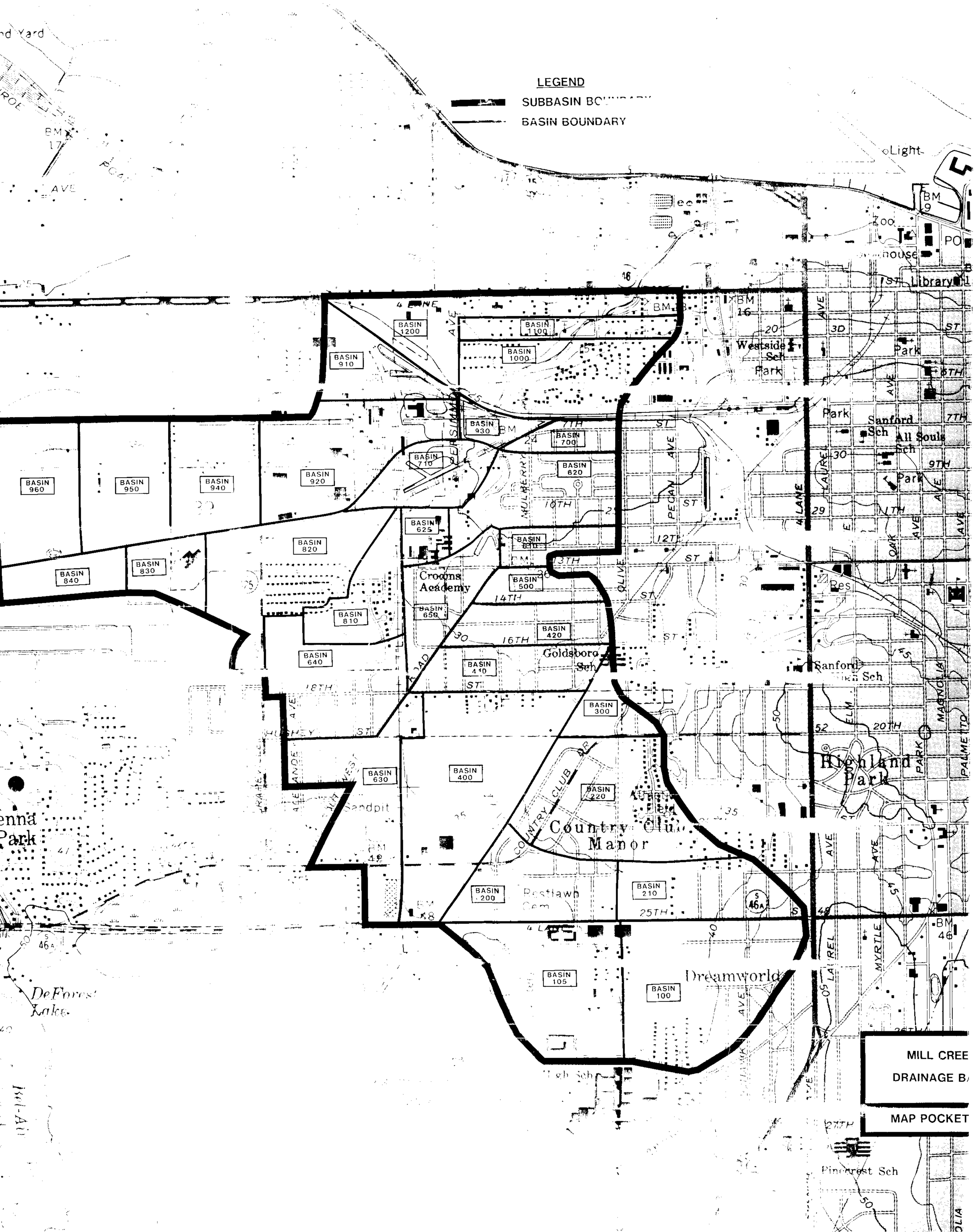
BASIN 920
BASIN 625
BASIN 610
BASIN 820
BASIN 830
BASIN 840
BASIN 500
BASIN 810
BASIN 653
BASIN 420
BASIN 640
BASIN 410
BASIN 300
BASIN 630
BASIN 400
BASIN 220
BASIN 210
BASIN 105
BASIN 100
Courthouse
Library
Westside Sch
Park
Sanford Sch
All Souls Sch
Crooms Academy
Goldsboro Sch
Sanford Jr High Sch
Country Club Manor
Dreamworld
Sch
MILL CREEK
DRAINAGE BA
MAP POCKET


