279a

Big Slough Watershed Study Status Report

City of North Port
5650 North Port Boulevard
North Port, Florida 34287

December 1990

Funds for this project were provided by the Department of Environmental Regulation, Office of Coastal Management, using funds made available through the National Oceanic and Atmospheric Administration under the Coastal Zone Management Act of 1972, as amended.

Big Slough Watershed Study
Preliminary Storm Water Management Model (SWMM) Results

The Big Slough Watershed (BSW) originates in Manatee County, extends through Sarasota County and discharges into the Myakka River in the City of North Port, Florida. The drainage area is 195 square miles (125,000 acres). The primary waterways are the Myakkahatchee Creek, and the Big Slough itself.

The City of North Port encompasses 74.5 square miles, and is platted for 85,479 residences. At present, about 7 percent of these dwellings have been constructed, although nearly all of the property within the corporate boundaries has been cleared and improved. All roadways and drainage systems were constructed during the early 1960's. Considerable re-growth of vegetation has occurred throughout much of the unused developed land, and much of the original channelization has eroded and filled with sediments.

Flooding in downstream reaches has occurred several times in the past 4 years, although remarkably, structural damage has been virtually non-existent. Nevertheless, during September, 1988, a four day rain event occurred which inundated North Port's primary evacuation routes for 4 days. The return interval of this event was slightly less (72 hr/23 yr) than 25 years, raising concern about the adequacy of the existing drainage system to cope with future storms, especially hurricanes.

In August, 1990, the City of North Port contracted with Camp Dresser & McKee (CDM) to develop a master stormwater plan, including evaluation of existing flooding potential, and potential at build-out. Final recommendations will consider both flooding/quantity issues, as well as future water quality. The objectives of Phase I presented in this status report are a) selection of an appropriate hydrologic/hydraulic model, b) development of a BSW input data set, and c) preliminary calibration and verification of the predicted results with observed storm events. The activities undertaken through December 10, 1990, and the results to date are further described herein.

Task Series 700 - ESTABLISH COMPUTER MODELING METHODOLOGY

Model Selection (Task 710)

CDM reviewed five public domain hydrologic/hydraulic models as candidates for use in performing the BSW study. Copies of the report and matrix (Table 1) were distributed to City and County staff, North Port Water Control District (NPWCD) staff, and South West Florida Water Management District (SWFWMD) staff. The results were discussed with staff, and a consensus was reached to use the Runoff and Extended Transport Block (EXTRAN) of the Stormwater Management Model (SWMM). Both model blocks are in international use, and are supported by both the U.S. Environmental Protection Agency and

TABLE 1

EVALUATION MATRIX FOR MODEL SELECTION

Evaluation Criteria[1]	STORMWATER MANAGEMENT MODEL				
	RUNOFF[2]	EXTRAN[2]	TR-20	HEC-1	HEC-2
A. Rainfall-Runoff					
Simulation of Base Flow	Constant	N/A	Constant	Constant	N/A
Continuous Simulation	Yes	N/A	No	No	N/A
Single Event Simulation	Yes	N/A	Yes	Yes	N/A
Multiple Hyetograph Input	Yes	N/A	Yes	Yes	N/A
Areal Weighting of Hyetographs	No	N/A	No	Yes	N/A
Infiltration Methodology	Horton Green-Ampt	N/A	SCS CN	SCS CN Holtan Init/Constant Exponential	N/A
Direct Input of Land Use Data	Yes	N/A	No	Average	N/A
Runoff Methodology	Kinematic Wave	N/A	SCS CN	Clark UH Synder UH SCS CN Kinematic Wave	N/A
Published Values for Hydrologic Parameters Can Represent Small Subbasins (e.g., 25 acres)	No	N/A	High	Average	N/A
	Yes	N/A	Yes	Yes	N/A
Complexity/Sophistication Rating	High	N/A	Average	High	N/A

TABLE 1

EVALUATION MATRIX FOR MODEL SELECTION
(Continued)

Evaluation Criteria[1]	STORMWATER MANAGEMENT MODEL				
	RUNOFF[2]	EXTRAN[2]	TR-20	HEC-1	HEC-2
B. Channel/Sewer Hydraulics					
Time Varying vs Steady-State	Yes	Yes	Yes	Yes	Steady-State
Flow Routing Methodology	Non-Lin Reserv	St. Venant	Att-Kin	Muskingum Working R&D Modified Puls Kinematic Wave Avg. Lag	Standard-Step
Trapezoidal Channels	Yes	Yes	No	Yes	Yes
Irregular Cross-sections	Yes	Yes	No	No	Yes
Bridges	No	Fair	No	No	High
Diversion Structure	No	Yes	Indirectly[3]	Yes	Indirectly[3]
Culverts	Fair	Average	No	Fair	Average
Storm Sewers	Yes	Yes	No	No	No
Surcharging	No	Yes	No	No	No
Pressure Flow	No	Yes	No	No	No
Pumps	No	Yes	No	No	No
Backwater Profiles	No	Yes	No	No	Yes
Unsteady Flow (Dynamic Simulation of Flow and Water Surface Profile)	No	Yes	No	No	No
Downsteam Boundary					
Tidal	No	Time Varying	No	No	Constant
Fluvial	No	Time Varying	No	No	Constant
Complexity/Sophistication Rating	Average	High	Average	Average	Average

