North Anna Power Station
Updated Final Safety Analysis Report

Chapter 2

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CHAPTER 2 SITE CHARACTERISTICS

This chapter primarily describes the site characteristics for the North Anna Power Station as they existed when the facility was licensed. As such, current site characteristics may not agree with these descriptions. The site characteristics described here include geography, demographics, nearby facilities, meteorology, hydrology, geology, and seismology. This information was gathered to support or develop the original plant design bases. Chapter 2 also contains evaluations of these site characteristics demonstrating how applicable siting criteria were met at the time of original licensing of the facility. Because this information is not expected to be used to support current or future plant operations or regulatory activities, Chapter 2 does not need to be updated to reflect minor changes to these site characteristics. However, this does not preclude the need to update this chapter to reflect significant changes to this information.

In the past, minor changes to site characteristics have been incorporated into Chapter 2. While the updates were not required, these changes have not been removed. Therefore, some parts of this chapter reflect more recent information.

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 Site Location and Description

2.1.1.1 Site Location

The North Anna Power Station is located in the northeastern portion of Virginia in Louisa County. The site is on a peninsula on the southern shore of Lake Anna at the end of State Route 700. The earth dam that creates Lake Anna is about 5 miles southeast of the site. The North Anna River flows southeasterly, joining the South Anna to form the Pamunkey about 27 miles southeast of the site.

The largest community within 10 miles of the site is the Town of Mineral (Louisa County), which had a population of 452 in 1990, and is about 6 miles west-southwest of the site. The community of Louisa, whose 1990 population was 1088, is about 12 miles to the west of the site. Figure 2.1-1 shows the general location of the plant site and localities surrounding the site within 10 miles.

Regionally, as indicated in Figure 2.1-2, the site is approximately 40 miles north-northwest of Richmond, Virginia; 36 miles east of Charlottesville, Virginia; 22 miles southwest of Fredericksburg, Virginia; and 70 miles southwest of Washington, D.C. Highways U.S. 1 and I-95, the two principal highways joining Richmond with the rest of the eastern corridor, pass within 15 and 16 miles, respectively, east of the site.

The coordinates of the reactor containment structures are as follows:

Unit	Latitude	Longitude	Universal Transverse Mercator (UTM)		
Unit 1	38° 3' 36" N	77° 47' 23" W	4,215,990 mN	255,240 mE;	zone 18S
Unit 2	38° 3' 38" N	77° 47' 26" W	4,215,960 mN	255,170 mE;	zone 18S

2.1.1.2 **Site Description**

The plant property comprises 1803 acres, of which about 760 acres are covered by water. The site is laid out according to the site plan as shown in Figure 2.1-3. VEPCO owns, in fee simple, and controls all of the land within the site boundary, both above and beneath the surfaces, including those portions of the North Anna Reservoir and Waste Heat Treatment Facility that lie within the site boundary. VEPCO also owns, in fee simple, all land outside the site boundary that forms the North Anna Reservoir and the Waste Heat Treatment Facility up to their expected high-water marks. The station and all supporting facilities including the North Anna Reservoir, Waste Heat Treatment Facility, earthen dam, dikes, railroad spur, and roads constitute approximately 13,775 acres out of a total land allocation of some 18,643 acres.

The topography in the site region is characteristic of the central Piedmont Plateau with a gently undulating surface varying from 200 to 500 feet above sea level. The surrounding region is covered with forest and brushwood interspersed with an occasional farm. The land adjacent to Lake Anna is becoming increasingly residential as the land is developed.

Lake Anna was constructed to serve the needs of the North Anna Power Station. The North Anna Reservoir was designed to provide adequate cooling water for an ultimate nuclear station capacity of approximately 4000 MWe.

Lake Anna is approximately 17 miles long, with an irregular shore line of more than 200 miles. Lake Anna is divided into two major portions, the North Anna Reservoir and the Waste Heat Treatment Facility. The lake covers a surface area of 13,000 acres and contains approximately 100 billion gallons of water. The largest segment, the North Anna Reservoir, consists of approximately 9600 acres and functions as a storage impoundment to ensure adequate water for condenser cooling. The smaller segment, the Waste Heat Treatment Facility, has an area of about 3400 acres and is separated from the North Anna Reservoir by dikes. The first of the Waste Heat Treatment Facility’s three cooling lagoons receives the heated condenser cooling water after its passage through the units. The heated water transfers most of its heat to the atmosphere as it moves, via canals, to the second and third cooling lagoons. The cooled water is discharged from the third cooling lagoon to the North Anna Reservoir at a point immediately upstream of the dam.

2.1.1.3 **Boundaries For Establishing Effluent Release Limits**

The radiological effluent releases are based on the unrestricted area as depicted in Figure 2.1-3. The gaseous effluent release limits apply at or beyond the site boundary as shown in Figure 2.1-3 and the liquid effluent release limits apply at the end of the discharge canal, which is designated as the release point to unrestricted areas.

The site boundary, shown in Figure 2.1-3, is the perimeter of a 5000-ft-radius circle from the center of the now abandoned Unit 3 containment. Since VEPCO owns, in fee simple, all of the land within the site boundary, it has total control over access to these areas. Access is controlled by the security guard force. Exposure of individuals to radiation in these areas will be within limits established in 10 CFR 20.

All areas outside the site boundary are unrestricted areas in the context of 10 CFR 20. Assuming conservative atmospheric dispersion and the release presented in Table 11.3-3, which was calculated using expected and anticipated operational occurrences, areas outside of the site boundary should not experience airborne concentrations in excess of the limits specified in Table II, Column 1, of Appendix B of the revision of 10 CFR 20 in effect when the plant was licensed. Appendix B was revised in the 10 CFR 20 revision published May 21, 1991.

2.1.2 Exclusion Area Authority and Control

2.1.2.1 **Authority**

The containments for North Anna Units 1 and 2 are numbered sequentially from east to west with approximately 273 feet between the containment centers of Units 1 and 2. Safety analysis calculations indicate that the minimum exclusion distance for Units 1 and 2 should be 4000 feet from the respective containment centers. However, similar calculations for the proposed, and subsequently canceled, Units 3 and 4 indicated that the minimum exclusion distance should be 5000 feet. For conservatism, VEPCO has elected to define the exclusion boundary envelope at a radius of 5000 feet from the now abandoned Unit 3 containment as shown on Figure 2.1-3. As a result the minimum distance to the exclusion boundary envelope exceeds 4400 feet to the east-northeast of the center of the Unit 1 containment structure.