LEGEND
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BASIN 630
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BASIN 220
BASIN 200
BASIN 210
BASIN 105
BASIN 100
Crooms Academy
Goldsboro Sch
Westside Sch
Sanford Sch
All Souls Sch
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Country Club Manor
Sandpit
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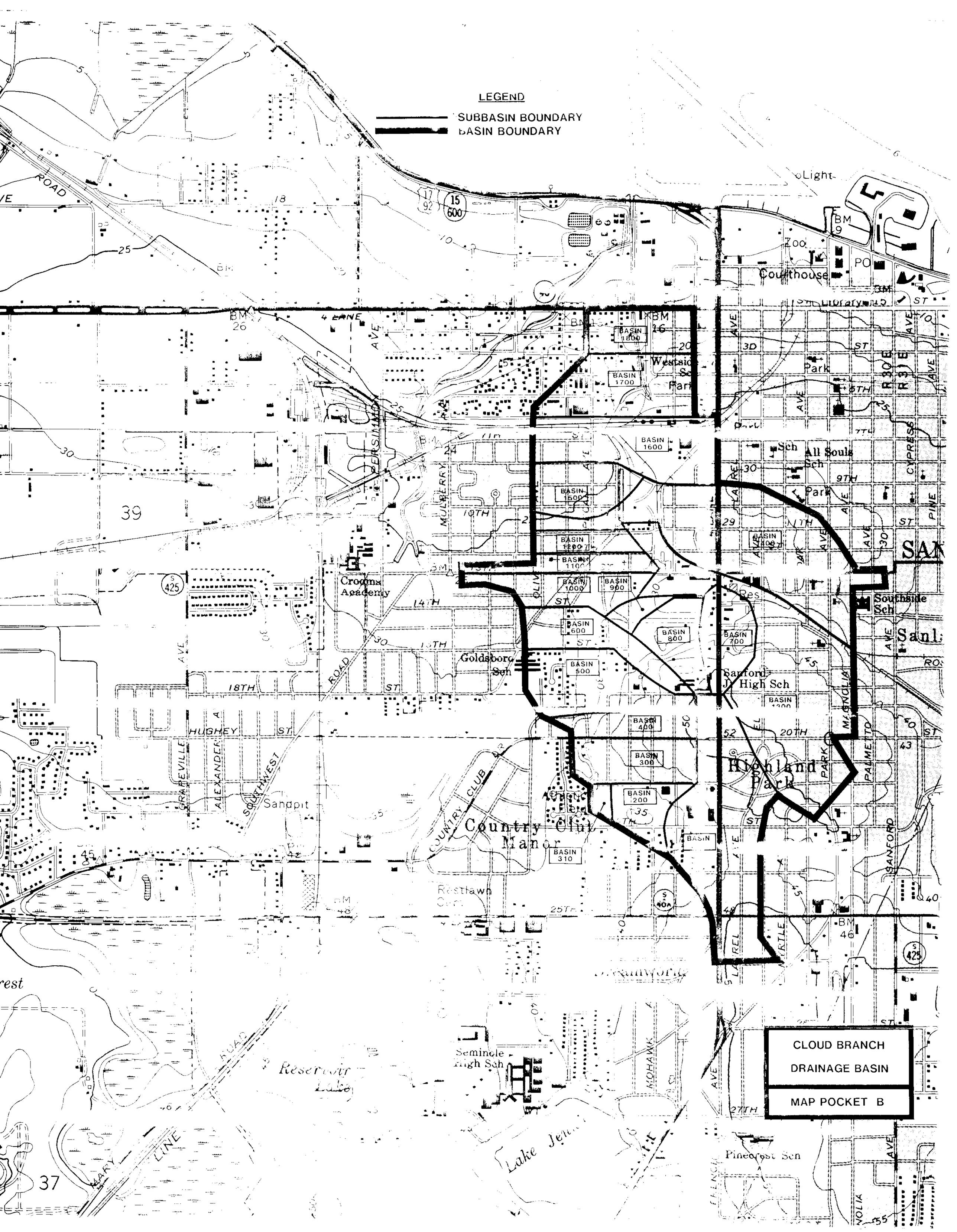
Zoo
Park
Res
MILL CREE
DRAINAGE B
MAP POCKET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BASIN BOUNDARY
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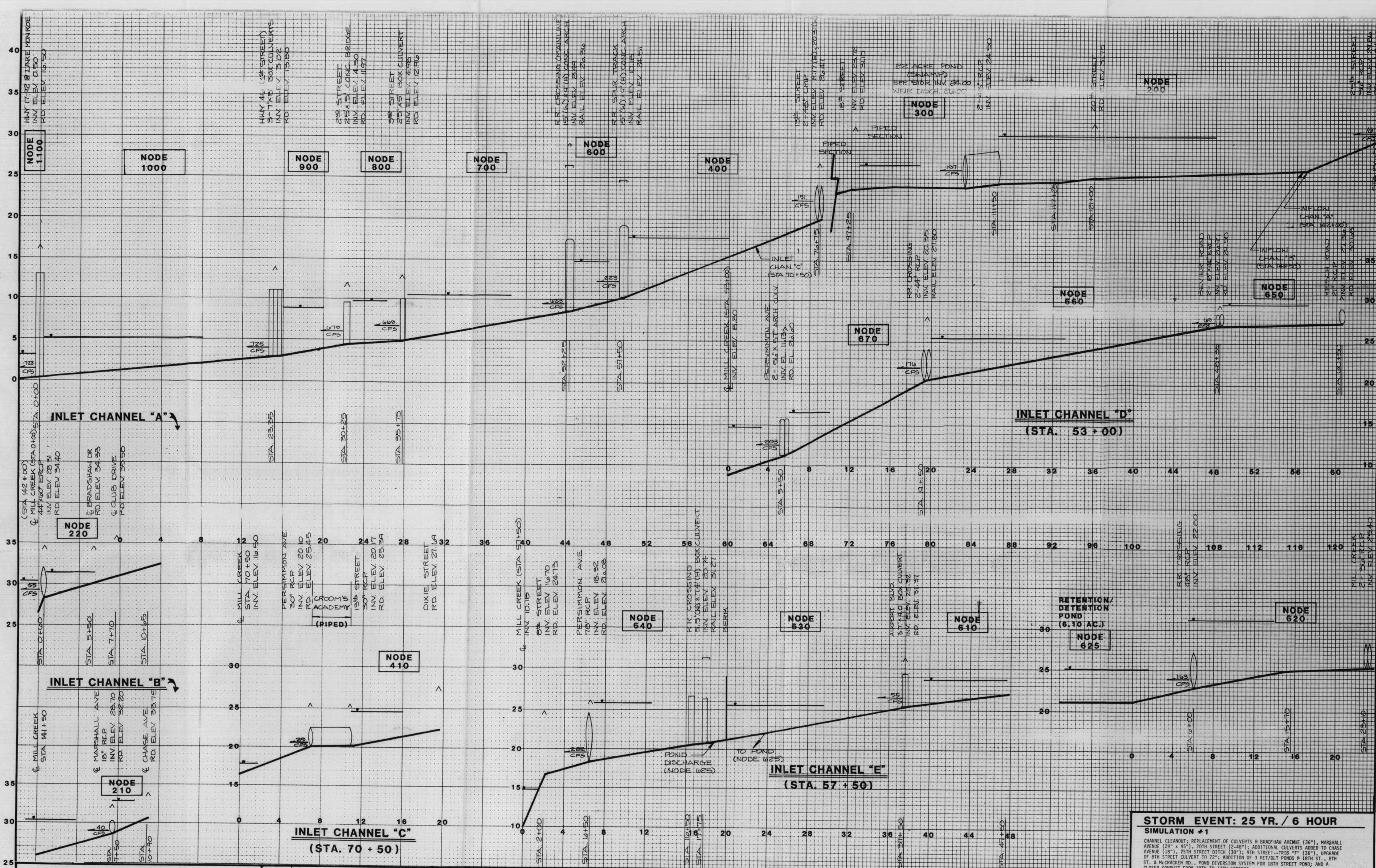
BASIN 800
BASIN 700
BASIN 600
BASIN 500
BASIN 400
BASIN 300
BASIN 200
BASIN 310
Courthouse
Zoo
Library
Westside Sch
Park
All Souls Sch
Crooms Academy
Goldsboro Sch
Southside Sch
Sanford Jr High Sch
Highland Park
Country Club Manor
Sandpit
Reservoir Lake
Seminole High Sch
Lake Jennie
Pinecrest Sch
CLOUD BRANCH
DRAINAGE BASIN
MAP POCKET B