TABLE 1

EVALUATION MATRIX FOR MODEL SELECTION
(Continued)

Evaluation Criteria[1]	STORMWATER MANAGEMENT MODEL				
	RUNOFF[2]	EXTRAN[2]	TR-20	HEC-1	HEC-2
C. Reservoir Routing					
Detention Basins	Yes	Yes	Yes	Yes	N/A
Lakes/Reservoirs	Yes	Yes	Yes	Yes	N/A
Reservoir Routing Methodology	Stor-Disch	St Venant	Stor-Disch	Stor-Disch	N/A
Tailwater Control	No	Time varying	No	No	N/A
Direct Simulation of Outflow Structure Geometry	Fair	High	Low	Fair	N/A
Complexity/Sophistication Rating	Fair	High	Fair	Fair	N/A
D. Input					
User-Friendly	Fair	Low	Low	High	High
Input Format	Fixed	Fixed	Fixed	Free/Fixed	Free/Fixed
Preprocessors	Yes	Yes	No	Yes	Yes
E. Output					
User Selected Format and Options	Yes	Yes	Yes	Yes	Yes
Plot (Graphics) Routines	Fair	Fair	Fair	Fair	Fair
Error/Warning Messages	Average	Average	Average	High	High
Post-Processor	No	Fair	No	No	High

TABLE 1

EVALUATION MATRIX FOR MODEL SELECTION
(Continued)

Evaluation Criteria[1]	STORMWATER MANAGEMENT MODEL				
	RUNOFF[2]	EXTRAN[2]	TR-20	HEC-1	HEC-2
F. Documentation					
Clear, Well-Written	Average	Average	Low	High	High
Examples Given	Yes	Yes	Yes	Yes	Yes
Diagnostics	Average	Average	Fair	High	High
User Support Groups	EPA/U of FL/CDM	EPA/U of FL/CDM	SCS	Private	Private
Program Maintained and Updated	Yes	Yes	Yes	Yes	Yes
G. Credibility					
Widely Used for Stormwater Studies	Yes	Yes	Yes	Yes	Yes
State-of-the-Art	Average	High	Average	Average	Average
H. Computer System Application					
Main Frame	Yes	Yes	Yes	Yes	Yes
Microcomputer	Yes	Yes	Yes	Yes	Yes
Run Times	Average	High	Average	Average	Low
Interactive	No	No	No	No	No

[1] Hierarchy: HIGH> AVERAGE> FAIR> LOW> NO

[2] CDM version

[3] Represented indirectly through other parameters

the University of Florida. The SWMM model is used to generate runoff from land surface, and for routing/conveyance in systems where there is a free flow of water through an outfall. The EXTRAN model does not intrinsically generate runoff data, but interfaces with the SWMM runoff data. EXTRAN is used to calculate flows and water surface elevations in conveyance systems in which flows are impeded by the inability of the system to discharge at the rate of inflow. In essence, the water 'backs up' on itself, causing a reduction in flow and an increase in water surface elevation.

Task Series 800 – DEVELOP AND CALIBRATE MODEL PARAMETERS

Delineation/Characterization of Sub watersheds (Tasks 810-840)

A total of seventy-one (71) sub watersheds have been developed within the BSW. The undeveloped areas north, and west of the corporate boundaries were sub-divided into 12 sub-basins of approximately 4,700 acres each. Within the corporate boundaries, in general, the developed areas were divided into more numerous, smaller (ie 1,200 acres) sub-basins, while the undeveloped (cleared, and improved, but without residences) areas within the corporate boundaries were represented by 52 sub-basins. The remaining seven sub-basins include the developed portions of the city. Within each sub-basin, the following characteristics were determined and included in the model input data set:

Drainage area - Sub-basin drainage areas were planimetered, or taken from AUTOCAD digital drawings. The base maps used were USGS 7.5 minute quads, or aerial photography (scales of 1:200, 1:1000, or 1:1800 as appropriate) taken in 1989 and 1990.

Land Use - Land use was determined from aerial photography, as previously described.

Percent imperviousness - Percent urban impervious area is the impervious areas (roof area, driveway and roadway area), divided by the total area. For preliminary modeling efforts, these values were taken from the land use zoning maps, coupled with percent imperviousness determined from other Florida studies for similar land uses. The values will be verified by comparison with aerial photography of the City of North Port and BSW.

Average overland slope - The average overland slope was primarily determined from USGS 7.5 minute quads, and 'as built' drawings of drainage structures.

Channel/pipe characteristics - The hydraulic characteristics of conveyance channels, ditches and major canals were determined from 'as built' drawings, and field inspections for the preliminary modeling effort. Video recordings of major structures were made in October, 1990. Additional survey, and field investigations remain to be conducted prior to final model calibration. Preliminary SWMM linkages are given in Figures 1-5.