The perimeter of the exclusion boundary on land is adequately posted with “No Trespassing” signs. Also, floating bottom-moored buoys supporting the “No Trespassing” signs have been implanted, with suitable spacing, across the entrance to the small inlet of the North Anna Reservoir immediately north of Units 1 and 2, from which the circulating water pumps of those units take suction. All markers conform to State of Virginia standards. Also, a log-type boom arrangement and a small number of bottom-moored floating buoys supporting “No Trespassing” signs have been placed across the entrance to the main cooling water canal (Canal A). Both the floating buoy array at the inlet immediately north of Units 1 and 2, as well as

the long boom/buoy arrangement across the entrance to Canal A, are shown in dotted lines and solid lines, respectively, in Figure 2.1-3.

Along Lake Anna, outside the exclusion area, VEPCO has granted to each landowner an easement to use the portion of VEPCO's property above the fluctuating water line for the erection of piers, jetties, or other recreational structures for access to the lake waters. Such structures require VEPCO's approval as to type and location and are permitted only to the extent that they will not be detrimental to the development, operation, and maintenance of the electric generating facilities, the dam, the reservoir, the dikes, and the cooling lagoons.

With respect to the land bordering the cooling lagoons, VEPCO has granted to each owner a permit to use the VEPCO lands above the fluctuating water level; however, this permission is expressly revocable by VEPCO to the extent necessary to preserve the character and maintain the operation of the Waste Heat Treatment Facility (cooling lagoons) as a private water treatment facility. A limited number of land owners have been granted permission to erect docks on the shoreline within the exclusion area.

2.1.2.2 **Control of Activities Unrelated to Plant Operation**

A portion of the smallest cooling lagoon, which is used primarily for fishing, lies within the exclusion boundary. Water skiing and recreational boating are more prevalent in the other two, much larger cooling lagoons, which are entirely outside the exclusion area. Access to all the cooling lagoons is restricted to property owners and their guests, as there is no means of access by boat from the North Anna Reservoir to any of the cooling lagoons.

Boaters on the North Anna Reservoir also have access to the exclusion area. Such use is largely transient as boaters from the marinas and boat ramps north and west of the plant site access the area between the plant site and the dam.

Should an emergency at the North Anna Power Station necessitate controlling boating and water use on Lake Anna, such action would be initiated in accordance with the guidelines presented in the North Anna Power Station Emergency Plan (Reference 1). Such control of boating and water use on Lake Anna will be under the direction and authority of Game Wardens of the Virginia Department of Game and Inland Fisheries and the Sheriffs Departments of Louisa and Spotsylvania Counties. These arrangements are documented in the North Anna Station Emergency Plan.

2.1.2.3 **Arrangements for Traffic Control**

State Route 700 provides plant staff access to the plant site and access by the general public to the North Anna Visitors Center.

2.1.3 Population and Population Distribution

Population information is contained in an appendix to the North Anna Emergency Plan.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

2.1.3.1 Population Within 10 Miles

Figure 2.1-1 shows the general locations of the municipalities and other features within 10 miles of the North Anna site. As indicated on Figure 2.1-1, Mineral with a 1990 population of 452 is the only town within 10 miles of the plant site.

The population distribution within 10 miles of the site was computed by overlaying 1990 census block data (Reference 2) (the smallest unit of census data), on the grid shown on Figure 2.1-1 and summing the population of the census blocks falling in each of the polar sectors comprising the grid. The population of census blocks shared by more than one polar sector was apportioned based on the fraction of the census block area in each sector. The census block summing and allocation was accomplished with computer software operating directly on census data.

The area of a census block is generally inversely proportional to the population of the census block. Thus, an urban census block may be geographically as small as a few city blocks. However, a sparsely populated rural census block could be several miles across, but include only several residents. As a result any error from the allocating process should be very small. The 10 mile population distribution for 1990 is shown on Figure 2.1-4.

Population projections for the areas within 10 miles of the North Anna site for the years 2000, 2010, 2020 and 2030 are given in Figures 2.1-5 through 2.1-8, even though the current license expiration dates for the two North Anna units are 2038 and 2040 respectively. Population projections were based on Virginia Population Projections prepared by the Virginia Employment Commission (Reference 3).

There are no population projections available for census units smaller than counties or independent cities. Hence, it was assumed that each component (or fraction) of a county (or independent city) had the same decennial rate of growth as that for the county (or city) as a whole. This is tantamount to assuming that the fraction of the county's population within each such component remains unchanged for the period (1990 through 2030) involved.

For conservatism, the projected population of polar sectors encompassing portions of more than one jurisdiction was escalated at the highest rate among the applicable jurisdictions.

The 1990 resident populations within 6 miles, the low population zone, and 10 miles of North Anna Power Station site were 3643 and 11,887 persons, respectively.

2.1.3.2 Population Between 10 and 50 Miles

Estimates of the 1990 resident population from 10 to 50 miles from the North Anna site were computed using the same methodology used to develop the 10-mile population distribution. The population grid from 10 to 50 miles is shown on Figure 2.1-2 and the 50-mile population distribution for 1990 is shown on Figure 2.1-9.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Population projections for the areas between 10 and 50 miles for the years 2000, 2010, 2020 and 2030 were based on the same methodology as the 10 mile projections. These population projections are given in Figures 2.1-10 through 2.1-13.

The population contribution for the one Maryland county (Charles) concerned, which at its closest point is 37 miles from the site, was under 10,000. The population growth projection was based on the adjacent Virginia jurisdiction. These jurisdictions are among the fastest growing in Virginia, whereas that portion of Charles county is more rural.

2.1.3.3 **Transient Population**

Information concerning transient population for the area was collected from several sources as this information is not available from the 1990 census data. The area within 10 miles of the site is predominantly rural and characterized by farmland and wooded tracts of land. Since there are no significant industrial or commercial facilities in the area, and none are anticipated, the transient employment population is likely to be out of, rather than into, the area.