STORM EVENT: 25 YR. / 6 HOUR

SIMULATION #1

CHANNEL CLEANOUT: REPLACEMENT OF CULVERTS @ BRADSHAW AVENUE (36"), MARSHALL AVENUE (29" x 45"), 20TH STREET (2-48"); ADDITIONAL CULVERTS ADDED TO CHASE AVENUE (18"), 25TH STREET DITCH (30"); 9TH STREET--TRIB "F" (36"), UPGRADE OF 8TH STREET CULVERT TO 72"; ADDITION OF 3 RET/DET PONDS @ 18TH ST., 8TH ST. & McCRACKEN RD., POND DIVERSION SYSTEM FOR 18TH STREET POND; AND A CLOSED CONDUIT FROM 18TH TO 13TH STREETS.

Conklin Porter and Holmes ENGINEERS, INC.
POST OFFICE BOX 1976
500 W. FULTON STREET
SANFORD, FLORIDA 32771
TEL 305 322-6841 TEL 305 831-5717

DATE TO FOR
PROJECT CONTROL

ACTIVITY	NAME	DATE
DESIGNED BY	B.M.F.	4/88
DRAWN BY	B.M.F./ J.L.D.	4/88
CHECKED BY	J. C. B.	4/88
APPROVED BY	J. C. BRANCH	4/88
REGISTRATION NO	34791	