BIG SLOUGH WATERSHED MODEL SCHEMATIC

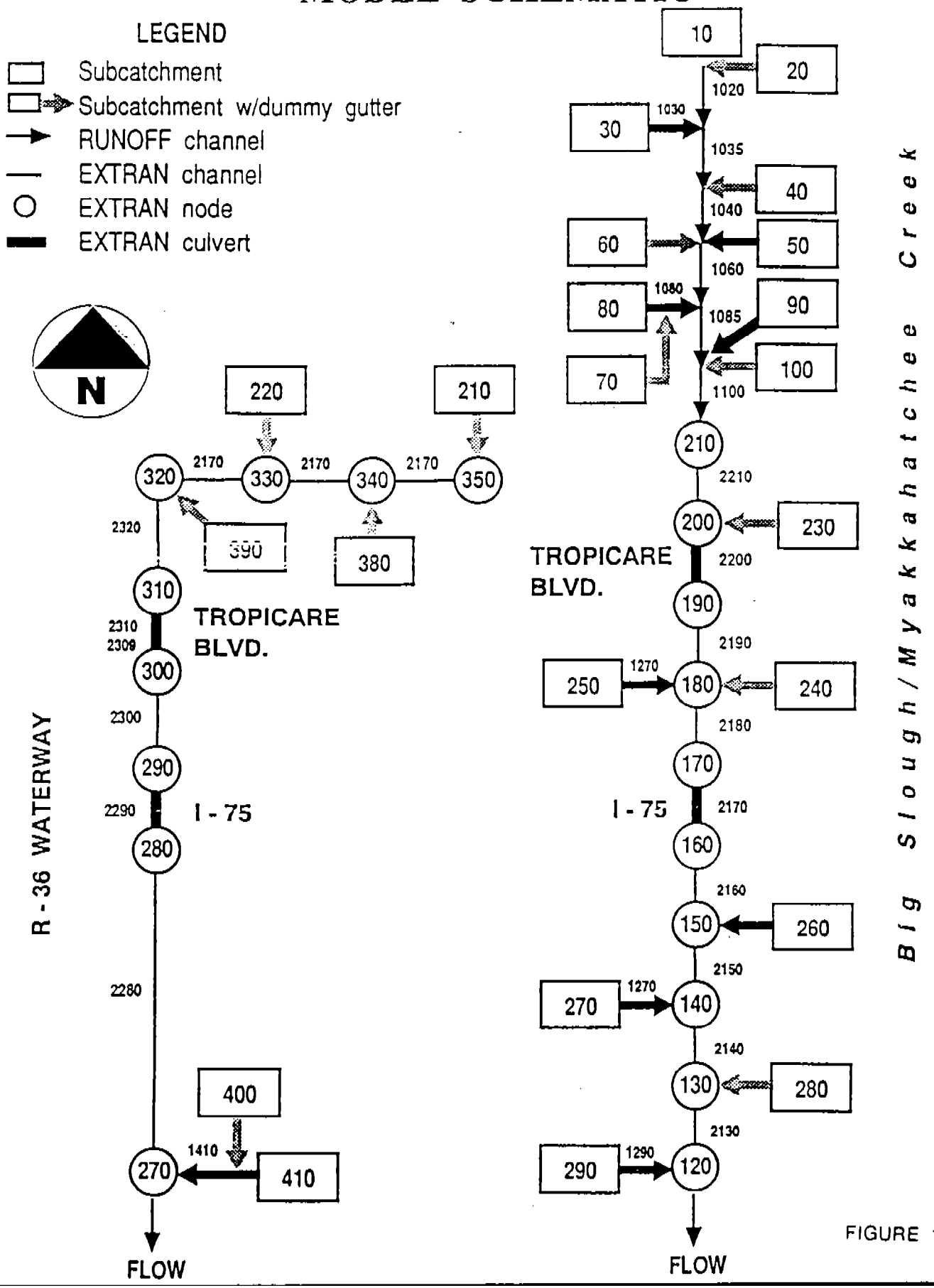


FIGURE 1

BIG SLOUGH WATERSHED MODEL SCHEMATIC