Recreational use of Lake Anna, including Lake Anna State Park, is the greatest contributor to transient population in the area. No data on use of the lake are available. Instead the use of the lake was estimated from a number of contributing factors including the number of boat ramps, wet slips, campsites, picnic areas, etc. These contributing factors are listed in Table 2.1-1. An estimate of lake usage on a peak weekend day in mid summer was developed based on representative usage of recreational facilities, e.g., boating, picnicking, camping, provided by the Virginia State Department of Conservation and Recreation (Reference 4) and the Lake Anna facilities listed in Table 2.1-1. This-estimate does not include use by local residents with their own docks. However, residents should be picked up in the census data. In addition, many residents without docks keep their boats in marina wet slips or use the boat ramps and are, therefore, included in the lake usage figures.

There are six marinas in the vicinity of the plant site. The closest is 1.4 miles north-northeast of the site. The remaining marinas are from 2 to 2.5 miles distant. A survey of several of the marinas indicated that their actual boat launches per ramp ranged from 15 to 40 per ramp per peak day, which is significantly lower than the number of 80 per day provided by the Virginia State Department of Conservation and Recreation as an upper limit for ramp usage, and that the usage per ramp has dropped as new ramps are added. This was attributed to parking space limitations and the fact that the lake usage by recreational boaters may be approaching saturation. A rate of 50 launches per ramp per day was selected for this update as being more representative of Lake Anna conditions.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Based on 50 launches per ramp per day, these marinas and other boat ramps, including those at Lake Anna State Park, could provide access for up to 1450 pleasure craft on the North Anna Reservoir. Peak day usage estimates for boats moored in wet slips ranged from 30 to 50%. Assuming that all slips are rented, 150 additional boats would be added bringing the total, excluding boats from private docks, to 1600. The resulting transient population at three persons per boat (Reference 4) would be 4800.

The two commercial campgrounds, with a total of more than 200 campsites, were estimated by the Virginia State Department of Conservation and Recreation (Reference 4) to contribute about 650 persons to the transient population at three persons per campsite. The number of picnickers was estimated at 450. Since both campsites have boat ramps, significant double counting is likely.

Lake Anna State Park provides facilities for picnicking, fishing, boat launching, swimming, and biking. The Park Manager estimated a peak daily attendance at 3000 and an annual attendance of 93,000 based on traffic counters (Reference 5). Double counting is likely as boaters are included in the traffic count.

The resulting estimated total peak daily transient population on the North Anna Reservoir is 8900. See Table 2.1-2. Given the conservative assumptions and the potential for double counting, this number appears to be conservatively high.

Since use of the cooling lagoons is limited to residents and their guests, there are no public boat ramps. The transient population estimate of 1000 is based on one guest for each resident in the polar sectors encompassing the cooling lagoons.

Annual transient population is very uncertain because of the dramatic drop in boating on week days and outside the summer months. Based on the Lake Anna State Park data, assuming 180 days of operation, the average daily attendance is less than one fifth of the peak daily attendance. Conservatively assuming that the average attendance, excluding the park, is one half the peak daily figure, the total annual attendance would be about 710,000 based on a 180-day season.

2.1.3.4 Low Population Zone

The low population zone, as shown in Figure 2.1-1, is bounded by a 6-mile-radius circle centered at the Unit 1 reactor containment building. The Low Population Zone (LPZ) boundary was established to ensure that the dose limitation requirements of 10 CFR Parts 100.3 and 100.11(a)(2) are met. With the issuance of Regulatory Guide 1.183 and employing the Alternative Source Term methodology, consistent with NUREG-1465, the radiological consequences at the LPZ are within the limits provided in 10 CFR 50.67 and revised dose criteria in Regulatory Guide 1.183.

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

The resident population distribution within the low-population zone is indicated in Figures 2.1-4 through 2.1-8 based on the 1990 census and projections every 10 years through to the year 2030. In summary, the low-population zone population for 1990, and the projected population through 2030, are as follows:

1990	3643
2000	4303
2010	4868
2020	5428
2030	5989

By comparison, the original projected 1990 resident population in the low-population zone in the FSAR was 3236, an under projection of only 13%.

The only school in the low-population zone is Livingston Elementary, which is located in Spotsylvania County, 5.7 miles to the north-northeast (Reference 6). All schools within 10 miles of the plant site are listed in Table 2.1-3 (References 6 & 7).

As noted in the previous Section, the only significant source of transient population within the LPZ is recreational use of Lake Anna. Since most of the lake area falls within the LPZ, the entire estimated peak transient population could be in the LPZ.

Considering the available road network leading from the low-population zone together with the availability of private as well as public vehicles, there is reasonable assurance that these populations could be evacuated in a timely manner in the event of a design basis accident.

2.1.3.5 **Population Center**

The nearest population center with more than 25,000 residents is the City of Charlottesville, which had a 1990 population of 40,475. The closest point of Charlottesville is 36 miles west of the site. The only closer population center whose population could reach 25,000 by 2030 is Fredericksburg, which is 22 miles to the northeast with a projected 2030 population of 24,568. The distance to Fredericksburg is well in excess of the minimum population center distance of one-and-one-third times the distance from the center of the site to the outer boundary of the low-population zone as required by 10 CFR 100.

2.1.3.6 **Population Density**

The cumulative resident population in 1990 to a distance of 50 miles in all directions from the plant is compared with the cumulative population resulting from a uniform population density of 500 people per square mile in Figure 2.1-14. Similarly, the projected cumulative resident population in 2030 to a distance of 50 miles in all directions from the plant is compared with the cumulative population resulting from a uniform population density of 1000 people per square mile.

2.1 REFERENCES

1. North Anna Power Station Emergency Plan, Virginia Electric and Power Company, dated January 1, 1994, Revision 15.
2. U.S. Department of Commerce, Bureau of the Census, *1990 Census of Population, Number of Inhabitants.*
3. Virginia Population Projections 2010, with Supplemental Projections For 2020 and 2030. Virginia Employment Commission, June 1993.
4. Commonwealth of Virginia, Department Of Conservation and Recreation; Robert S. Munson; Letter to D. Hostetler, Grove Engineering, dated March 1, 1994.
5. Lake Anna State Park; Doug Graham, Park Manager; Telecon with Brent Christ, Grove Engineering; March 10, 1994.
6. Spotsylvania County; John W. Taylor, Long Range Planner; Fax from James Meyer, Spotsylvania schools, February 16, 1994.
7. Louisa County; Chris Motherhead, Director of Planning; Fax to Brent Christ, Grove Engineering, February 14, 1994.