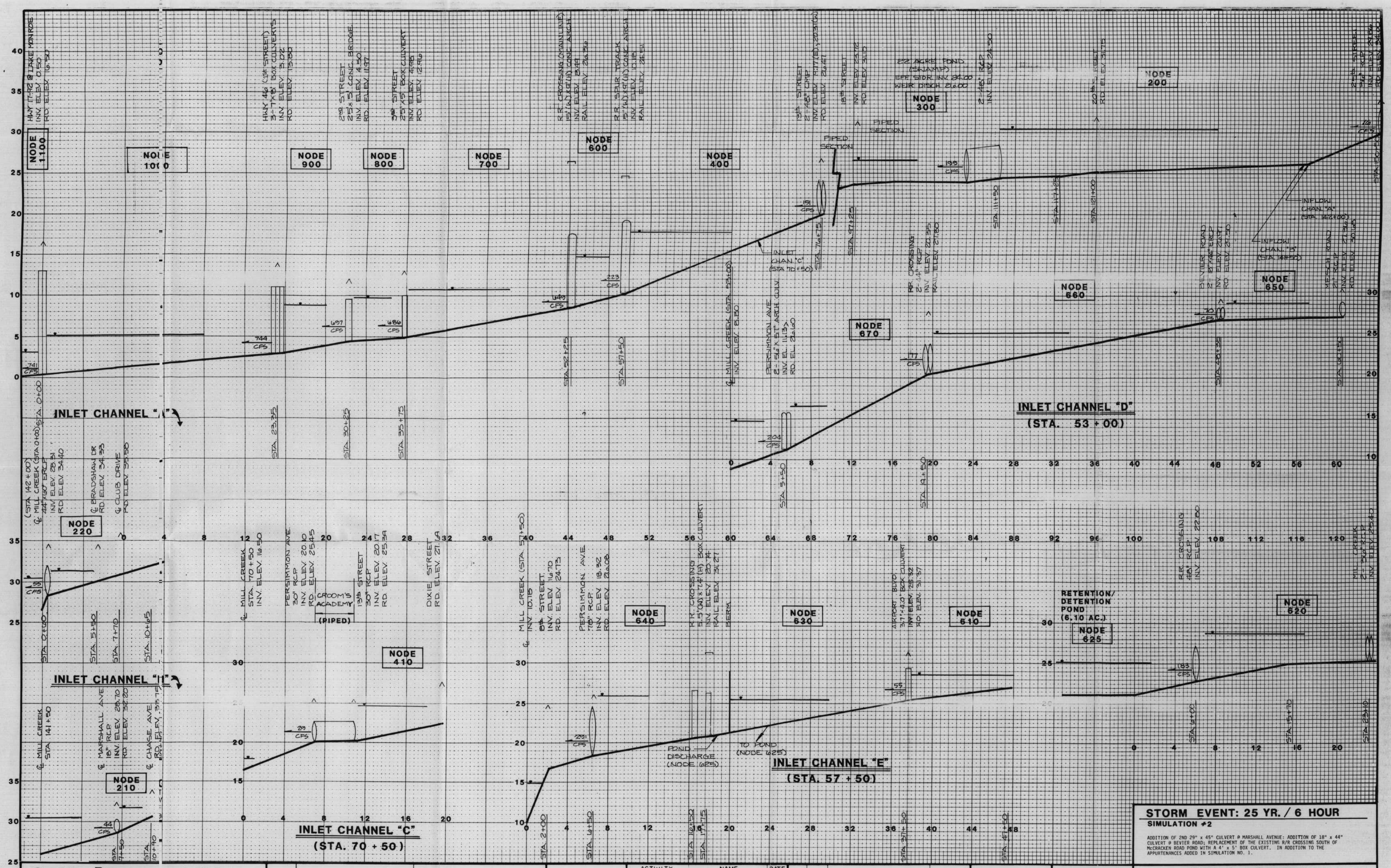
NO	DATE	REVISION	APPROVED

SCALE 1" 400'
DATE APRIL 1988
JOB NO. S0607.00

DRAWING NO. 1 of 6

MILL CREEK DRAINAGE STUDY

MAP POCKET C



STORM EVENT: 25 YR. / 6 HOUR

SIMULATION #2

ADDITION OF 2ND 29" x 45" CULVERT @ MARSHALL AVENUE: ADDITION OF 18" x 44" CULVERT @ BEVIER ROAD; REPLACEMENT OF THE EXISTING R/R CROSSING SOUTH OF McCRACKEN ROAD POND WITH A 4' x 5' BOX CULVERT. IN ADDITION TO THE APPURTENANCES ADDED IN SIMULATION NO. 1.

Conklin Porter and Holmes
ENGINEERS, INC.
POST OFFICE BOX 1976
500 W. FULTON STREET
SANFORD, FLORIDA 32771
TEL 305 322-6841 TEL 305 831-5717

DATE	TO	FOR
	PROJECT CONTROL	

ACTIVITY	NAME	DATE
DESIGNED BY	B.M.F.	4/88
DRAWN BY	B.M.F./ J.L.D.	4/88
CHECKED BY	J. C. B.	4/88
APPROVED BY	J. C. BRANCH	4/88
REGISTRATION NO	34791	

NO	DATE	REVISION	APPROVED

SCALE 1" 400'