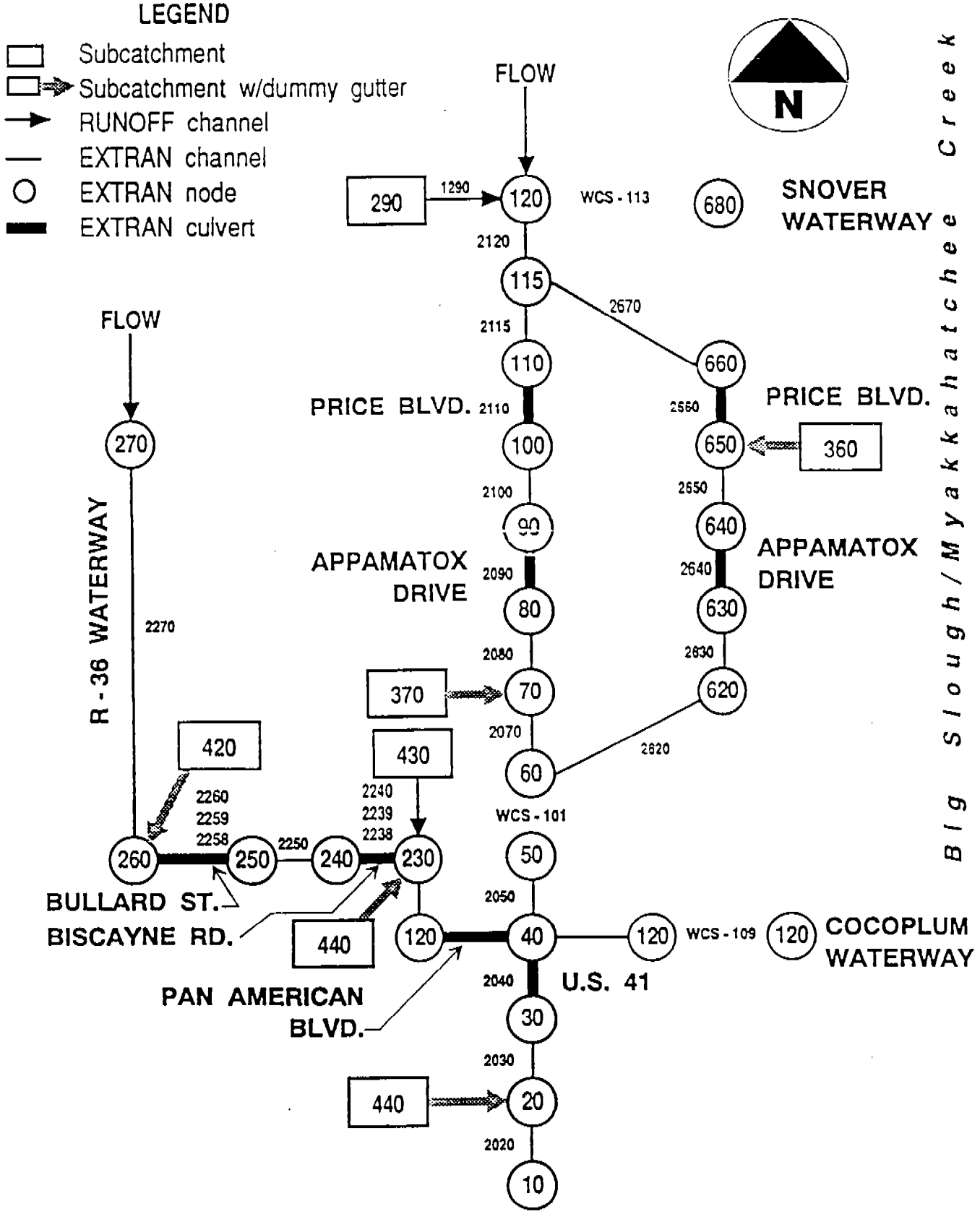


FIGURE 2

BIG SLOUGH WATERSHED
MODEL SCHEMATIC

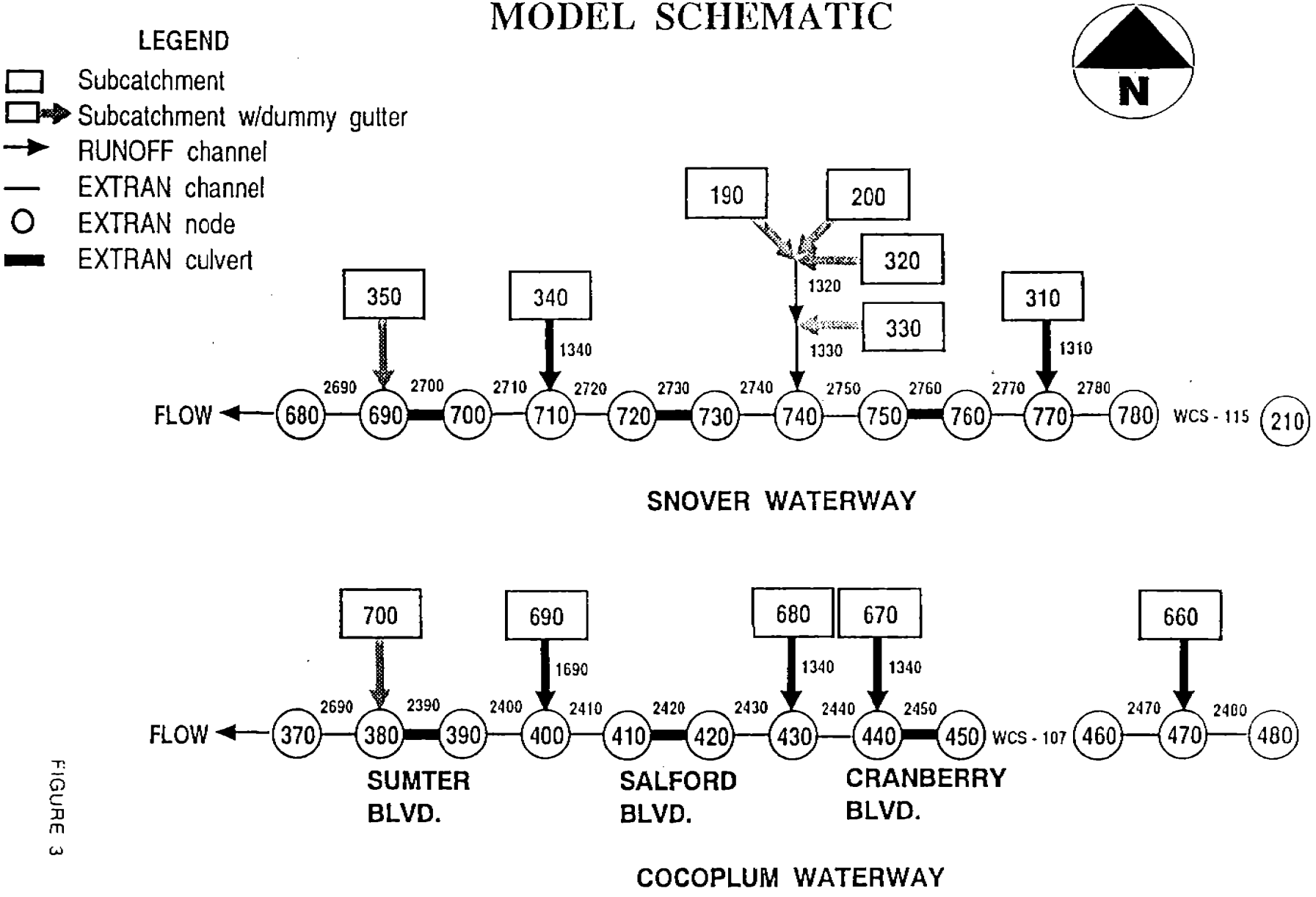


