Characteristics of Four Urbanized Basins in South Florida

Open-File Report 79-694

PREPARED IN COOPERATION WITH THE
BROWARD COUNTY WATER MANAGEMENT DIVISION ● BROWARD COUNTY ENVIRONMENTAL QUALITY CONTROL BOARD ● FLORIDA DEPARTMENT OF TRANSPORTATION ● DADE COUNTY ENVIRONMENTAL RESOURCES MANAGEMENT ● FLORIDA DEPARTMENT OF ENVIRONMENTAL RESOURCES ● SOUTH FLORIDA WATER MANAGEMENT DISTRICT

U.S. GEOLOGICAL SURVEY

UNITED STATES
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GEOLOGICAL SURVEY

CHARACTERISTICS OF FOUR URBANIZED BASINS IN SOUTH FLORIDA

By Robert Adam Miller, 1940-

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Broward County Water Management Division

Broward County Environmental Quality Control Board

Florida Department of Transportation

Dade County Environmental Resources Management

Florida Department of Environmental Resources

South Florida Water Management District

Tallahassee, Florida

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UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY

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CONVERSION TABLE

For use of those readers who may prefer to use metric units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain metric unit
acres	0.4047	hectares (ha)
feet (ft)	0.3048	meters (m)
inches (in.)	25.4	millimeters (mm)

CHARACTERISTICS OF FOUR URBANIZED BASINS IN SOUTH FLORIDA

By Robert Adam Miller

ABSTRACT

Physical characteristics of four urbanized basins in south Florida are presented. Land use of the four basins are low-density residential, highway, commercial, and high-density residential. Maps of each basin include a photomosaic, a sewerage map, a drainage map, and an impervious-area map. Tabular data include pervious and impervious areas; sewer data, such as pipe diameter, length, and slope; and inlet elevations. General descriptions of the soil cover and type, vegetation, streets, gutters, and curbs are also provided.

INTRODUCTION

Urbanized basins are the superposition of two distinct drainage features--the natural topographic drainage and the manmade sewerage system. Together these two features provide a conveyance for rainfall runoff.

Rainfall and runoff data are used to calibrate formulations of mathematical expressions, called models, which define the rainfall runoff process. A model contains parameters which generally represent physical characteristics of a watershed and are used to determine the amount of rainfall which is to appear as runoff, and how that runoff is moved (routed) to the basin outlet. Common characteristics include

drainage area, channel slope, soil types, pipe diameters and slopes, and interconnection of impervious areas.

The purpose of this report is to present the basin characteristics needed for rainfall-runoff modeling studies in south Florida (fig. 1). This report is one of a series of reports on the work accomplished. Subjects of reports published to date (1979) include the following:

Basic data (Mattraw and others, 1978; Hardee and others, 1978)

Data analysis (Mattraw and Sherwood, 1977; Mattraw, 1978; Miller, 1978)

Data management (Wilson and others, 1978)

Modeling (Jennings and Mattraw, 1976; Miller and others, 1978; Jennings and Doyle, 1978).

SELECTION AND DETERMINATION OF DRAINAGE BASIN CHARACTERISTICS

Rain falling on a natural basin can be separated into that which infiltrates the soil and that which moves through the basin as stormwater runoff. The movement of runoff through the basin can be divided further into an overland routing component and a channel routing component.

Several additional concepts are needed when the urbanized basin is considered. First the impervious area must be separated from the pervious area. Impervious areas absorb and retain a small, but measurable fraction of the rainfall in the form of surface wetting and depression storage. All additional rainfall on impervious areas becomes overland flow. This distinction between impervious and pervious areas becomes especially important in areas of mild slope and highly pervious soils. Second, the routing of overland flow is considered as two separate processes; that which occurs over the soil surface and that which occurs, at a faster rate, over the impervious surface. Third, in urbanized

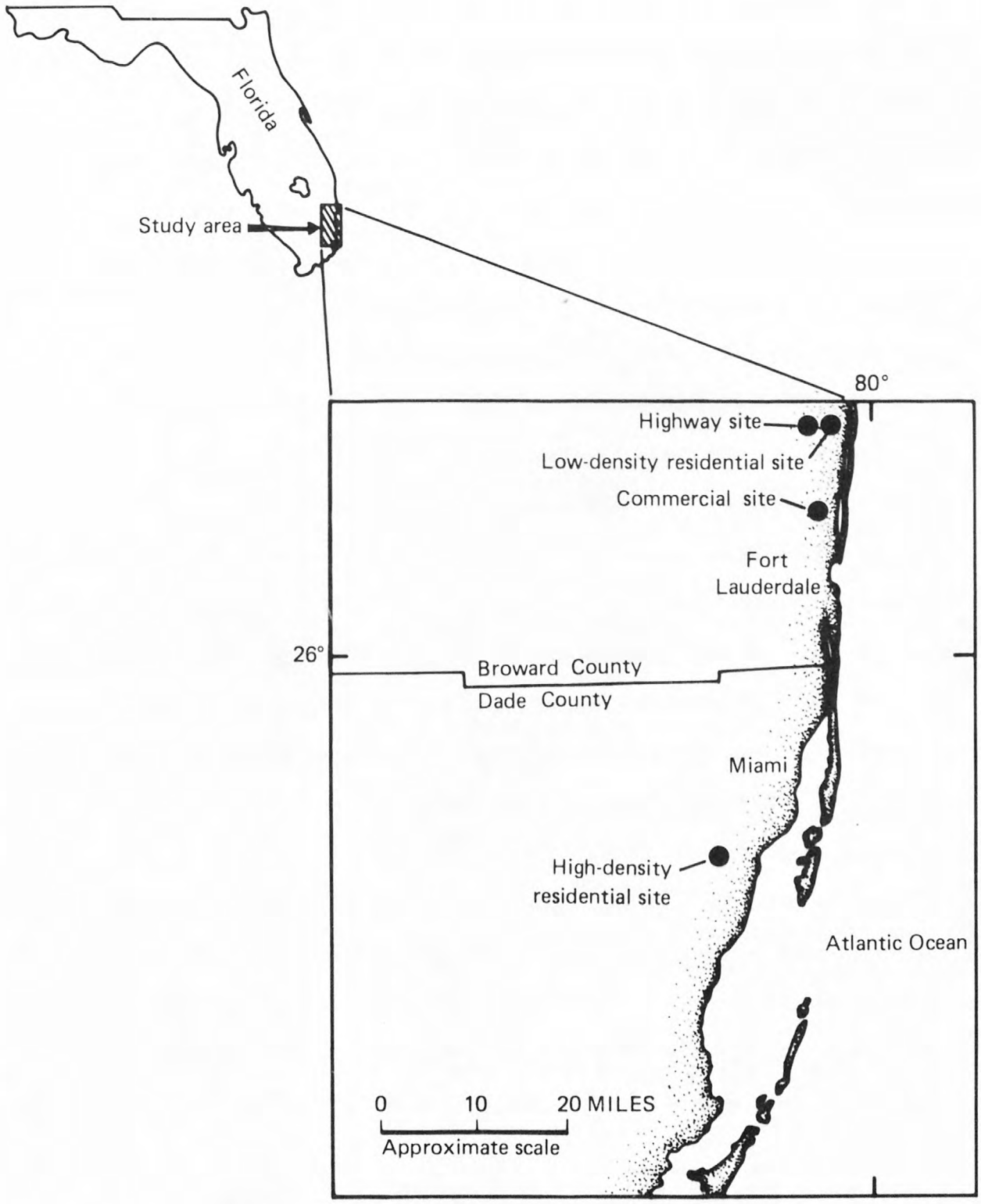

Figure 1.--Map showing locations of urbanized basins----

basins some natural channels are replaced by lined channels or sewers and the traveltime of runoff is thereby shortened. Fourth, it is sometimes necessary to consider each drainage subbasin contributing to a storm drain in the sewer system as an individual basin and to route the subbasin flows through the sewer system to the basin outfall.

Most deterministic models presently available utilize the concepts of rainfall separation and runoff routing, and therefore, require parameter values for the basin characteristics associated with these concepts. The rainfall separation requires soil properties be known or estimated so that infiltration amounts can be calculated. The amount of impervious area, its interconnection, slope, and resistance to flow must be determined. Resistance to flow and slope for both the overland and channel segments must be quantified. For closed conduits the shape and size must be known. Also, the pipe layout and inlet location must be given so that the flows in the pipes may be properly added together.

The basin characteristics determined in this study are presented in table 1. They are listed as three distinct groups--basin features, area data, and sewerage data.

Field surveying provided data on the inlet elevations, but more importantly provided horizontal and vertical control so aerial photographs could be used in compiling topography and natural drainage. Sewerage maps and design drawings available for the areas provided information on the layout of the sewer system and the size and slope of the pipes.

Table 1.--Basin characteristics determined for the south Florida stormwater studies

BASIN FEATURES	AREA DATA (each subbasin)	SEWERAGE DATA
Location	Total area	Pipe:
Size	Pervious area	Diameter
Land use	Impervious area	Length
Mean annual rainfall	Hydraulically effective impervious area	Slope
Soil types	impervious area	Inlet elevation
Vegetation		
Type of sewerage system		
Conduit shape		
Conduit material		
Downspout connection		
Street description		
Gutter and curb description		

Photogrammetric procedures were used to determine the hydraulically effective impervious area, that impervious area which contributes runoff directly to the sewer inlet immediately after surface wetting and depression storage takes place (Miller, 1978). Black and white aerial photographs were taken at an altitude of 1,500 feet with a 6-inch focal length camera. The resulting scale of the photographs was approximately 1:3,000 or 1 inch equals 250 feet. Vertical and horizontal controls were obtained for the basins and topographic maps were produced with a contour interval of 1 foot. From these maps the drainage basin boundaries and direction of overland flow were determined. The final step was to overlay the drainage map and the mosaic of the basin and to determine the pervious area, the impervious area, and the hydraulically effective impervious area.

EXPLANATION OF THE BASIN CHARACTERISTICS DATA

General Basin Data Table

The basin data table contains general data concerning the basin. Included are the basin location, various area determinations, and descriptions of the soil, vegetation, sewerage, and streets.

Photomosaic Map

The photomosaic of the basin shows the streets, houses, and other permanent development of the basin. Superimposed are the locations of the rain gages and the data-collection site. The photomosaic and maps which follow it are constructed at the same scale.

Sewerage Map

The sewerage map contains the layout of the sewer pipes and inlets. Both the pipes and inlets are numbered so that data concerning these elements can be referenced.

Drainage Map

The drainage map shows the topography of the basin with 1-foot contour intervals and the direction of surface flow as determined from the topography. The basin is divided into subbasins such that each subbasin has one sewer inlet. Overland slope is not presented in the tables because there is no universally accepted method for determining it.

Imperviousness Map

The imperviousness map shows the location of the pervious and impervious areas within the basin. The impervious area is divided into two parts; the hydraulically effective impervious area and the non-effective impervious area. The hydraulically effective impervious area is defined as that impervious area which contributes water to the sewer system immediately after surface wetting and depression storage have been completed. The noneffective impervious area drains onto pervious areas.