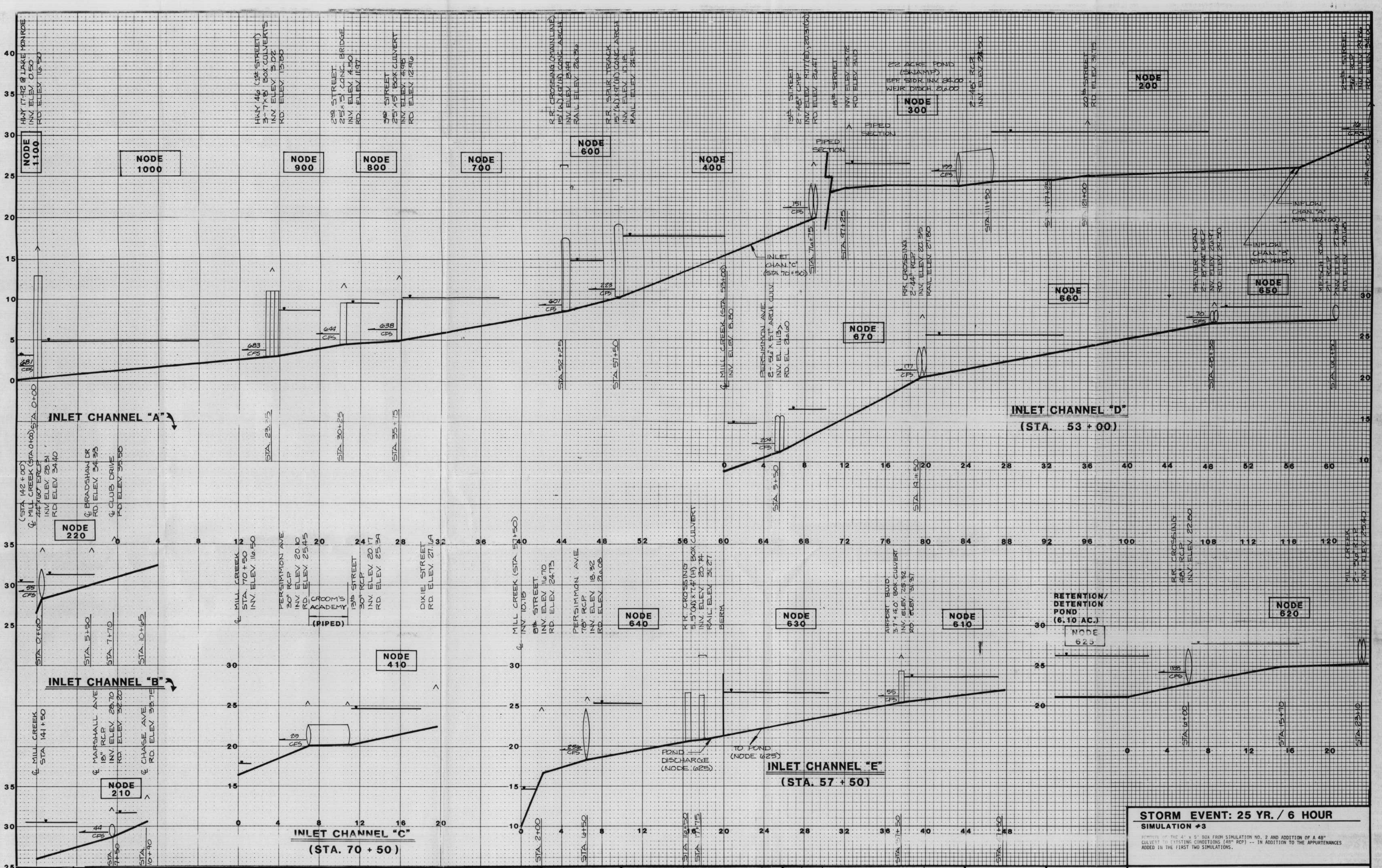
DATE APRIL 1988

JOB NO S0607.00

DRAWING NO. 2 of 6

MILL CREEK DRAINAGE STUDY

MAP POCKET D



STORM EVENT: 25 YR. / 6 HOUR

SIMULATION #3

REMOVAL OF THE 4' x 5' BOX FROM SIMULATION NO. 2 AND ADDITION OF A 48" CULVERT TO EXISTING CONDITIONS (48" RCP) -- IN ADDITION TO THE APPURTENANCES ADDED IN THE FIRST TWO SIMULATIONS.

Conklin Porter and Holmes ENGINEERS, INC.
POST OFFICE BOX 1976
500 W. FULTON STREET
SANFORD, FLORIDA 32771
TEL 305 322-6841 TEL 305 831-5717

DATE	TO	FOR
	PROJECT CONTROL	

ACTIVITY	NAME	DATE
DESIGNED BY	B.M.F.	4/88
DRAWN BY	B.M.F./ J.L.D.	4/88
CHECKED BY	J. C. B.	4/88
APPROVED BY	J. C. BRANCH	4/88
REGISTRATION NO	34791	

NO	DATE	REVISION	APPROVED

SCALE 1" 400'