FIGURE 3

BIG SLOUGH WATERSHED MODEL SCHEMATIC

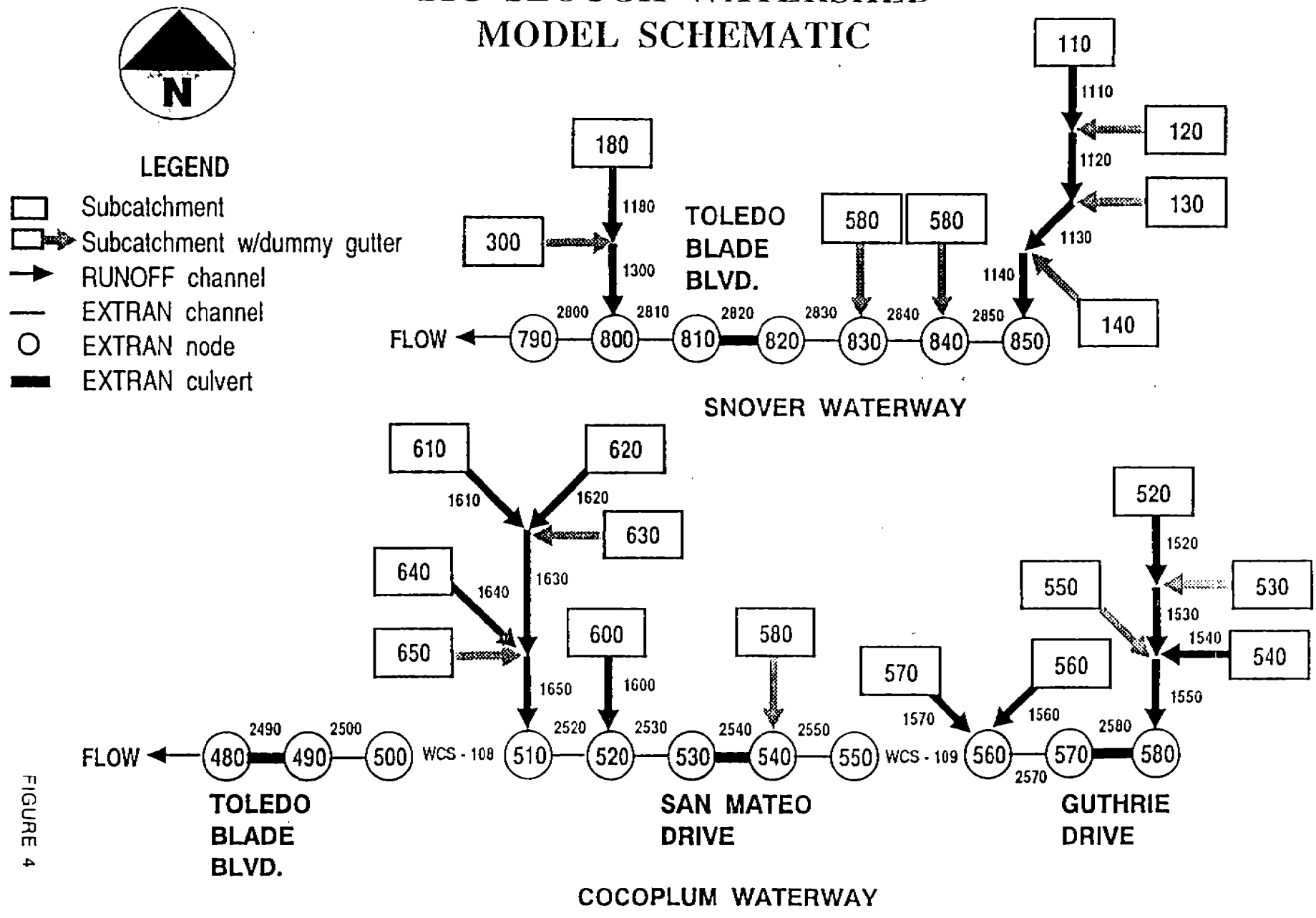


FIGURE 4

2746