Table 2.1-1
LAKE ANNA RECREATIONAL FACILITIES

Facility	Distance	No. Wet Slips	No. Ramps	Camp Sites
Marinas				
Anna Point	2.3 Mi. NNW	25	1	
Dukes Creek	2.2 Mi. E	55	5	
High Point	2.3 Mi. NNW	50	4	
Lake Anna	1.4 Mi. NNE	160	2	
Rocky Branch	2.3 Mi. NNE	None	4	
Sturgeon Creek	2 Mi. N	36	5	
Public Landings				
Christopher Run Campground	6 Mi. WNW		1	152
Hunters Landing	6.6 Mi. NW		1	
Lake Anna Campground	2.5 Mi. NW		1	61
Lake Anna Landing	9 Mi. NW		1	
Lake Anna State Park	4.3 Mi. NNW		2	
Pleasants Landing	5.6 Mi. SE		1	
Sullivan’s Landing	8 Mi. NW		1	
Totals		326	29	213

Table 2.1-2
TOURIST ATTRACTIONS, PARKS AND RECREATIONAL AREAS

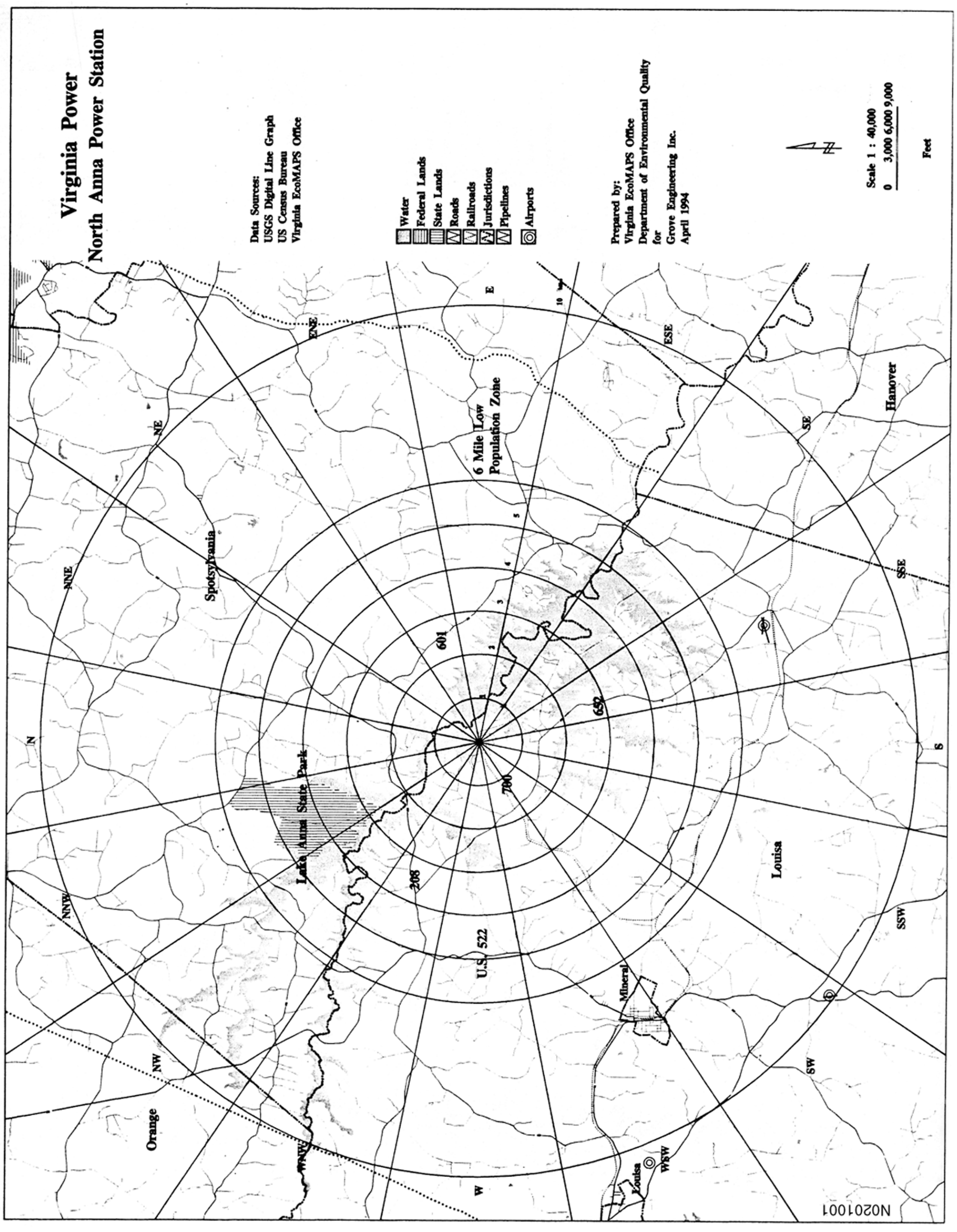
Facility	Location	Annual Usage	Peak Daily*	Comments
Within Low Population Zone (6 miles)				
Lake Anna recreational usage North Anna Reservoir	See Table 2.1-1	530,000	5900 (1)	Annual use based on 180 days @ 2950/average day.
Waste Heat Treatment Facility		90,000	<1000	Peak daily based on doubling the resident population in cooling lagoon sectors (one guest per resident). Annual use based on 180 days @ 500/average day.
Lake Anna State Park	2.8 miles NNW	93,000	3000	Peak daily use during summer. Annual use was 93,000 in 1991. Use in 1993 was 87,000. Park closed in winter. Usage includes occupants of boats launched at the park.

* Peak weekend day in mid summer.
(1) Average of 3 persons per boat, camp site and picnic area.