Areal Data Table

The subbasin data table contains the acres of contributing area, pervious area, impervious area, and hydraulically effective impervious area for each subbasin. The noneffective impervious area is not tabulated but can be determined by subtracting the hydraulically

effective impervious area from the impervious area. At the bottom of the table are listed the totals and percentages of each area breakdown.

Sewer Data Table

The sewer data table contains the diameter, length, drop, and slope of each of the sewer segments as shown on the sewerage map. Much of these data were taken from design drawings and little were surveyed in the field.

Inlet Data Table

The inlet data table contains the grate elevations of all inlets, in feet above National Geodetic Vertical Datum of 1929 (NGVD). These data were field surveyed.

BASIN CHARACTERISTICS DATA

The basin characteristics for the four stormwater runoff basins are presented in the figures and tables that follow. Presentation is by site, that is low-density residential, highway, commercial, and high-density residential.

Table 2.--General basin data, low-density residential basin

LOCATION: Pompano Beach, Broward County, Florida

LATITUDE AND LONGITUDE OF GAGE: 26°16'15", 80°05'59"

NEAREST INTERSECTION: NE 31 St. and U.S. 1

DRAINAGE AREA, Acres: 40.8

IMPERVIOUS AREA, Acres: 17.9

HYDRAULICALLY EFFECTIVE IMPERVIOUS AREA, Acres: 2.41

LAND USE: Single family housing. Average lot size is 80' by 100'. Average house size is 40' by 60'.

MEAN ANNUAL RAINFALL, Inches: 62

SOIL COVER: Lawn and shrubbery

SCS SOIL TYPES: Paola-Urban land complex.

SOIL DESCRIPTION: Fine sand; single grained; loose; permeability is very rapid; available water capacity is very low; hydrologic soil group A

VEGETATION: Garden variety shrubbery and palm trees

STORM SEWER SHAPE AND MATERIAL: Circular and rectangular, concrete

DOWNSPOUT CONNECTION: Onto lawn

STREET, GUTTER, AND CURB DESCRIPTION: The streets have no curb and gutter. Instead, water is carried by swales laid in the lawn approximately 3 feet from and parallel to the street. The swale is a depression 1 to 6 feet wide and 3 to 6 inches deep.