BIG SLOUGH WATERSHED
MODEL SCHEMATIC

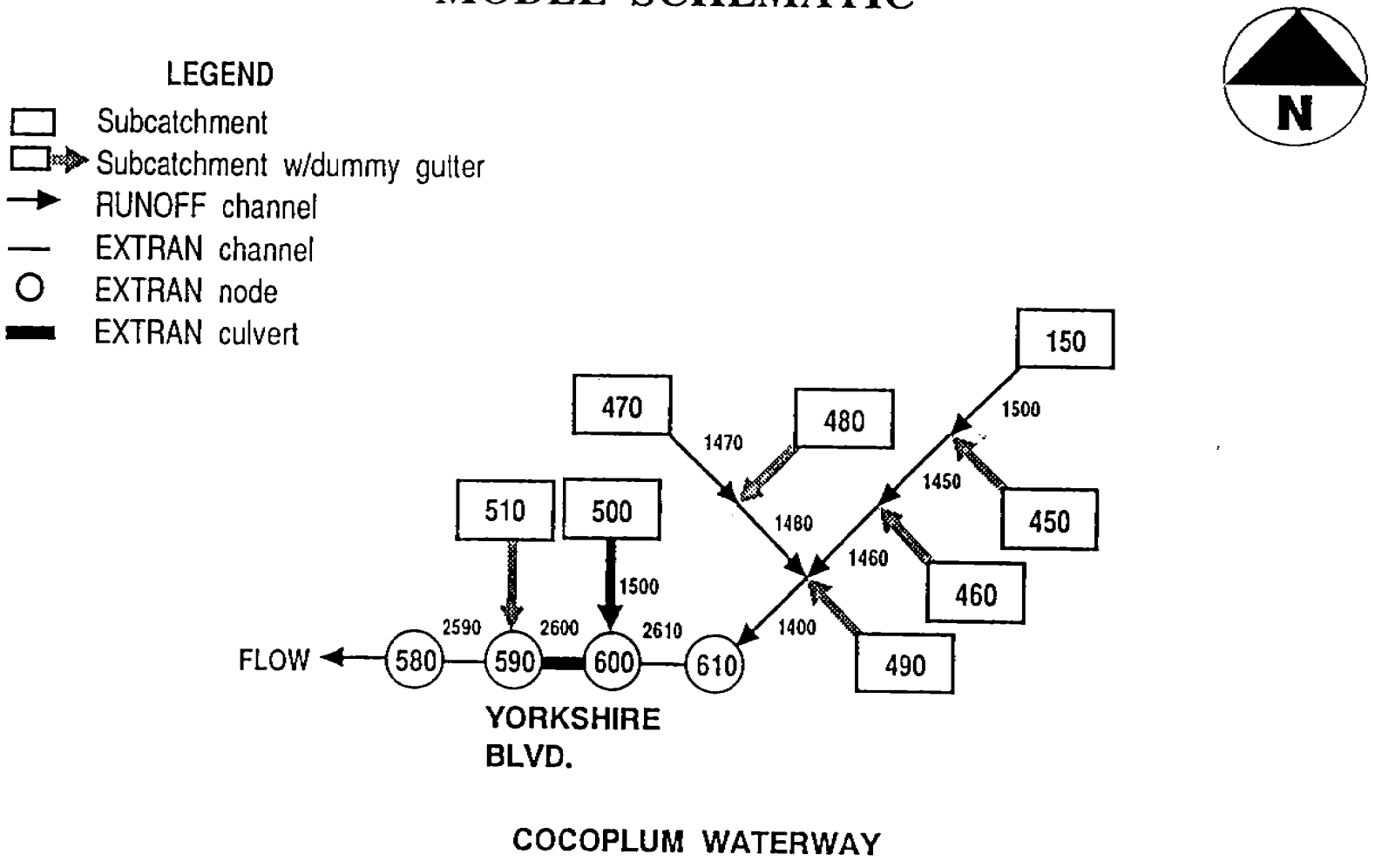
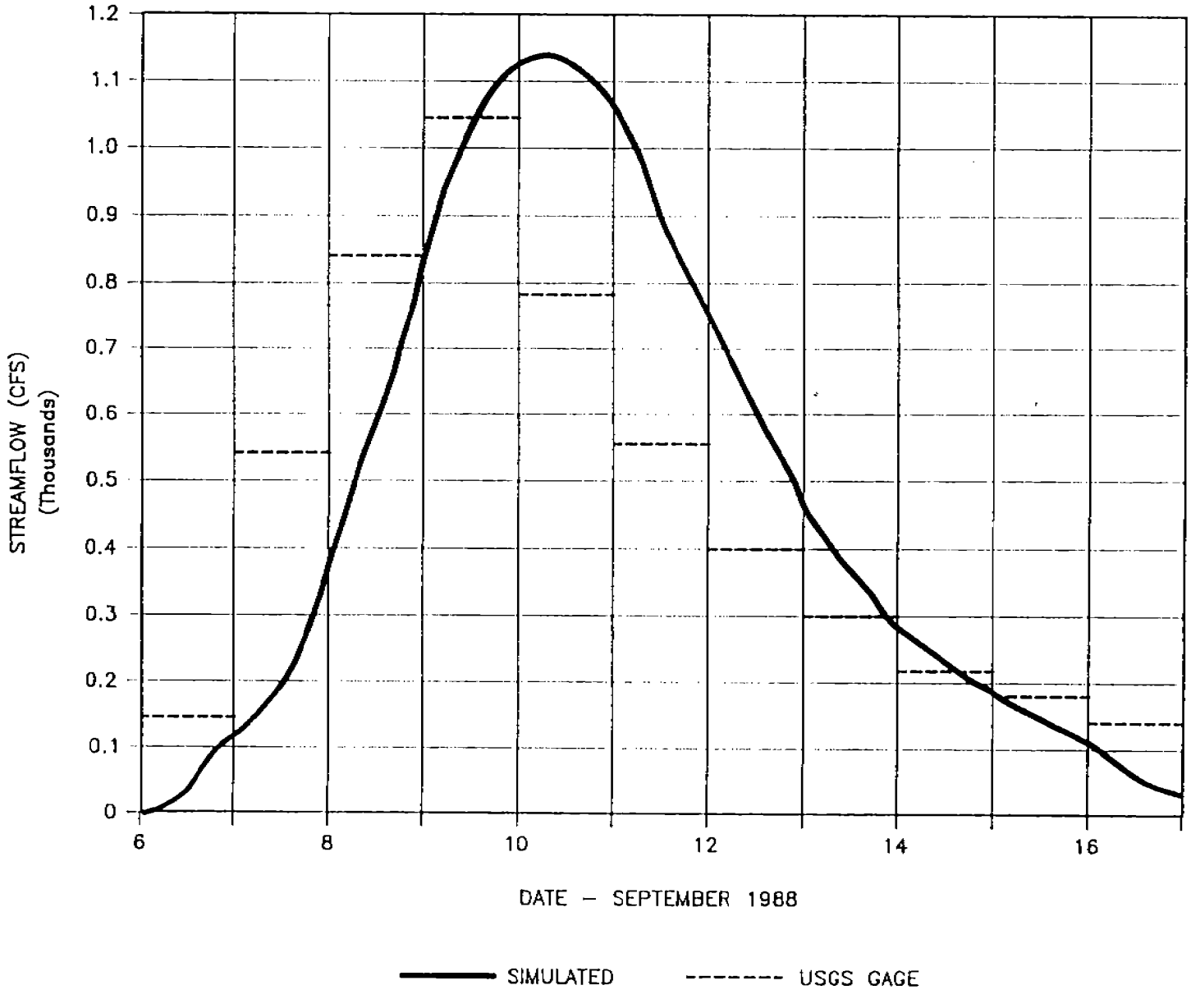