Table 2.1-3
SCHOOLS WITHIN 10 MILES OF PLANT SITE

School	Number of Students (1993)	Distance (miles)	Direction from Plant
Louisa County			
Louisa County High School	993	7	WSW
Louisa County Middle School	594	7	WSW
Spotsylvania County			
Livingston Elementary	433	6	NE

Figure 2.1-1
TEN MILE SURROUNDING AREA



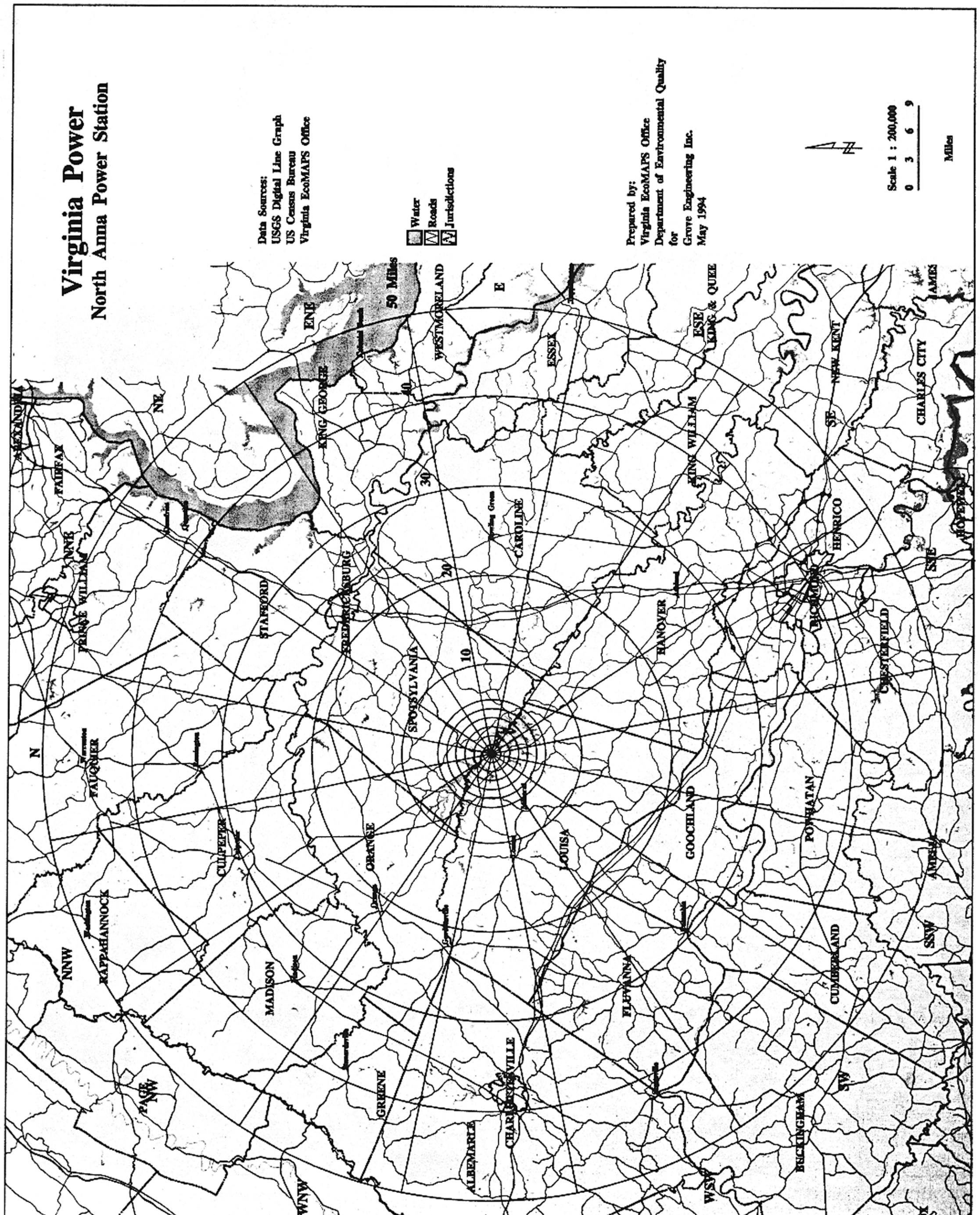
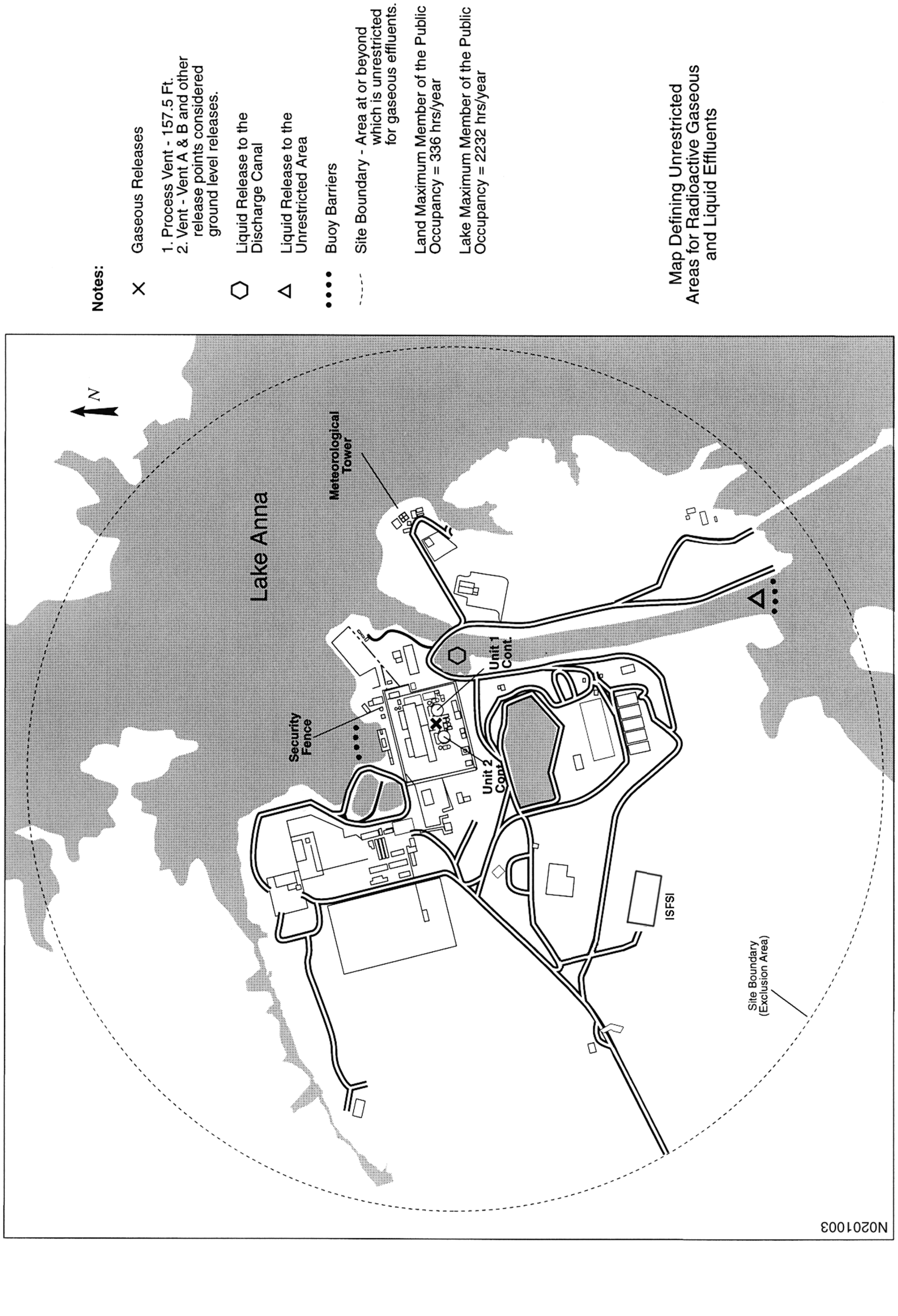