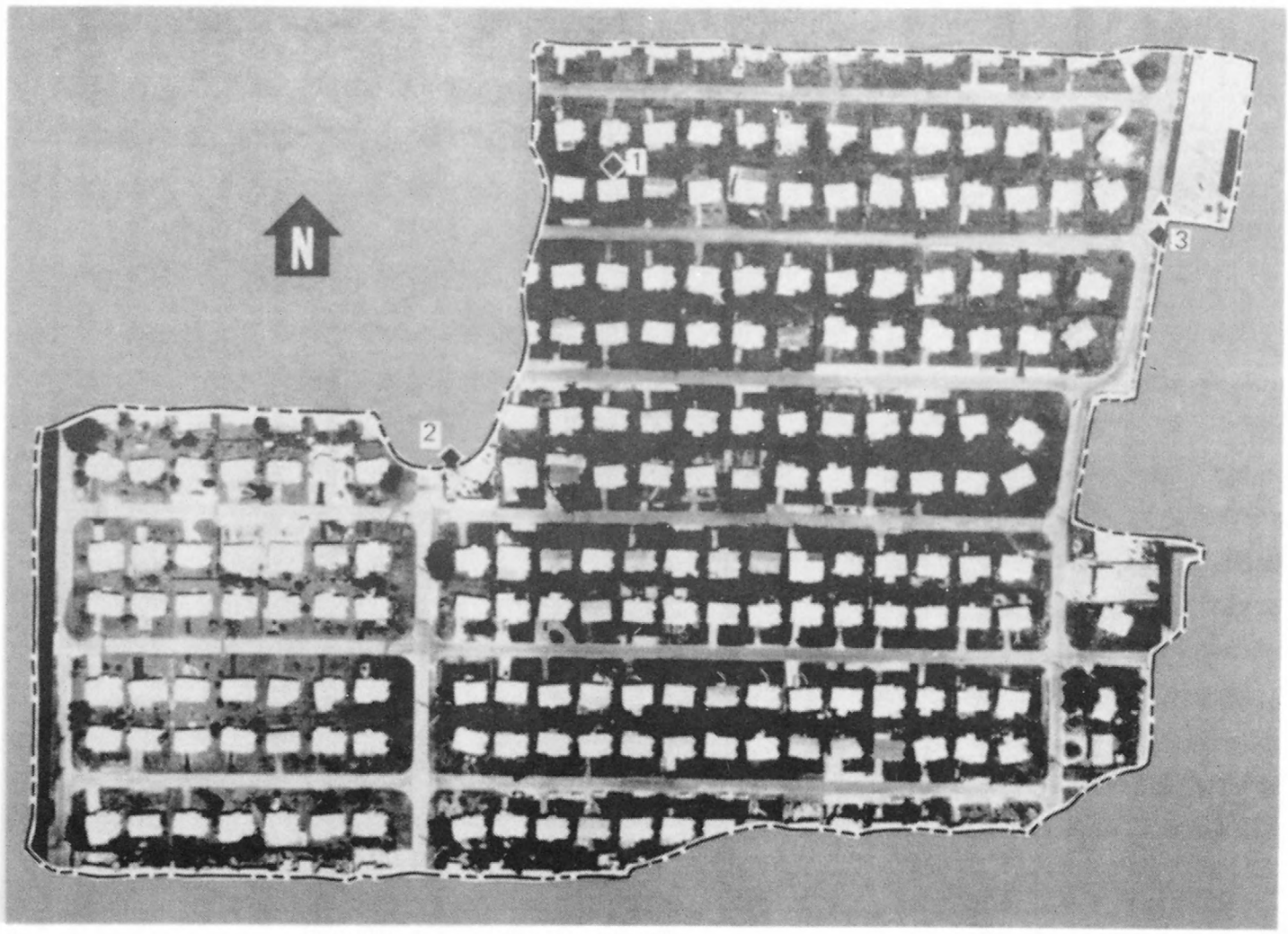

Figure 2.--Photomosaic of low-density residential basin-

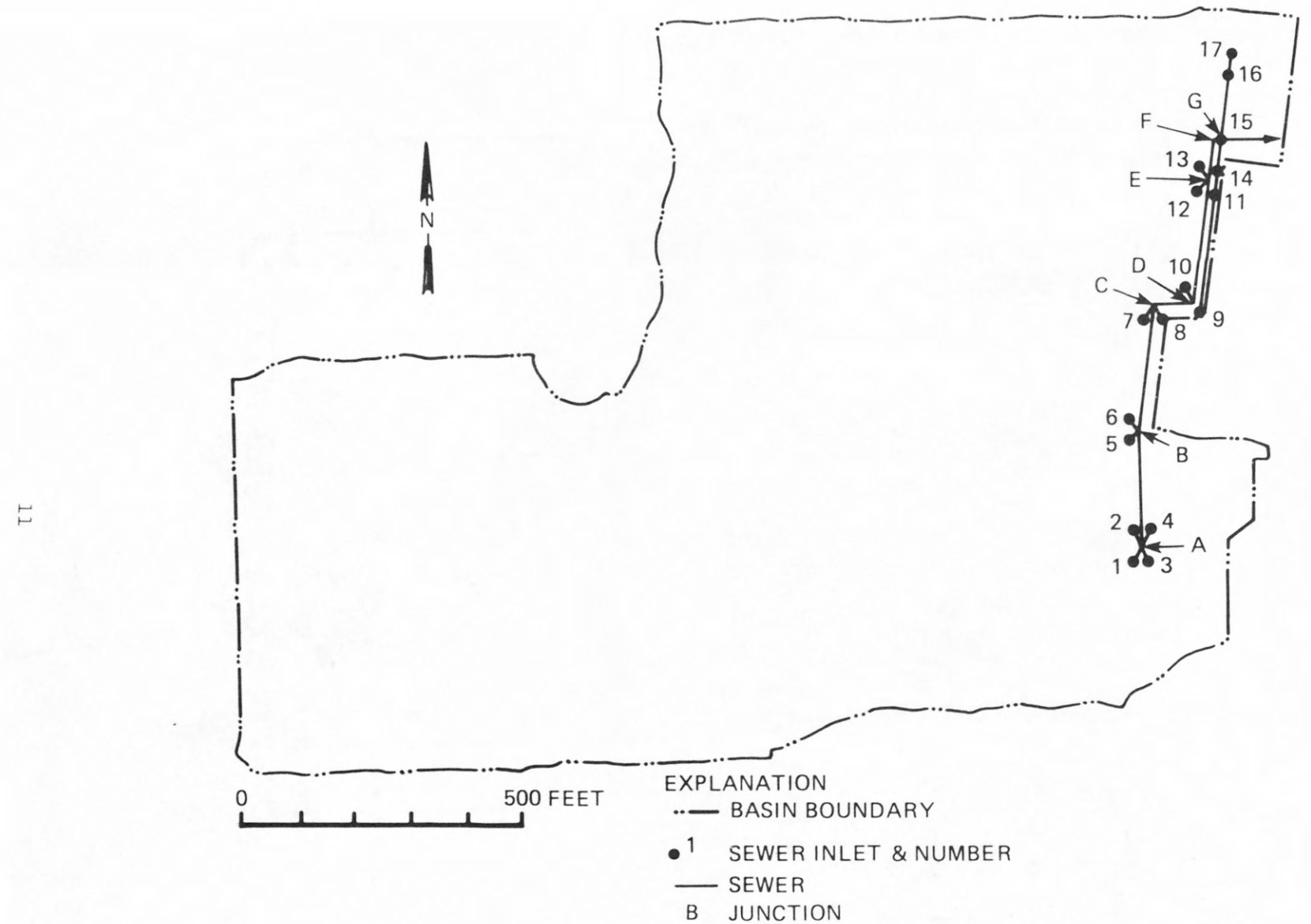

Figure 3.--Sewerage----------

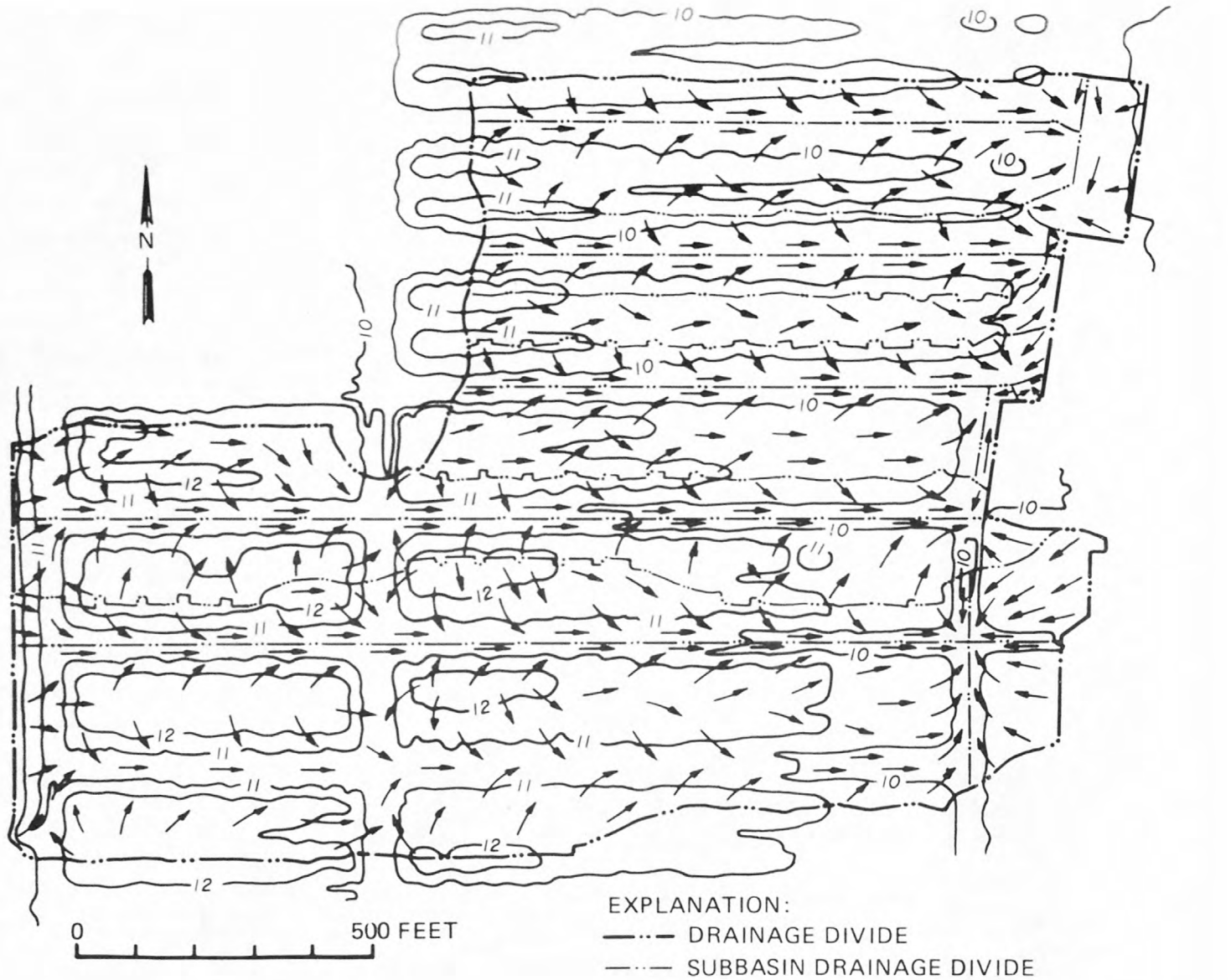

Figure 4.--Drainage

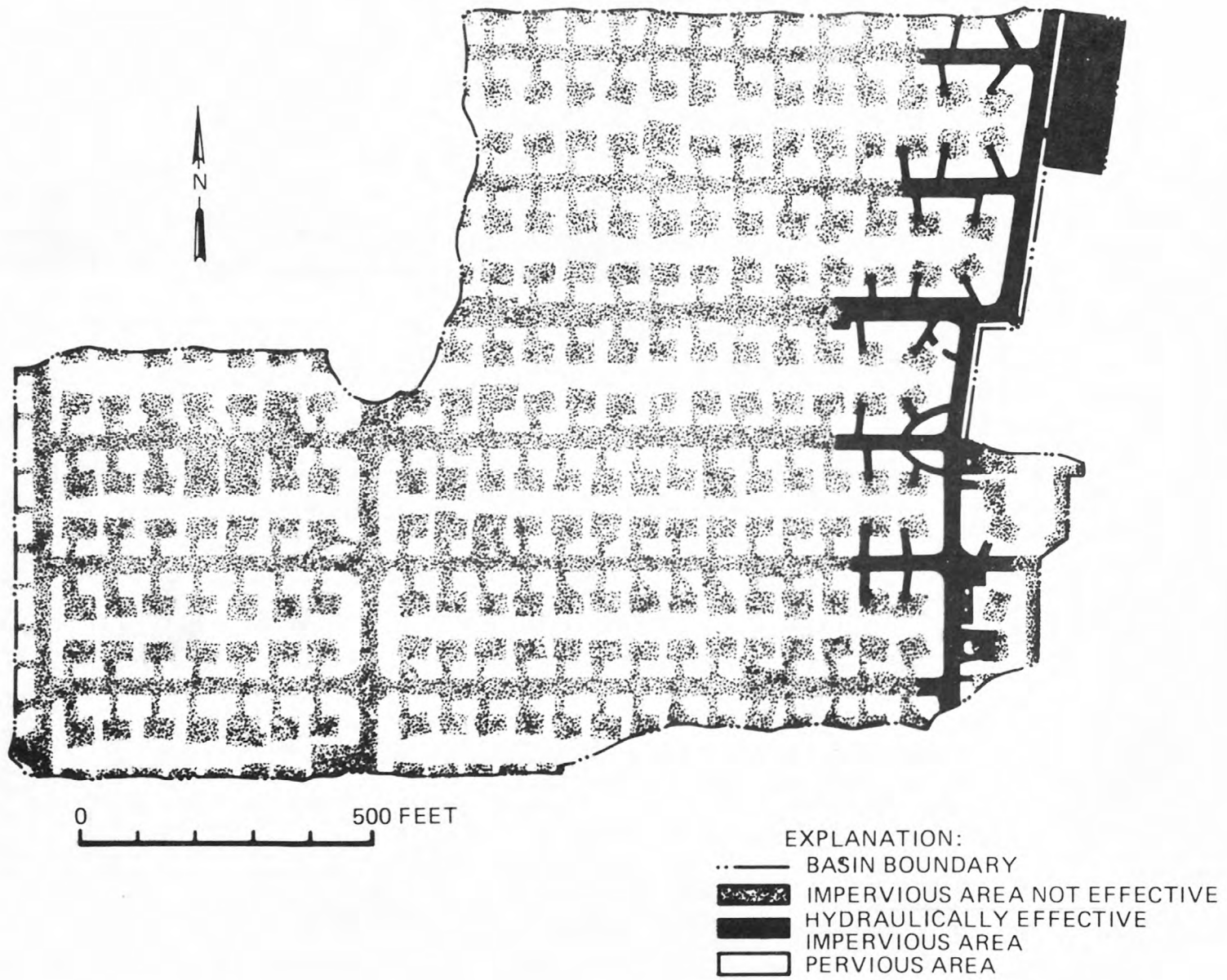

Figure 5.--Imperviousness----------

Designation*	Contributing area (acres)	Pervious area (acres)	Total impervious area (acres)	Hydraulically effective impervious area (acres)
CA-1	12.149	6.905	5.244	0.152
CA-2	3.422	1.751	1.671	.092
CA-3	.712	.329	.383	.196
CA-4	.650	.375	.275	.073
CA-5	4.506	2.529	1.977	.168
CA-6	3.666	1.993	1.673	.108
CA-7	3.220	1.989	1.231	.150
CA-8	.119	.064	.055	.055
CA-9	.042	.029	.013	.013
CA-10	1.605	.823	.782	.221
CA-11	1.851	1.249	.602	.061
CA-12	1.470	.864	.606	.094
CA-13	1.533	.848	.685	.124
CA-14	.029	.018	.011	.011
CA-15	.675	.045	.630	.630
CA-16	3.408	2.079	1.329	.147
CA-17	1.701	.966	.735	.117
TOTAL	40.758	22.856	17.902	2.412
PERCENTAGE	100.0	56.1	43.9	5.92

*The number contained within the designation of the contributing area is the inlet number shown on sewerage map, figure 3. Contributing areas are outlined on the drainage map, figure 4.

Table 4.--Sewer data, low-density residential basin

Segment	Diameter* (inches)	Length (feet)	Slope (feet/feet)
I1-A	15	40	-
I2-A	15	40	-
I3-A	15	40	-
I4-A	15	40	-
A-B	19 X 30	205	.001**
I5-B	15	35	-
I6-B	15	35	-
B-C	19 X 30	230	.004**
I7-C	15	35	-
I8-C	15	35	-
C-D	19 X 30	65	.002**
I10-D	15	35	-
D-E	24 X 38	235	.001**
I12-E	15	30	-
I13-E	15	30	-
E-F	24 X 38	95	-
F-G	24 X 38	10	.005**
I9-I11	24	210	-
I11-I14	24	60	-
I14-G	24	65	-
I17-I16	24	40	.004**
I16-G	24	120	-
G-flume	36	10	.00476

*Rectangular pipe when two numbers given.

**Estimated from inlet data.

Table 5.--Inlet data, low-density residential basin

Inlet number	Elevation of grate (NGVD)*
1	9.45
2	8.95
3	9.12
4	9.12
5	9.07
6	8.67
7	7.98
8	8.11
9	8.04
10	7.95
11	7.56
12	7.79
13	7.56
14	7.67
15	8.48 (elevated grate)
16	7.61
17	7.76

*National Geodetic Vertical Datum of 1929

Table 6.--General basin data, highway basin

LOCATION: Sample Road, Broward County, Florida

LATITUDE AND LONGITUDE OF GAGE: 26°16'29", 80°07'24"

NEAREST INTERSECTION: Sample Road and I-75

DRAINAGE AREA, Acres: 58.3

IMPERVIOUS AREA, Acres: 21.1

HYDRAULICALLY EFFECTIVE IMPERVIOUS AREA, Acres: 10.5

LAND USE: Highway with adjacent business establishments and open lots.

MEAN ANNUAL RAINFALL, Inches: 62

SOIL COVER: Mostly unvegetated, but some native shrubs

SCS SOIL TYPES: St. Lucie, Paola fine sand, Paola-Urban land complex

SOIL DESCRIPTION: Fine sand; single grained; loose; permeability is very rapid; available water capacity is very low; hydrologic soil group A

VEGETATION: Sparse Palmetto palms with wild grass

STORM SEWER SHAPE AND MATERIAL: Circular, concrete

DOWNSPOUT CONNECTION: Onto lawn

STREET, GUTTER, AND CURB DESCRIPTION: The east-west portion of the highway, Sample Road, contains six lanes with adjacent curbs and gutters. The north-south street, NE 3 Ave., is four lanes with swale and lawn drainage.