FIGURE 5

CDM
environmental engineers, scientists, planners, & management consultants

BIG SLOUGH AT S.R. 72



(Note: USGS Gage is Daily Average)

FIGURE 6

Soils Characteristics - Soil characteristics and soils groups were determined from the Manatee County and Sarasota County Soil Conservation soils maps. The majority of the soils belong the to B/D group, which means that in the absence of artificial drainage, the soils behave like 'D' (high runoff potential) group soils. However, with adequate drainage of surficial groundwater, these soils can be raised to the 'B' group (moderate to low runoff potential). Improvements to the land generally require installation of drainage structures, resulting in a 'B' soil group. Urbanized (developed and undeveloped) areas, improved pastures and agricultural lands were assumed to be acting as 'B' soil types, with only the native, undisturbed areas remaining as 'D' soils groups.

Calibrate/Define Storm Event (Task 860)

The September 5-9, 1988 storm event was used to calibrate the models. Excellent precipitation, flow and flood water level records exist for this event, collected primarily by the USGS, NPWCD, and the City of North Port. Although a four day event is not commonly used as a design storm, extensive flooding occurred as a result of this event.

Rainfall records from five gages were distributed using the Theissen polygon method. This procedure provides a mechanism for distributing rainfall results from multiple gages according to the weighted area represented by the individual gages. In general, that portion of the watershed above the corporate boundaries was represented by the Carlton and Myakka State Park rain gage, while the gage at the North Port Water Treatment Plant represented most of the area within the corporate boundaries. The Peace River Water Treatment Plant was used to represent the extreme eastern part of the study area, and the Frizzell gage was applied to a small area in the southeastern part of the City. For the preliminary model results, the daily rainfall totals were assumed to be evenly distributed throughout the day.

The results of the preliminary modeling effort indicate good agreement between simulated and observed peak flows and total volume (Figure 6) observed at SR 72. The predicted time of peak flows lags the observed slightly, but will probably improve when the actual hourly distribution of rainfall is added to the input data set. In addition, the preliminary predicted results agreed quite well with the observed water levels. This comparison is given in Table 2.