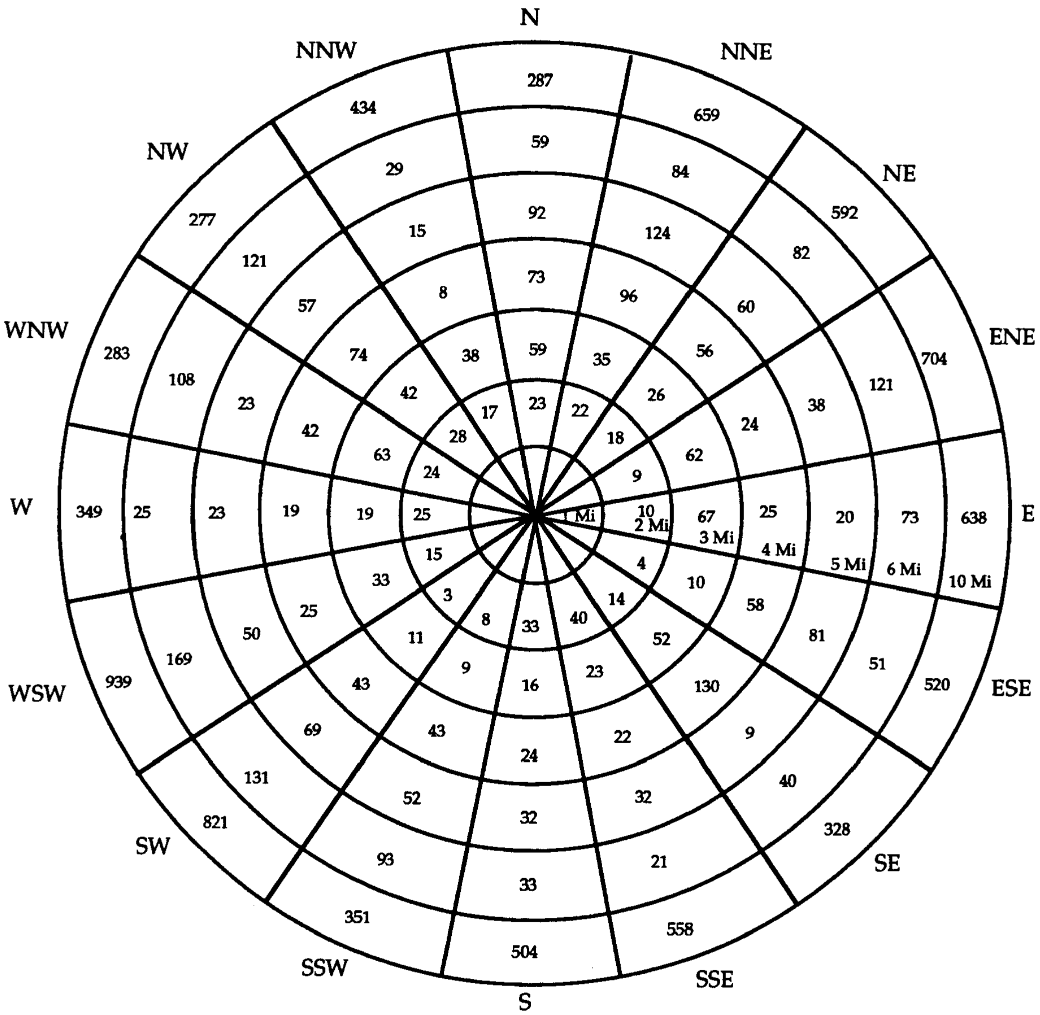
Figure 2.1-2
FIFTY MILE SURROUNDING AREA

Figure 2.1-3
SITE BOUNDARY AND UNRESTRICTED AREAS



The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Figure 2.1-4
TEN MILE POPULATION DISTRIBUTION—1990