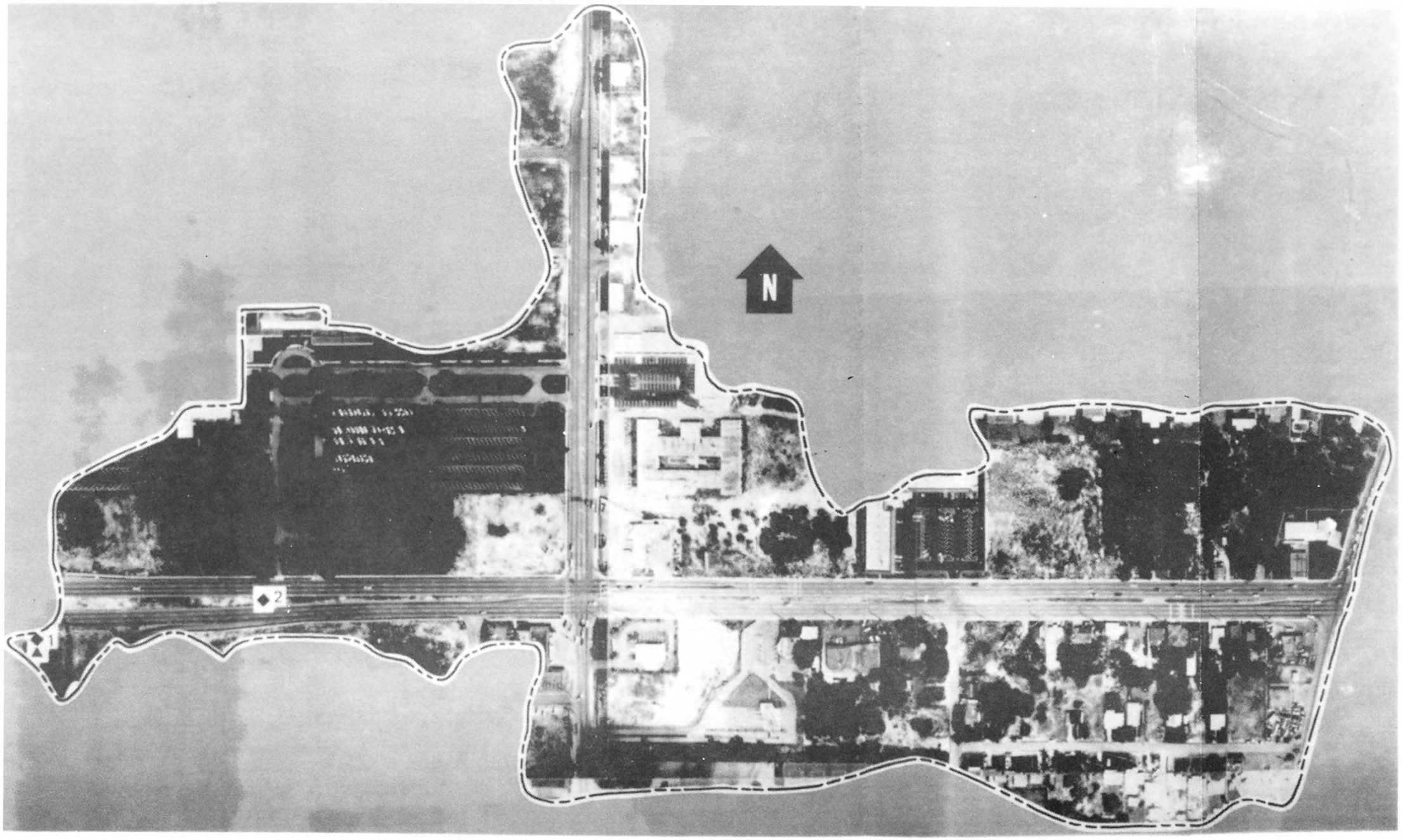

Figure 6.--Photomosaic of highway basin----------

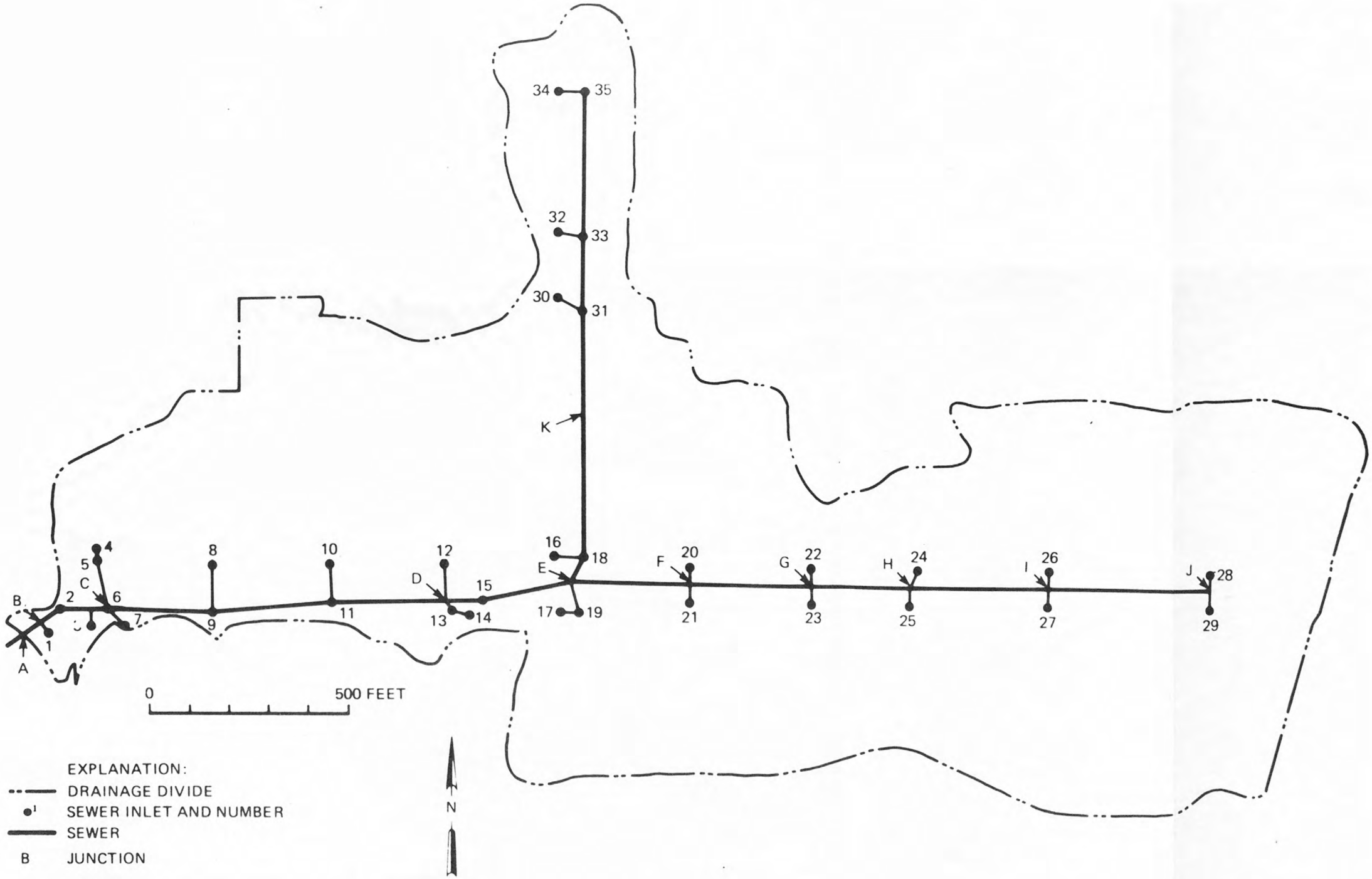

Figure 7.--Sewerage----------

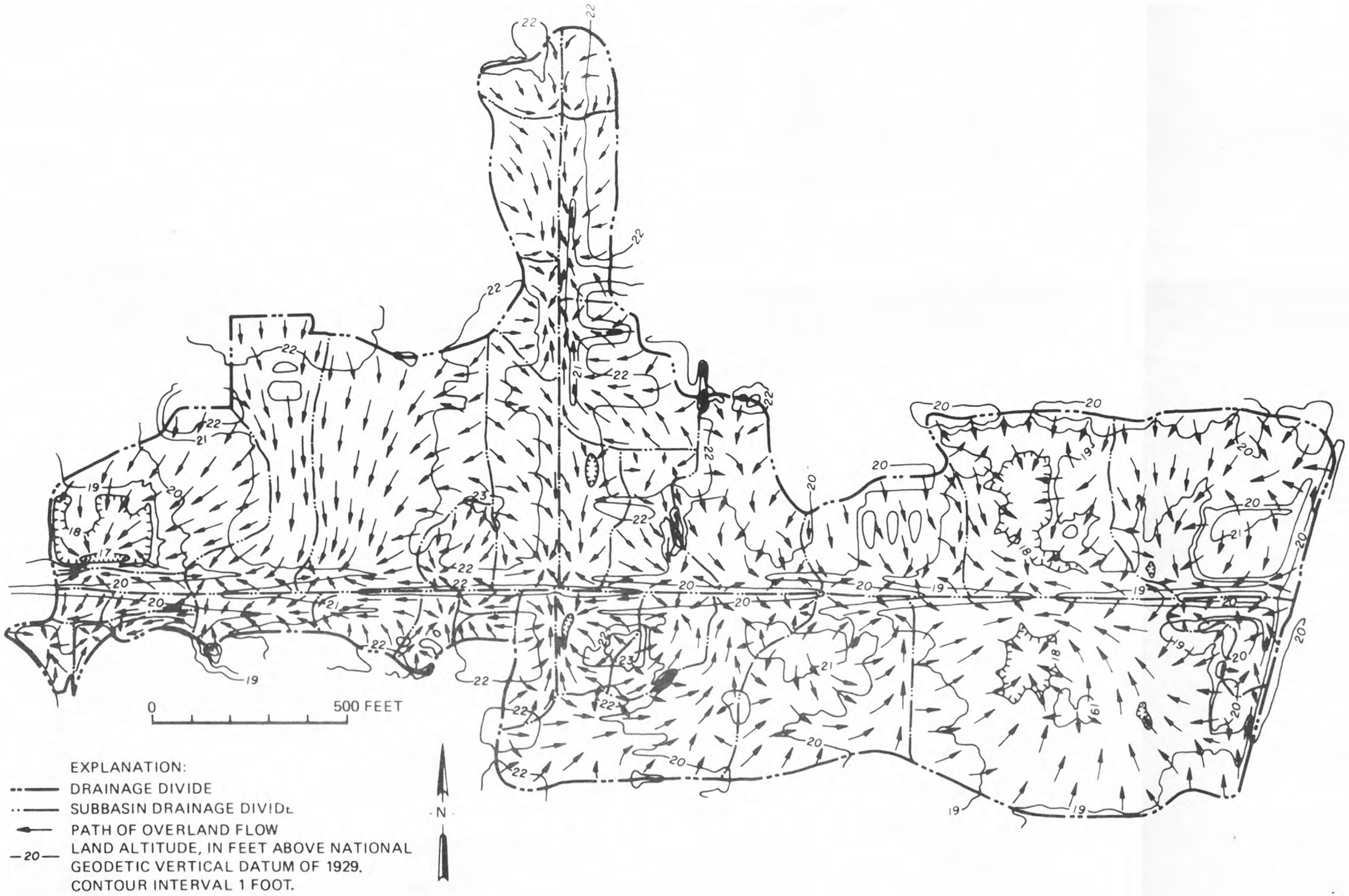

Figure 8.--Drainage----------

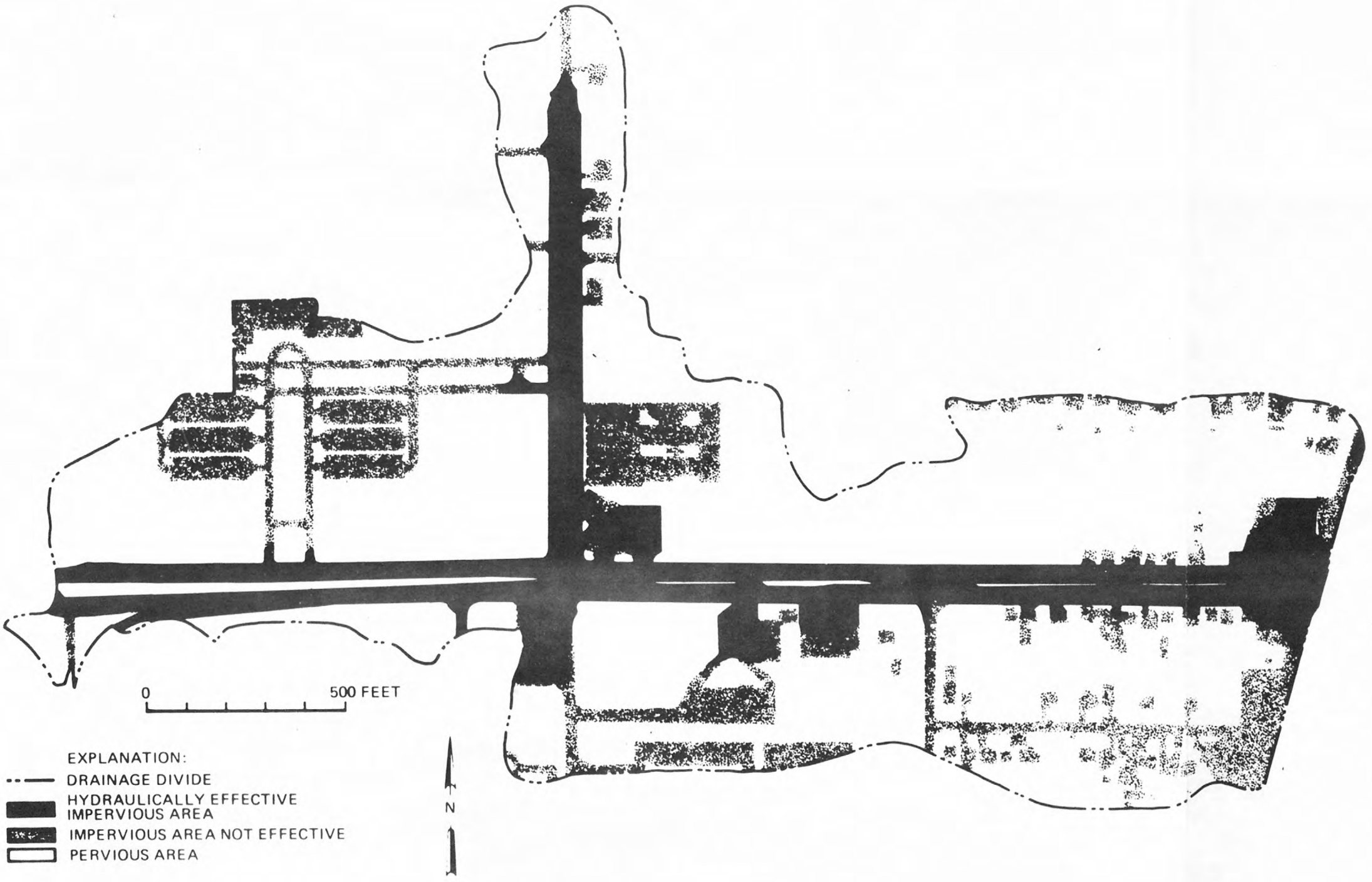

Figure 9.--Imperviousness----------

Table 7.--Areal data, highway basin

Designation*	Contributing area (acres)	Pervious area (acres)	Total impervious area (acres)	Hydraulically effective impervious area (acres)
CA-1	0.387	0.320	0.067	0.000
CA-2	.221	.095	.126	.126
CA-3	.175	.175	.000	.000
CA-4	3.387	2.517	.870	.000
CA-5	.341	.059	.282	.282
CA-6	.239	.105	.134	.134
CA-7	.212	.061	.151	.121
CA-8	2.713	1.466	1.247	.249
CA-9	.683	.325	.358	.358
CA-10	4.799	3.158	1.641	.372
CA-11	.710	.473	.237	.222
CA-12	.719	.569	.150	.150
CA-13	.443	.314	.126	.126
CA-14	.193	.055	.138	.138
CA-15	.239	.171	.068	.034
CA-16	2.058	1.361	.697	.617
CA-17	.738	.184	.554	.492
CA-18	1.118	.155	.963	.543
CA-19	.941	.637	.304	.273
CA-20	1.329	.506	.823	.490

Table 7.--Continued

Designation*	Contributing area (acres)	Pervious area (acres)	Total impervious area (acres)	Hydraulically effective impervious area (acres)
CA-21	0.941	0.789	0.152	0.152
CA-22	2.427	2.008	.419	.240
CA-23	3.452	1.742	1.710	.591
CA-24	2.196	1.856	.340	.340
CA-25	3.313	2.198	1.115	.502
CA-26	3.876	3.113	.763	.519
CA-27	8.611	5.335	3.276	.749
CA-28	4.753	3.221	1.532	.844
CA-29	.876	.146	.730	.526
CA-30	.646	.400	.246	.215
CA-31	1.993	1.238	.755	.302
CA-32	1.209	.868	.341	.279
CA-33	1.238	.627	.611	.397
CA-34	.572	.508	.064	.038
CA-35	.507	.366	.141	.113
TOTAL	58.255	37.121	21.131	10.534
PERCENTAGE	100.0	63.7	36.3	18.08