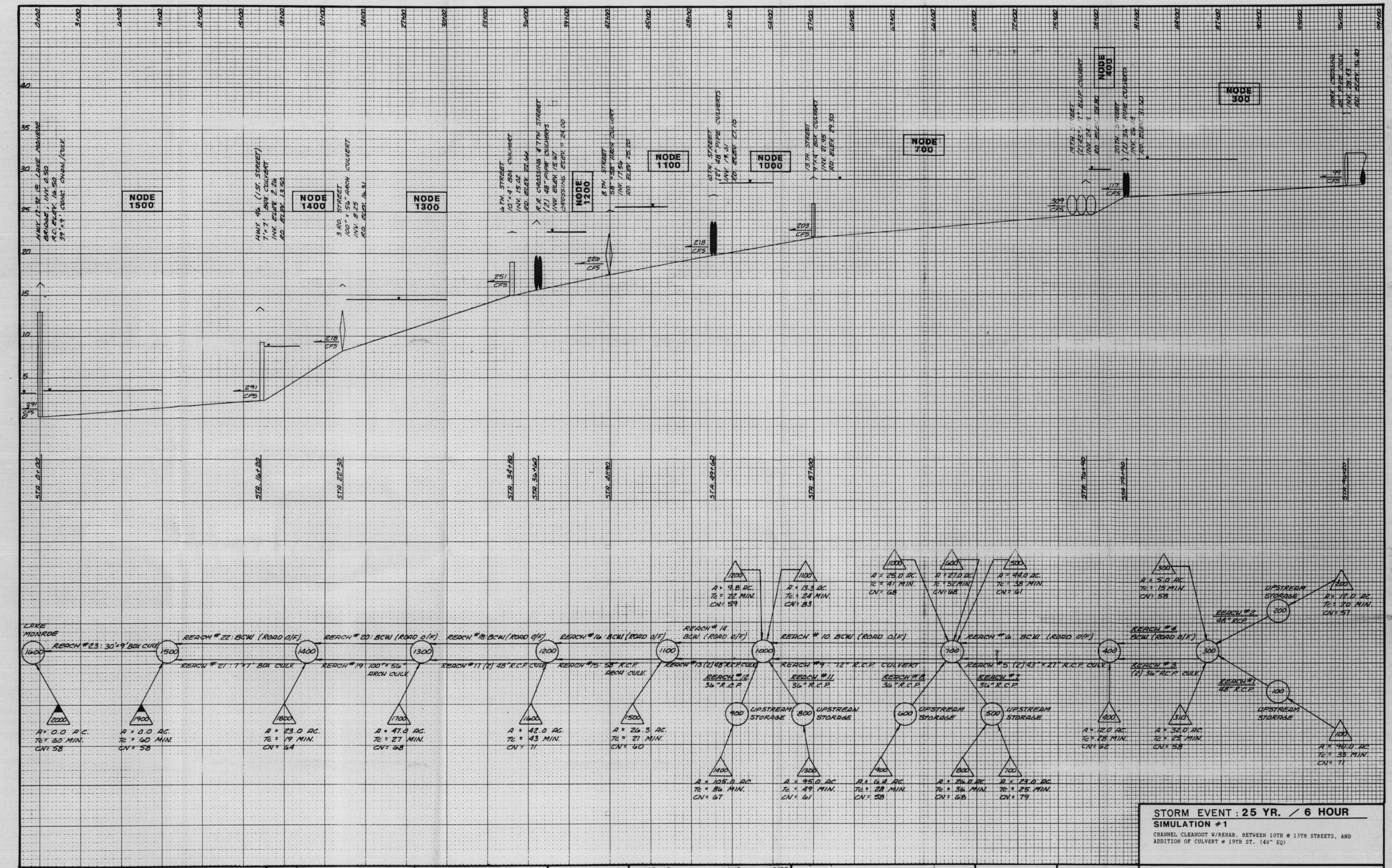
DATE APRIL 1988

JOB NO S0607.00

DRAWING NO. 3 of 6

MILL CREEK DRAINAGE STUDY

MAP POCKET E



STORM EVENT : 25 YR. / 6 HOUR

SIMULATION #1

CHANNEL CLEANOUT W/REHAB. BETWEEN 10TH @ 13TH STREETS, AND ADDITION OF CULVERT # 19TH ST. (48" EQ)

Conklin Porter and Holmes ENGINEERS, INC.
POST OFFICE BOX 1976
500 W. FULTON STREET
SANFORD, FLORIDA 32771
TEL 305 322-6841 TEL 305 831-5717

DATE	TO	FOR

PROJECT CONTROL

ACTIVITY	NAME	DATE
DESIGNED BY:	BMF	4/88
DRAWN BY:	HML	4/88
CHECKED BY:	JCB	4/88
APPROVED BY:	J.C. BRANCH	4/88
REGISTRATION NO:	34791	