POPULATION INSIDE ONE MILE

N	NNE	NE	ENE	E	ESE	SE	SSE
0	1	1	0	0	1	0	2
0	0	0	0	0	0	1	0
S	SSW	SW	WSW	W	WNW	NW	NNW

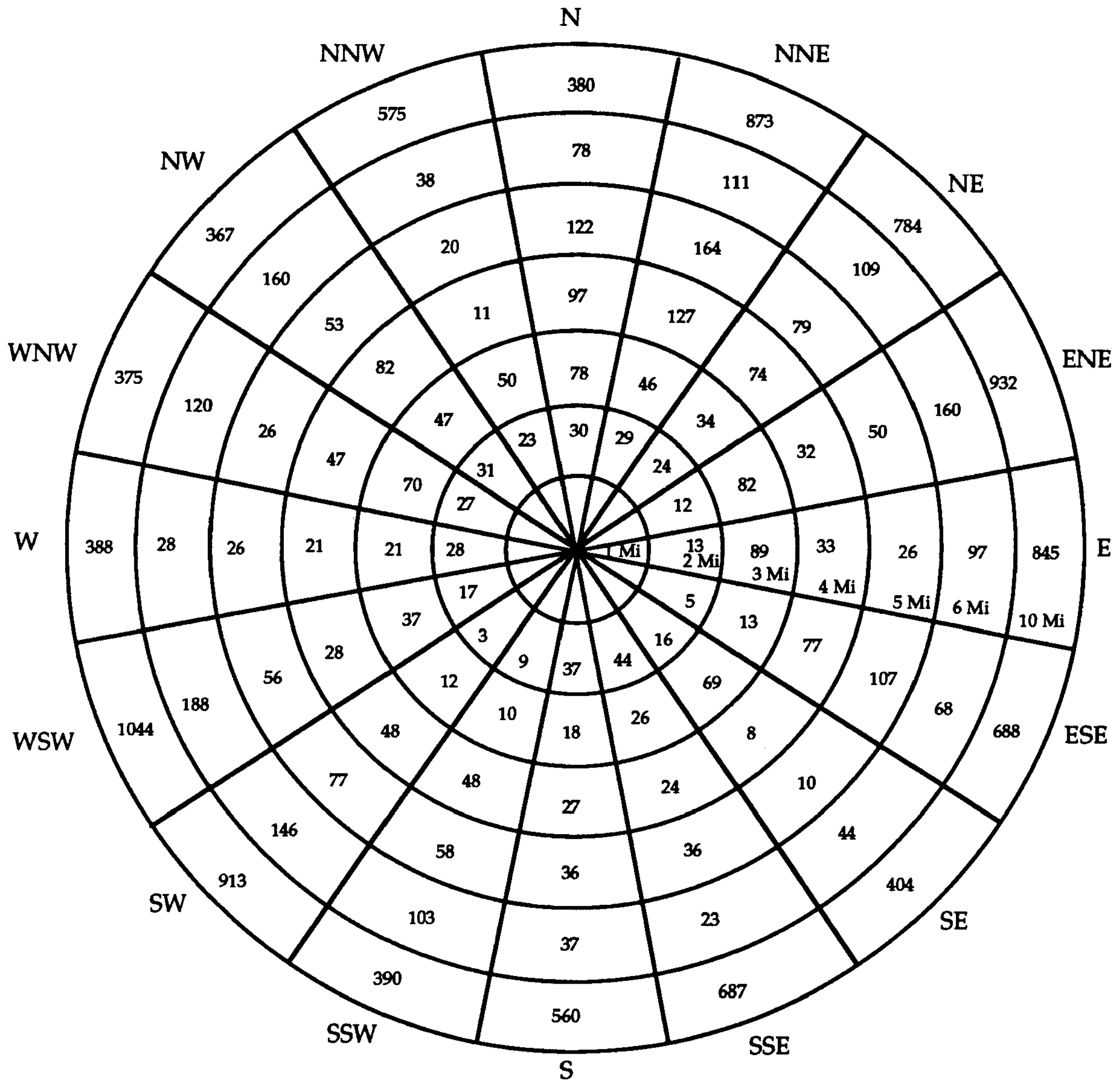
N0201004

POPULATION BY ANNULUS

ANNULUS	0 TO 1	1 TO 2	2 TO 3	3 TO 4	4 TO 5	5 TO 6	6 TO 10	TOTAL
POPULATION	6	293	565	762	777	1,240	8,244	11,887

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Figure 2.1-5
TEN MILE POPULATION DISTRIBUTION—2000