*The number contained within the designation of the contributing area is the inlet number shown on sewerage map, figure 7. Contributing areas are outlined on the drainage map, figure 8.

Table 8.--Sewer data, highway basin

Segment	Diameter (inches)	Length (feet)	Slope (feet/feet)
B-A	42	25	0.003
I1-B	15	25	-
I2-B	42	55	.008
C-I2	42	75	.002
I3-C	15	40	-
I6-C	42	35	.0006
I4-I5	15	30	-
I5-I6	18	115	-
I7-I6	15	50	-
I9-I6	42	260	.2
I8-I9	18	105	-
I11-I9	42	290	-
I10-I11	18	85	-
D-I11	42	265	-
I12-D	15	85	-
I13-D	15	15	-
I14-I13	15	35	-
I15-D	42	90	-
E-I15	42	200	-
I19-E	15	65	-
I17-I19	15	45	-
F-E	36	300	.1
I20-F	15	40	-
I21-F	15	40	-
G-F	36	300	.1
I22-G	15	40	-
I23-G	15	40	-
H-G	36	250	.1

Table 8.--Continued

Segment	Diameter (inches)	Length (feet)	Slope (feet/feet)
I24-H	15	45	-
I25-H	15	40	-
I-H	30	350	.1
I26-I	18	40	-
I27-I	18	40	-
J-I	24	400	.1
I28-J	15	40	-
I29-J	15	40	-
I18-E	24	70	1.0
I16-I18	15	70	-
K-I18	24	320	.406
I31-K	15	280	.286
I30-I31	15	60	-
I33-I31	15	170	.529
I32-I33	15	60	-
I35-I33	15	360	.222
I34-I35	15	60	-

Table 9.--Inlet data, highway basin

Inlet number	Elevation of grate (NGVD)*
I-1	16.6
I-2	19.3
I-3	16.6
I-4	16.5
I-5	18.1
I-6	18.9
I-7	17.4
I-8	19.2
I-9	19.0
I-10	19.8
I-11	-
I-12	20.5
I-13	20.0
I-14	20.8
I-15	20.3
I-16	20.8
I-17	21.4
I-18	21.0
I-19	20.8
I-20	20.4
I-21	19.7
I-22	19.7
I-23	20.4
I-24	18.4
I-25	18.6
I-26	17.3
I-27	17.5
I-28	17.9
I-29	18.0
I-30	20.6
I-31	20.5
I-32	20.9
I-33	20.7
I-34	-
I-35	-

*National Geodetic Vertical Datum of 1929

Table 10.--General basin data, commercial basin

LOCATION: Fort Lauderdale, Broward County, Florida

LATITUDE AND LONGITUDE OF GAGE: 26°10'02" 80°07'01"