NO.	DATE	REVISION	APPROVED

SCALE AS SHOWN

DATE APRIL 1988

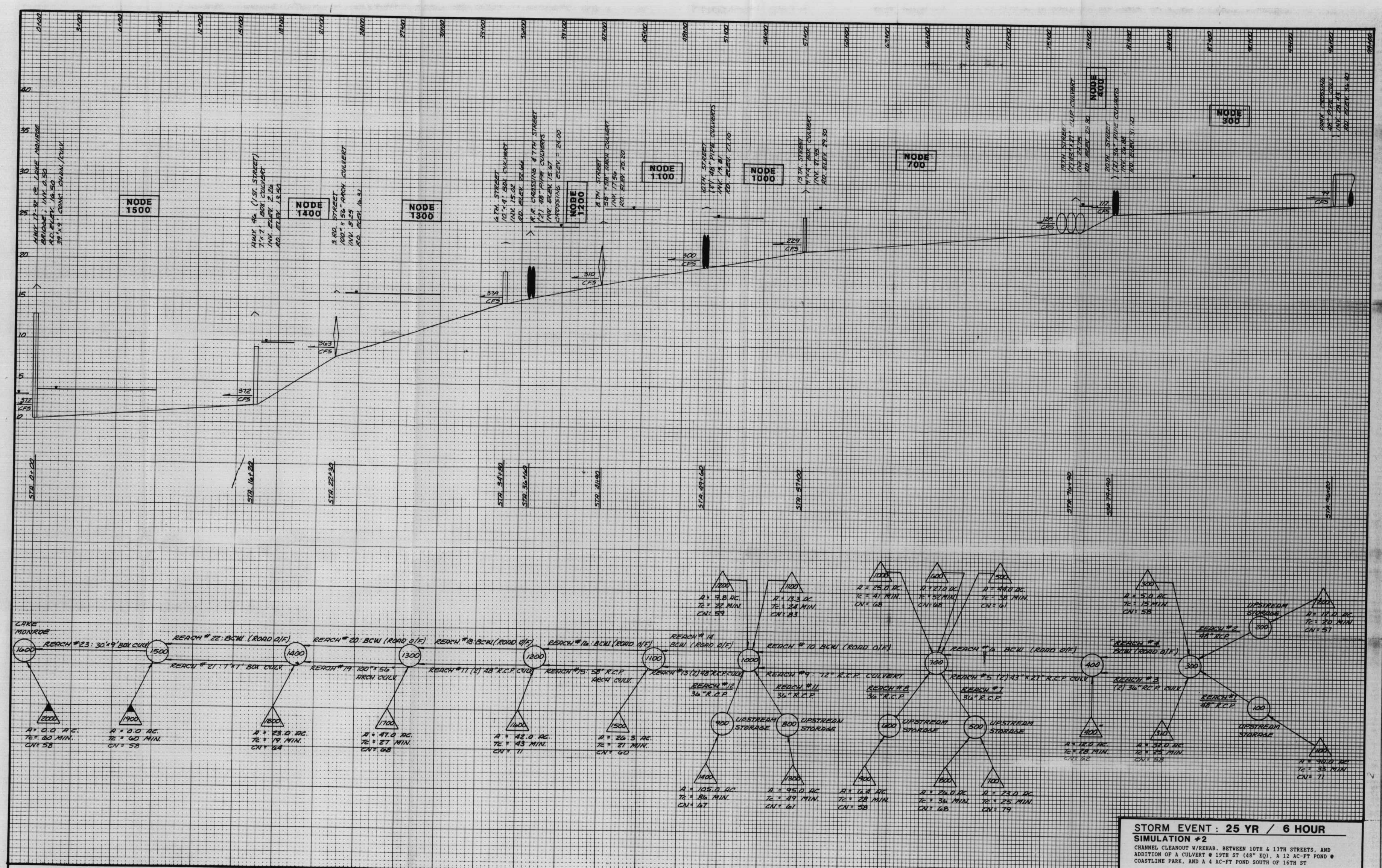
JOB NO. S0607.00

DRAWING NO. 4 of 6

CLOUD BRANCH HYDRAULIC SIMULATION

MAP POCKET F

BRUNING 44 431 65763



STORM EVENT : 25 YR / 6 HOUR

SIMULATION #2

CHANNEL CLEANOUT W/REHAB. BETWEEN 10TH & 13TH STREETS, AND ADDITION OF A CULVERT @ 19TH ST (48" EQ), A 12 AC-FT POND @ COASTLINE PARK, AND A 4 AC-FT POND SOUTH OF 16TH ST

Conklin Porter and Holmes ENGINEERS, INC.
POST OFFICE BOX 1976
500 W. FULTON STREET
SANFORD, FLORIDA 32771
TEL 305 322-6841 TEL 305 831-5717

DATE	TO	FOR

PROJECT CONTROL

ACTIVITY	NAME	DATE
DESIGNED BY:	BMF	4/88
DRAWN BY:	HML	4/88
CHECKED BY:	JCB	4/88
APPROVED BY:	J.C. BRANCH	4/88
REGISTRATION NO:	34791	