TABLE 2
PREDICTED AND OBSERVED FLOOD WATER ELEVATIONS (MSL)
September, 1988

Location	Observed	Predicted
Tropicare Bridge at Myakkahatchee Waterway	25.7′	25.5′
Water Control Structure 106 Cocoplum near Myakkahatchee	8′	8.5′
Intersection of Cold Spring Lane & Reistertown Rd. (centerline ?)	26.5′	25.6′
Water Control Structure 101 Myakkahatchee near Water Plant	7′	6.6′
Near intersection of Hennessey Street and Reistertown Road	24.9′	25.3′
R-36 Waterway	26.3′	minimal flooding

With regards to the R-36 waterway, the Tropicare crossing of R-36 was not included in the preliminary model runs. Consequently, the model does not adequately predict the observed flooding behind this junction. This issue will be resolved in future applications of the model.

Verification was conducted using an event in late March, 1987. In the case of the verification run, considerably less data was available for comparison. Predicted peak flows and total volume at SR 72 closely matched those recorded by the USGS. In terms of flooding, essentially the only flood data available was that which was available on the Real Estate Data Inc. (REDI) aerial photographs which were taken within a few days of the storm. While numeric comparisons cannot be made, the model adequately predicted flooding in areas indicated on the aerial maps. The exception was the area in the vicinity of the R-36 waterway, presumably for the reasons previously described.

Additional refinements will be made to the model as part of future work efforts, and the results presented are based on preliminary model results. Nevertheless, the results are quite good, and deemed sufficient to evaluate what conditions should be assumed for design storm conditions. A ten year return interval is specified in the City of North Port Comprehensive Plan, and several duration/antecedent moisture conditions were evaluated for peak upper watershed flows. Those results are:

10-Year Peak Flows for Various Design Storms

Duration (days)	Total Rainfall (inches)	Antecedent Conditions	Total Peak Flow (cfs)
1	7.1	Saturated	4,565
3	8.5	Rather Wet	4,438
5	9.8	Rather Dry	4,252

The results indicate that there is little difference in peak runoff for the various durations, and the 1 day storm actually results in slightly higher peak flows than the 3-day storm event.

Evaluate Existing Drainage Problems (Task 870)

Preliminary evaluations of existing drainage problems were completed as part of Task 860. City and water control district records were analyzed as part of the calibration/verification process. After land use and basin characteristic refinements are completed, and the design storms selected, these storm events will be simulated to identify problem areas.

Summary

Detailed Big Slough Watershed characteristics, and historic rainfall events have been input to the SWMM/EXTRAN model and areas of flooding have been adequately predicted for these historic events. The model has been used to evaluate several design storms to determine the most appropriate to use for future evaluations. Refinements to the input data set are currently underway, and upon completion, the existing problem flooding areas will be finalized. Subsequently, future land use conditions will be defined and the magnitude of problem flooding determined.

REPORT DOCUMENTATION PAGE	2. REPORT NO.	3. Recipient's Accession No.
4. Title and Subtitle Big Slough Watershed Study Preliminary Storm Water Management Model (SWMM) Results		5. Report Date December 10, 1990 6.
7. Author(s) Camp Dresser & McKee, Inc.		8. Performing Organization Rept. No. N/A
9. Performing Organization Name and Address City of North Port Road and Drainage District 5650 North Port Boulevard North Port, FL 34287		10. Project/Task/Work Unit No. CM - 275 11. Contract(C) or Grant(G) No. (C) NA89AA-D-CZ 228 (G)
12. Sponsoring Organization Name and Address U.S. Dept. of Commerce/NOAA OCRM 1825 Connecticut A., N.W. Washington, D.C. 20235	Dept. of Env. Reg. Coastal Management 2600 Blair Stone Rd. Tallahassee, FL 32399	13. Type of Report & Period Covered Final 14. Aug. 1990-Dec. 1990
15. Supplementary Notes		

16. Abstract (Limit: 200 words)

The Big Slough watershed encompasses 195 square miles in Sarasota, Manatee and DeSoto counties and drains into the Myakka River on the west coast of Florida. The watershed is largely agricultural/rural. The City of North Port was largely developed by General Development Corporation in the 1960's. Much of the 74.5 square miles within the corporate boundaries have been cleared, and improved with roads and drainage, although only 7% of the platted lots presently have building structures. Even at this low density, coastal flooding has occurred several times in past few years, creating impassable conditions for several days on the primary evacuation routes.

In order to evaluate the magnitude of flooding associated with future development, sub-basin and conveyance characteristics were determined and compiled as an input data set for the US EPA Stormwater Management Model (SWMM). Both the RUNOFF and EXTRAN simulation blocks were used to develop preliminary flood profiles for comparison with observed data.

This interim project report describes the development of sub-basin characteristics, preliminary model calibration and verification results for two separate storm events. In addition, peak runoff rates were evaluated for several storms of varying duration and antecedent moisture conditions to define a design storm for additional studies.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

Coastal zone management/

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
	Unclassified	