NEAREST INTERSECTION: NE 35 St. and U.S. 1

DRAINAGE AREA, Acres: 20.4

IMPERVIOUS AREA, Acres: 20.0

HYDRAULICALLY EFFECTIVE IMPERVIOUS AREA, Acres: 20.0

LAND USE: Shopping center

MEAN ANNUAL RAINFALL, Inches: 62

SOIL COVER: None

SCS SOIL TYPES: None

SOIL DESCRIPTION: None

VEGETATION: None

STORM SEWER SHAPE AND MATERIAL: Circular, concrete

DOWNSPOUT CONNECTION: To sewer system

STREET, GUTTER, AND CURB DESCRIPTION: None

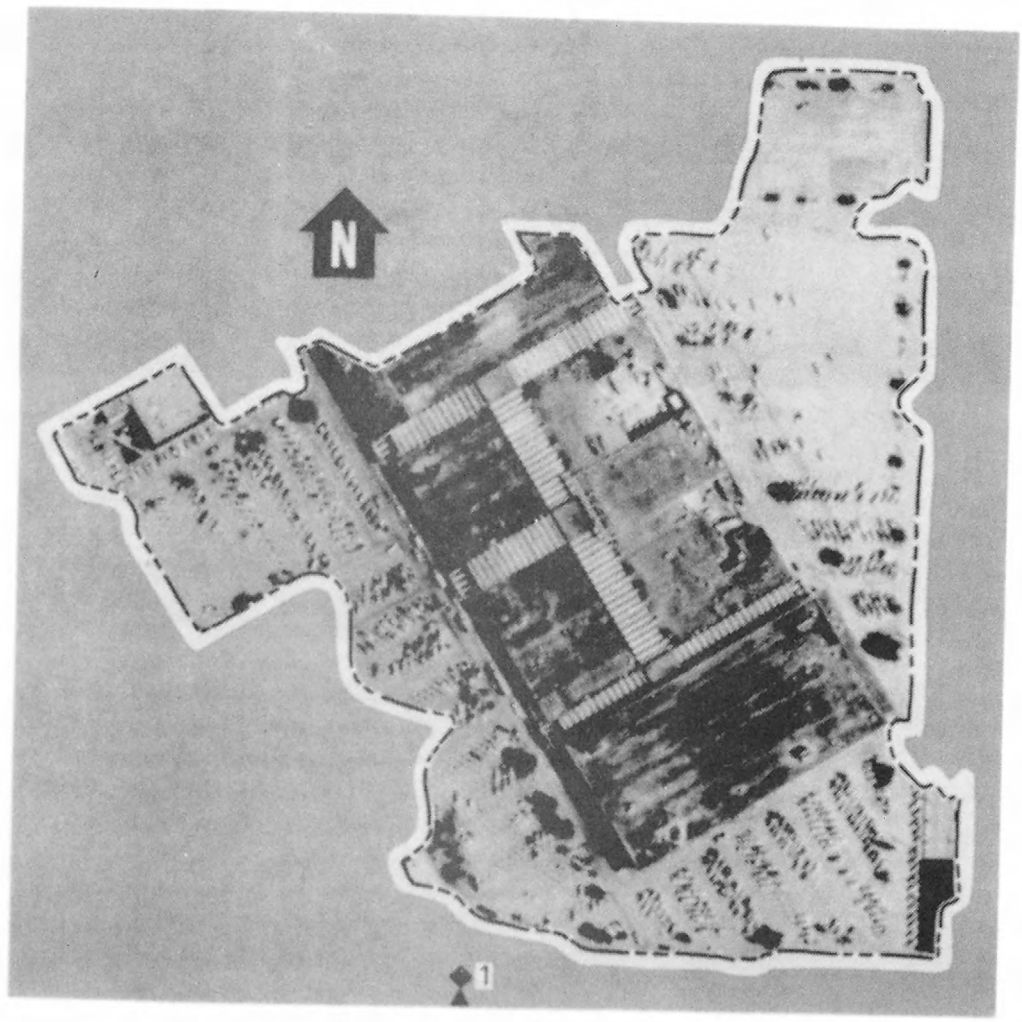

Figure 10.--Photomosaic of commercial basin------

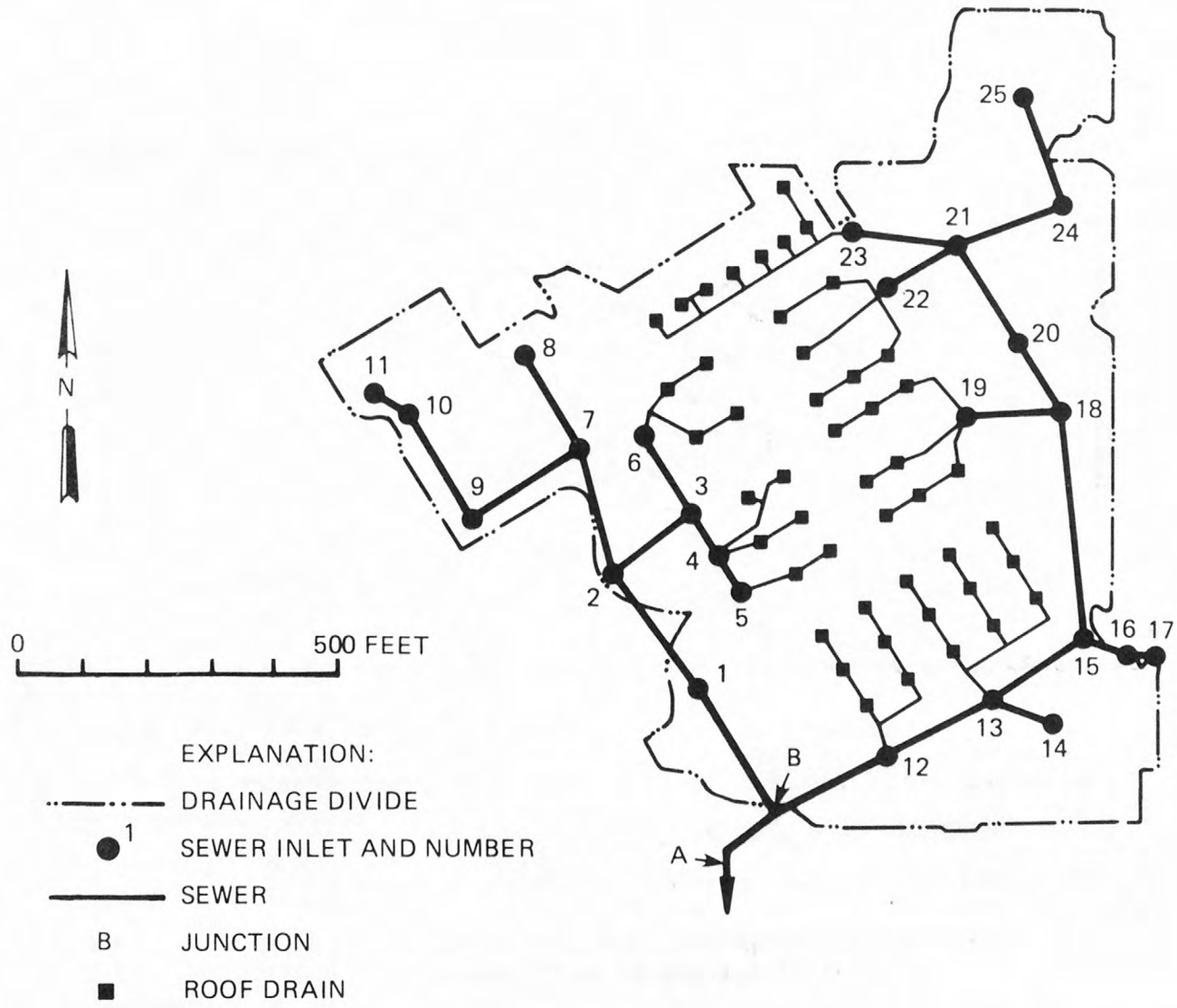

Figure 11.--Sewerage----------

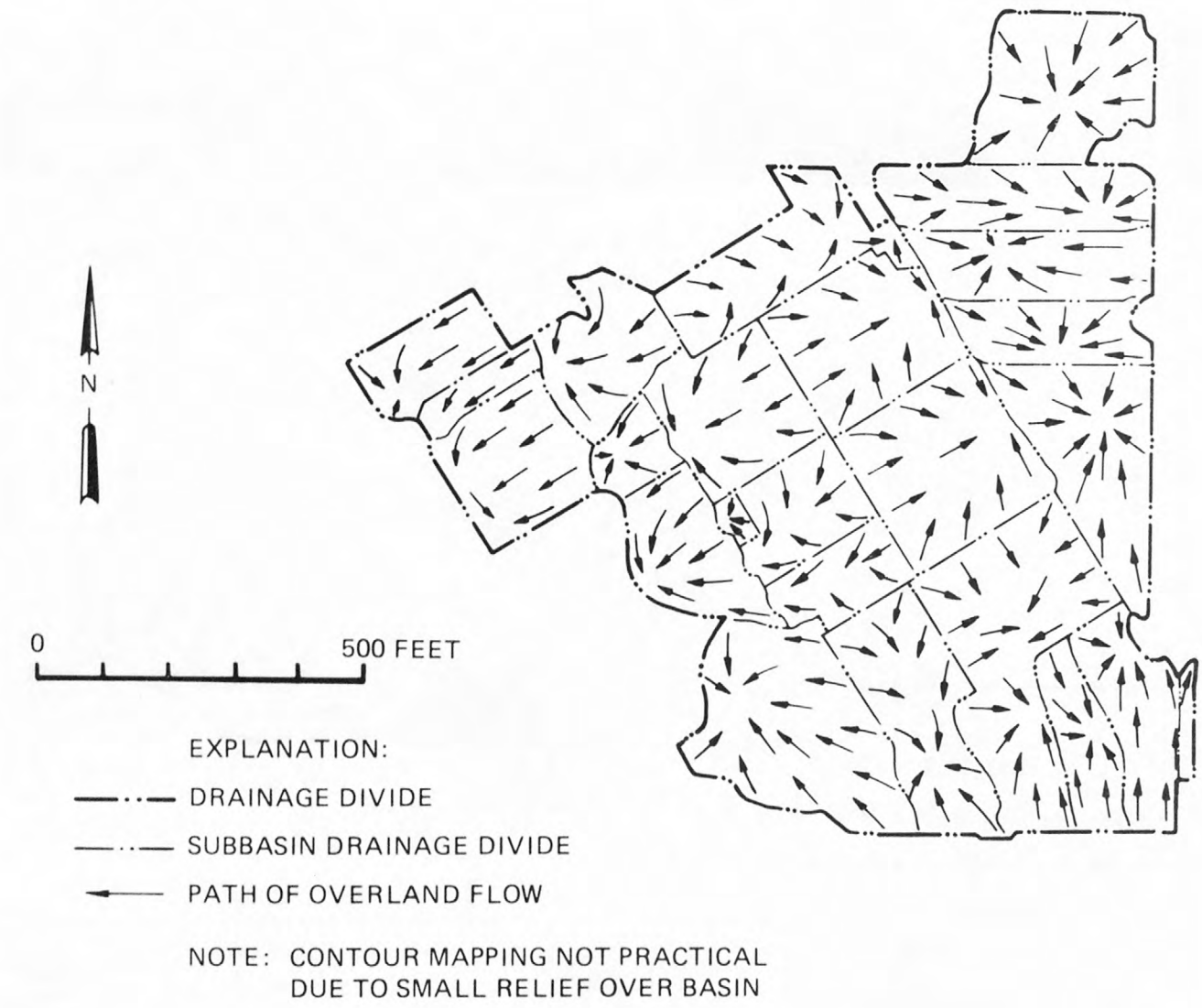

Figure 12.--Drainage----------

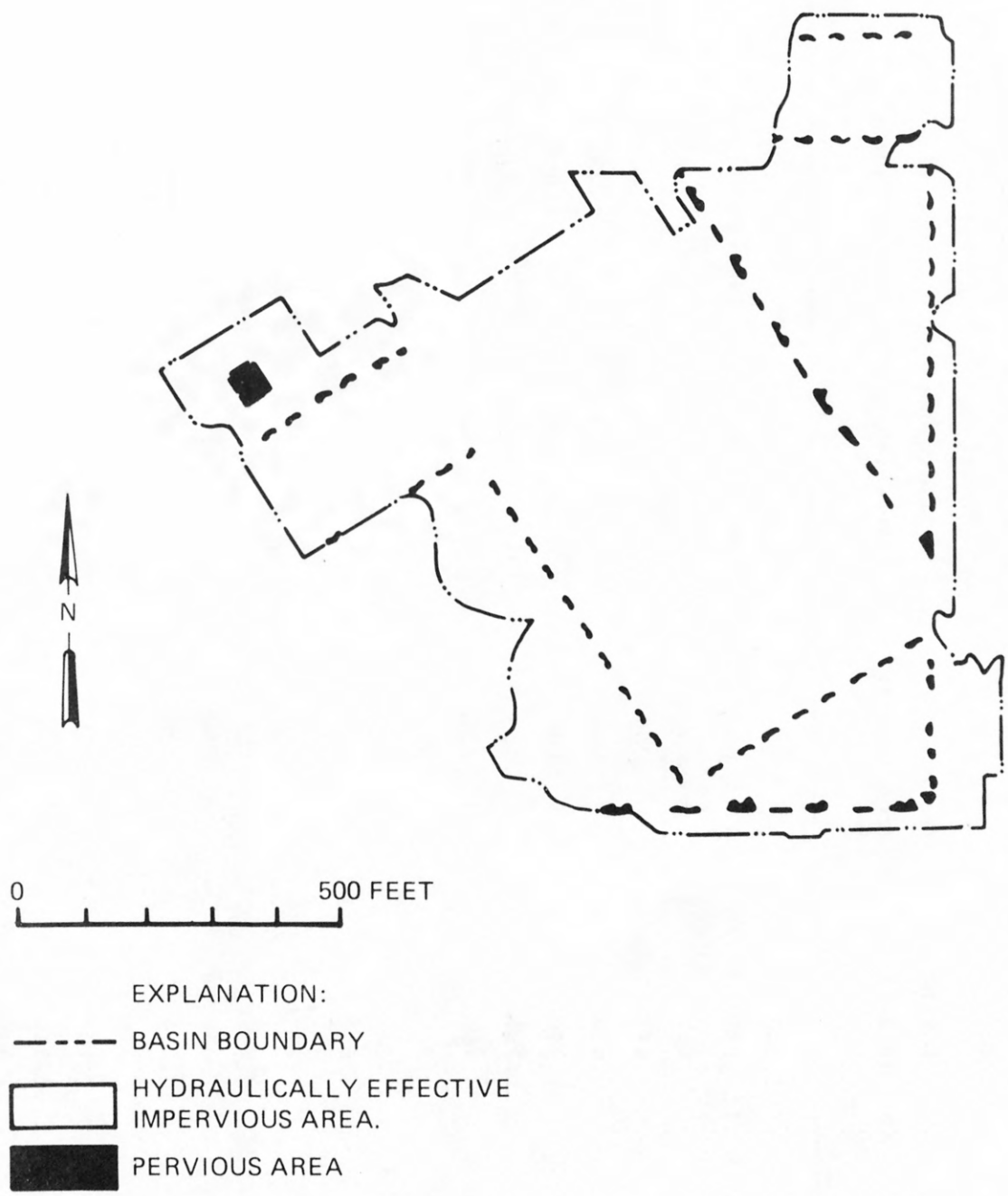

Figure 13.--Imperviousness----------

Table 11.--Areal data, commercial basin

Designation*	Contributing area (acres)	Pervious area (acres)	Total impervious area (acres)	Hydraulically effective impervious area (acres)
CA-1	1.747	0.039	1.708	1.708
CA-2	.807	.031	.776	.776
CA-3	.067	.000	.067	.067
CA-4	.647	.000	.647	.647
CA-5	.489	.000	.489	.489
CA-6	.999	.000	.999	.999
CA-7	.288	.010	.278	.278
CA-8	.769	.007	.762	.762
CA-9	.931	.027	.904	.904
CA-10	.222	.000	.222	.222
CA-11	.551	.040	.511	.511
CA-12	1.166	.015	1.151	1.151
CA-13	1.870	.024	1.846	1.846
CA-14	.560	.031	.529	.529
CA-15	.514	.016	.498	.498
CA-16	.154	.000	.154	.154
CA-17	.103	.000	.103	.103
CA-18	1.240	.069	1.171	1.171
CA-19	1.435	.000	1.435	1.435
CA-20	.609	.020	.589	.589

Table 11.--Continued

Designation*	Contributing area (acres)	Pervious area (acres)	Total impervious area (acres)	Hydraulically effective impervious area (acres)
CA-21	0.847	0.028	0.819	0.819
CA-22	1.211	.000	1.211	1.211
CA-23	1.028	.000	1.028	1.028
CA-24	.918	.025	.893	.893
CA-25	1.232	.046	1.186	1.186
TOTAL	20.404	.428	19.976	19.976
PERCENTAGE	100.0	2.10	97.9	97.90

*The number contained within the designation of the contributing area is the inlet number shown on sewerage map, figure 11. Contributing areas are outlined on the drainage map, figure 12.

Table 12.--Sewer data, commercial basin