NO.	DATE	REVISION	APPROVED

SCALE AS SHOWN

DATE APRIL 1988

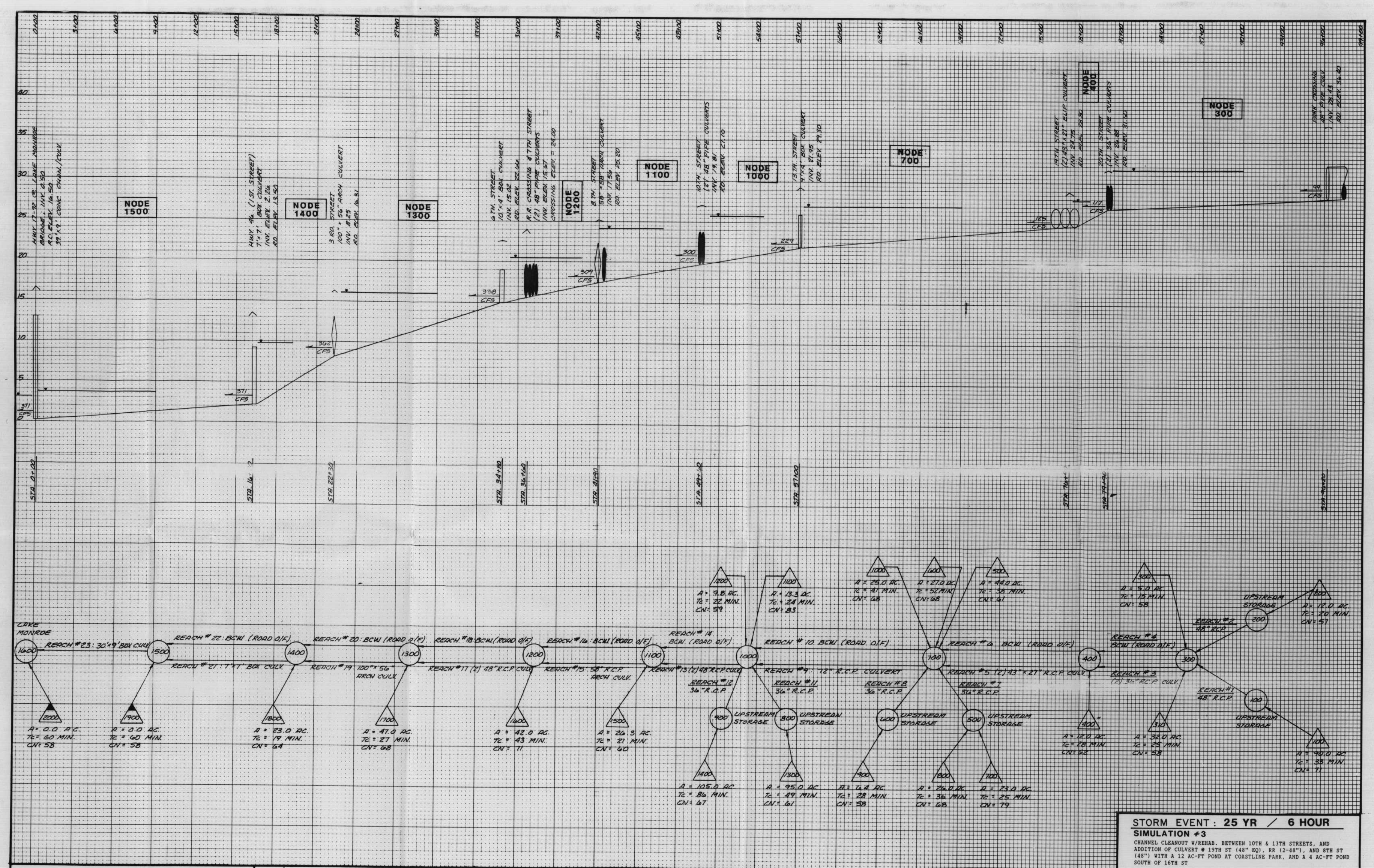
JOB NO. S0607.00

DRAWING NO. 5 of 6

CLOUD BRANCH HYDRAULIC SIMULATION

MAP POCKET 8

BRUNING 44-431 65763



STORM EVENT: 25 YR / 6 HOUR

SIMULATION #3

CHANNEL CLEANOUT W/REHAB. BETWEEN 10TH & 13TH STREETS, AND ADDITION OF CULVERT @ 19TH ST (48" EQ), RR (2-48"), AND 8TH ST (48") WITH A 12 AC-FT POND AT COASTLINE PARK, AND A 4 AC-FT POND SOUTH OF 16TH ST

Conklin Porter and Holmes
cph
ENGINEERS, INC.
POST OFFICE BOX 1976
500 W. FULTON STREET
SANFORD, FLORIDA 32771
TEL 305 322-6841 TEL 305 831-5717

DATE	TO	FOR

PROJECT CONTROL

ACTIVITY	NAME	DATE
DESIGNED BY:	BMF	4/88
DRAWN BY:	HML	4/88
CHECKED BY:	JCB	4/88
APPROVED BY:	J.C. BRANCH	4/88
REGISTRATION NO:	34791	

NO.	DATE	REVISION	APPROVED

SCALE: AS SHOWN

DATE: APRIL 1988

JOB NO. S0607.00

DRAWING NO. 6 of 6

CLOUD BRANCH HYDRAULIC SIMULATION

BRUNING 44-431 65763