Segment	Diameter (inches)	Length (feet)	Slope (feet/feet)
B-A	36	80	.00694
I1-B	24	228	.00202
I2-I1	21	220	.00195
I3-I2	15	146	-
I4-I3	10	85	-
I5-I4	10	67	-
I6-I3	10	145	-
I7-I2	18	203	.00197
I8-I7	12	167	.00782
I9-I7	15	197	.00229
I10-I9	15	175	.00206
I11-I10	12	78	.00205
I12-B	27	203	.00384
I13-I12	24	172	.00000
I14-I13	18	114	.00193
I15-I13	24	184	.00196
I16-I15	18 (est.)	75	-
I17-I16	18 (est.)	32	-
I18-I15	21	360	.00178
I19-I18	12	136	-
I20-I18	18	128	.00211
I21-I20	18	180	.00219
I22-I21	12	125	-
I23-I21	12	160	-
I24-I21	12	188	.00191
I25-I24	12	180	.00200

Table 13.--Inlet data, commercial basin

Inlet number	Elevation of grate (NGVD)*
I-1	8.56
I-2	8.57
I-3	10.17
I-4	10.27
I-5	10.27
I-6	9.78
I-7	8.52
I-8	8.44
I-9	8.00
I-10	7.96
I-11	7.75
I-12	10.52
I-13	10.48
I-14	9.53
I-15	9.59
I-16	9.50
I-17	9.40
I-18	8.31
I-19	10.74
I-20	8.02
I-21	8.10
I-22	10.43
I-23	10.26
I-24	8.12
I-25	7.53

*National Geodetic Vertical Datum of 1929

Table 14.--General basin data, high-density residential basin

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LOCATION: Kings Creek Apartments, South Miami, Florida

LATITUDE AND LONGITUDE OF GAGE: 25°40'31", 80°19'11"

NEAREST INTERSECTION: SW 77 Ave. and Camino Real

DRAINAGE AREA, Acres: 14.7

IMPERVIOUS AREA, Acres: 10.4

HYDRAULICALLY EFFECTIVE IMPERVIOUS AREA, Acres: 6.48

LAND USE: Apartments

MEAN ANNUAL RAINFALL, Inches: 56

SOIL COVER: Lawn

SCS SOIL TYPES: Perrine marl

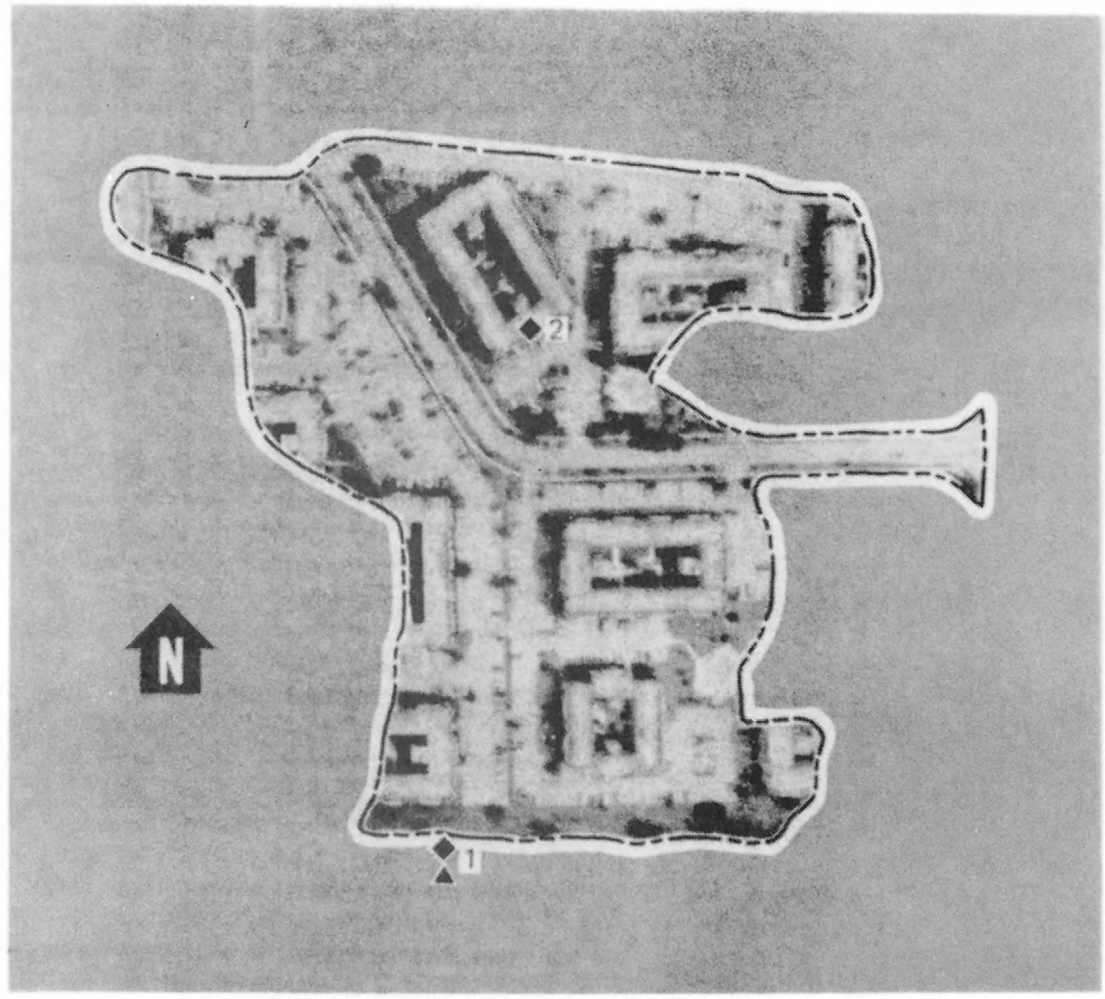
SOIL DESCRIPTION: Friable marl of silt-loam texture; contains few shell fragments; underlain by limestone; hydrologic soil group D

VEGETATION: Lawn sod with some garden shrubbery and trees

STORM SEWER SHAPE AND MATERIAL: Circular, corrugated metal except from inlet 5 to junction A which is concrete

DOWNSPOUT CONNECTION: Onto lawn

STREET, GUTTER, AND CURB DESCRIPTION: The streets have no curb and gutter, but are formed such that the centerline is the lowest point on the cross section. Stormwater is then drained towards, and conveyed along the center of the street. Street material is bituminous concrete.



0 500 FEET

EXPLANATION:

DRAINAGE DIVIDE

RAIN GAGE WITH NUMBER

URBAN HYDROLOGY MONITOR

Figure 14.--Photomosaic of high-density residential basin

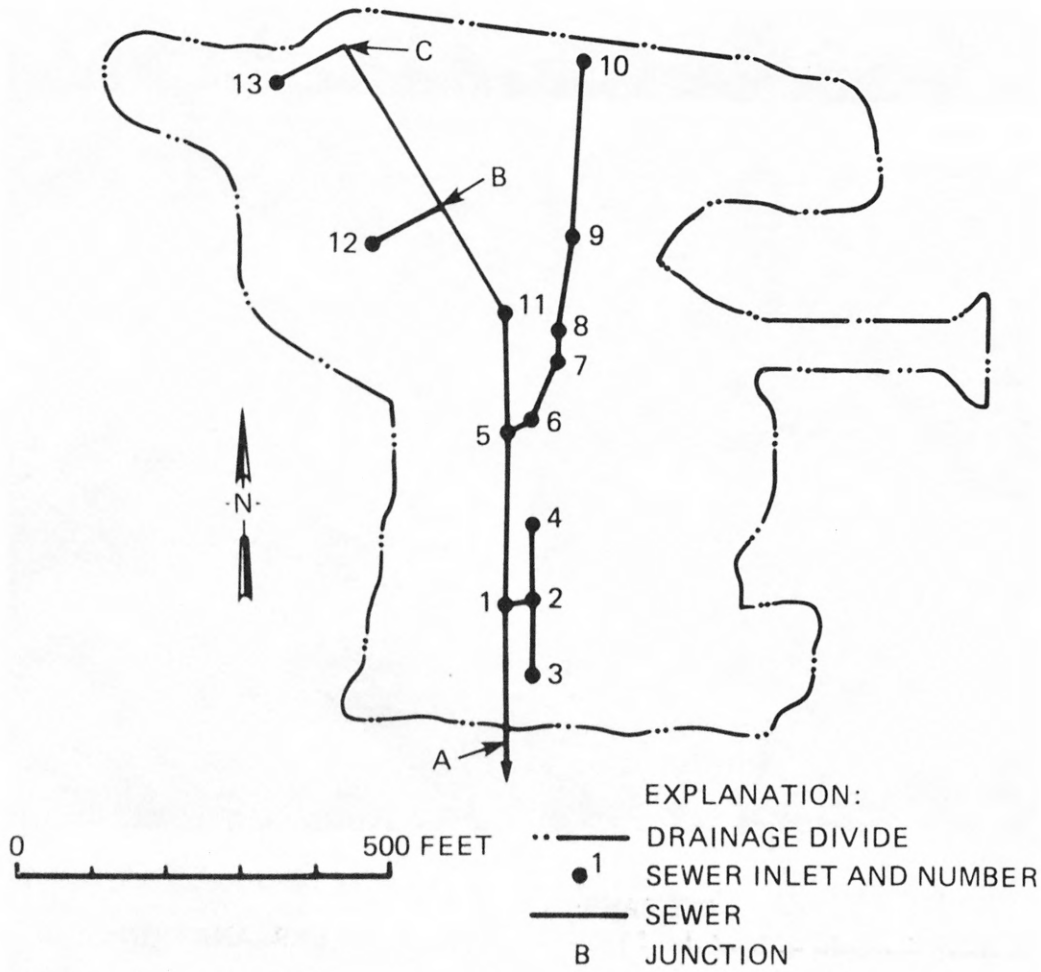


Figure 15.--Sewerage----------

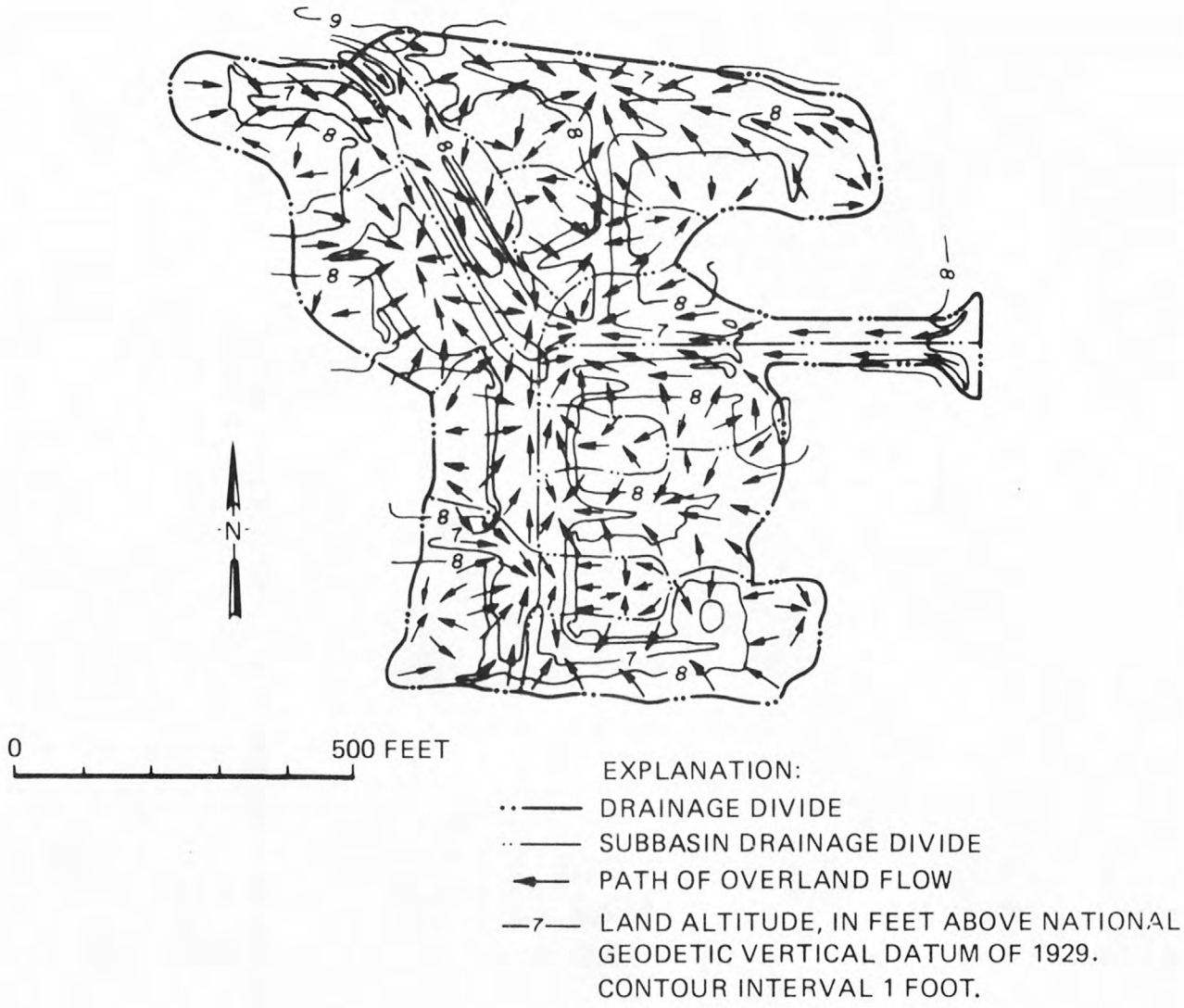


Figure 16.--Drainage----------

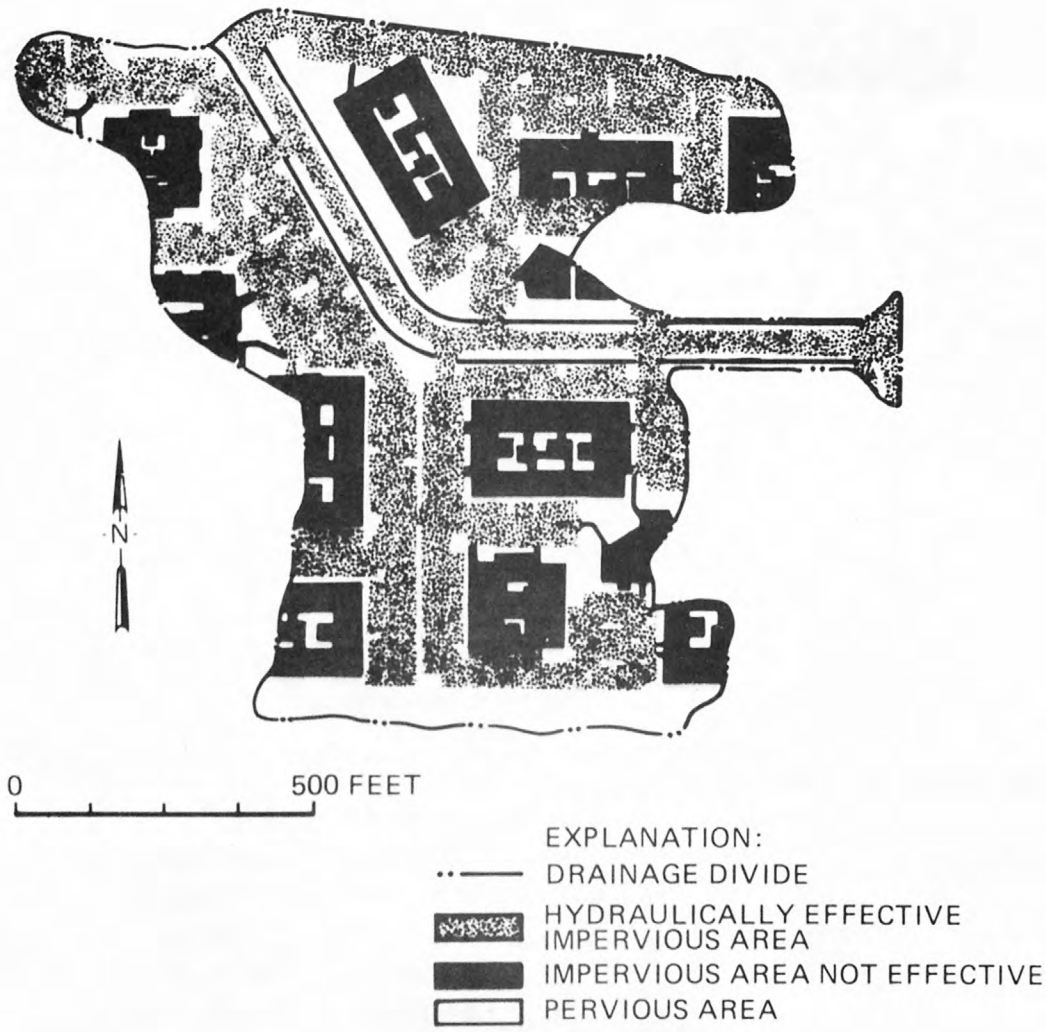


Figure 17.--Imperviousness----------

Designation*	Contributing area (acres)	Pervious area (acres)	Total impervious area (acres)	Hydraulically effective impervious area (acres)
CA-1	1.157	0.460	0.698	0.415
CA-2	.352	.043	.309	.109
CA-3	1.412	.626	.786	.568
CA-4	1.236	.380	.855	.459
CA-5	.842	.187	.655	.397
CA-6	.395	.093	.303	.126
CA-7	1.204	.315	.889	.585
CA-8	1.006	.310	.696	.513
CA-9	.761	.179	.582	.241
CA-10	2.798	.601	2.197	1.380
CA-11	1.049	.524	.525	.374
CA-12	1.452	.287	1.164	.864
CA-13	1.079	.293	.786	.444
TOTAL	14.743	4.298	10.445	6.475
PERCENTAGE	100.0	29.2	70.8	43.92

*The number contained within the designation of the contributing area is the inlet number shown on sewerage map, figure 15. Contributing areas are outlined on the drainage map, figure 16.

Table 16.--Sewer data, high-density residential basin

Segment	Diameter (inches)	Length (feet)	Slope (feet/feet)
I1-A	48	220	.00505
I2-I1	18	32	.02969
I3-I2	18	105	.00076
I4-I2	18	105	.00038
I5-I1	36	240	.00163
I6-I5	36	40	.02900
I7-I6	36	90	.00722
I8-I7	30	40	.02375
I9-I8	27	165	.00382
I10-I9	24	210	.00148
I11-I5	30	165	.00000
B-I11	30	175	.00237
I12-B	21	110	.00078
C-B	30	205	.00237
I13-C	21	110	.00682

Table 17.--Inlet data, high-density residential basin

Inlet number	Elevation of grate (NGVD)*
I-1	6.33
I-2	6.80
I-3	6.47
I-4	6.24
I-5	6.30
I-6	6.14
I-7	5.77
I-8	5.48
I-9	6.40
I-10	6.19
I-11	5.80
I-12	6.15
I-13	6.45

*National Geodetic Vertical Datum of 1929

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