POPULATION INSIDE ONE MILE

N	NNE	NE	ENE	E	ESE	SE	SSE
0	1	1	0	0	1	0	2
0	0	0	0	0	0	1	0
S	SSW	SW	WSW	W	WNW	NW	NNW

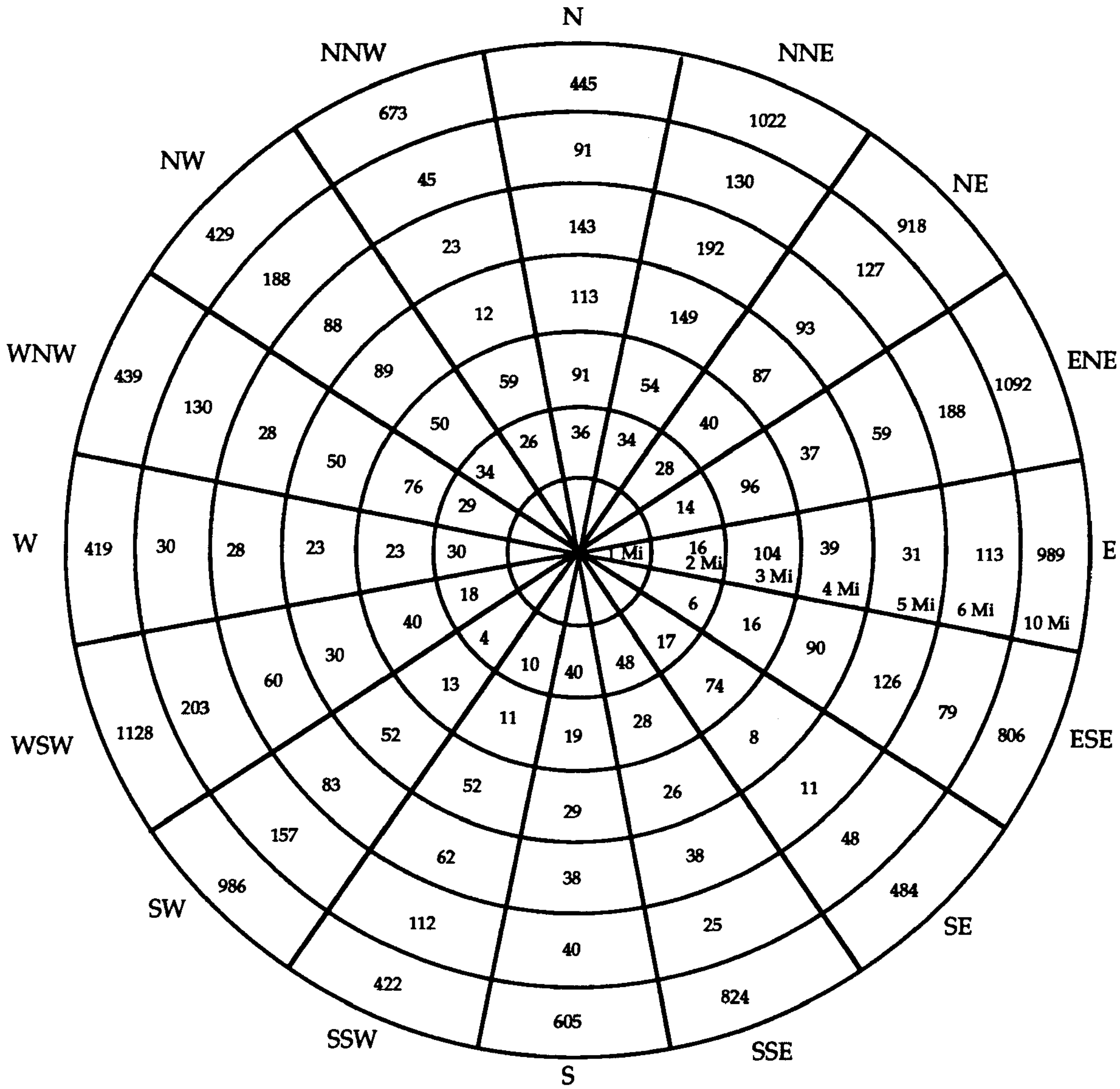
N0201005

POPULATION BY ANNULUS

ANNULUS	0 TO 1	1 TO 2	2 TO 3	3 TO 4	4 TO 5	5 TO 6	6 TO 10	TOTAL
POPULATION	6	348	702	782	955	1,510	10,203	14,506

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Figure 2.1-6
TEN MILE POPULATION DISTRIBUTION—2010



POPULATION INSIDE ONE MILE

N	NNE	NE	ENE	E	ESE	SE	SSE
0	2	2	0	0	2	0	2
0	0	0	0	0	0	1	0
S	SSW	SW	WSW	W	WNW	NW	NNW

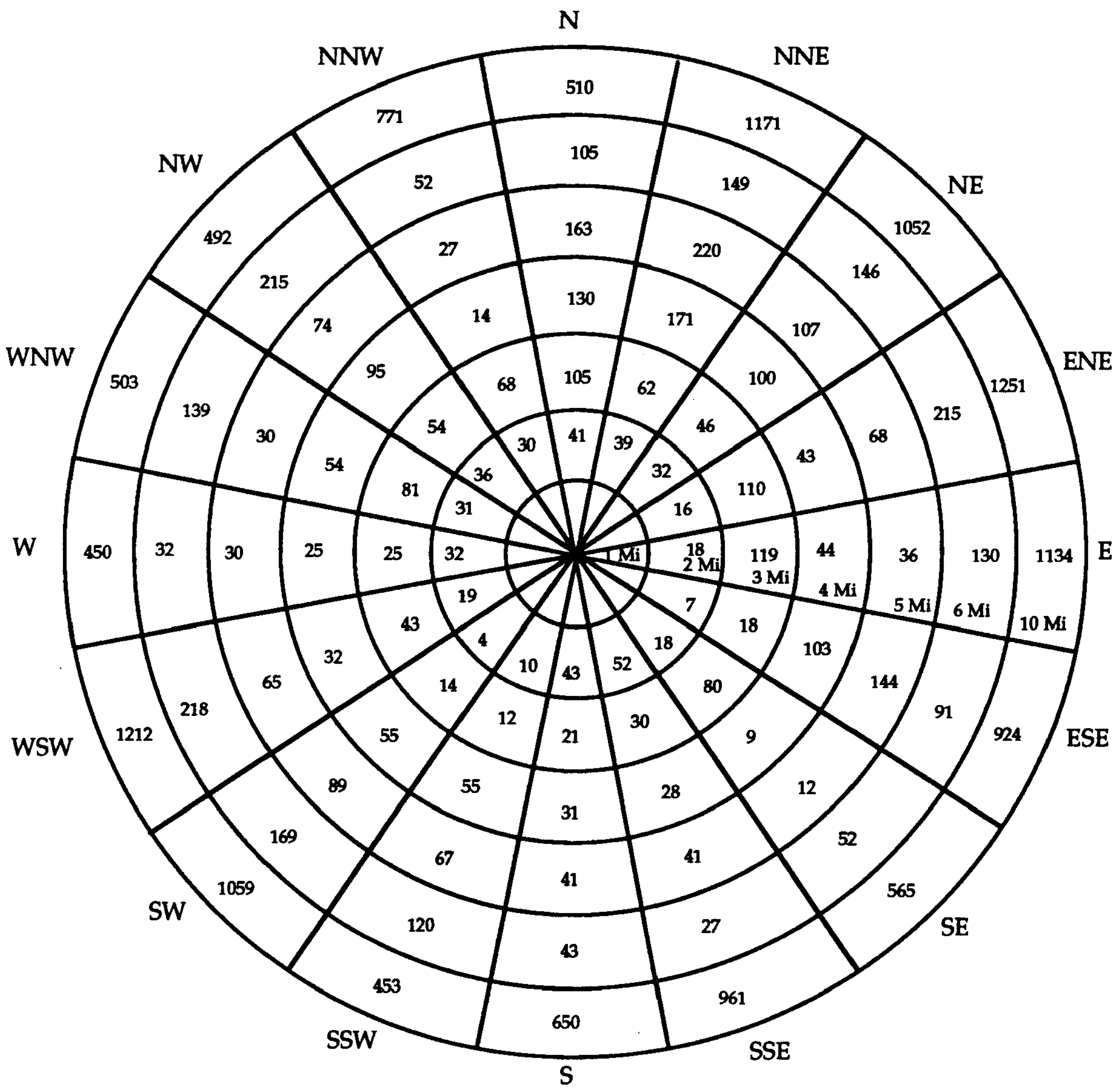
N0201006

POPULATION BY ANNULUS

ANNULUS	0 TO 1	1 TO 2	2 TO 3	3 TO 4	4 TO 5	5 TO 6	6 TO 10	TOTAL
POPULATION	9	390	794	886	1,083	1,706	11,681	16,549

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Figure 2.1-7
TEN MILE POPULATION DISTRIBUTION—2020



POPULATION INSIDE ONE MILE

N	NNE	NE	ENE	E	ESE	SE	SSE
0	2	2	0	0	2	0	3
0	0	0	0	0	0	1	0
S	SSW	SW	WSW	W	WNW	NW	NNW

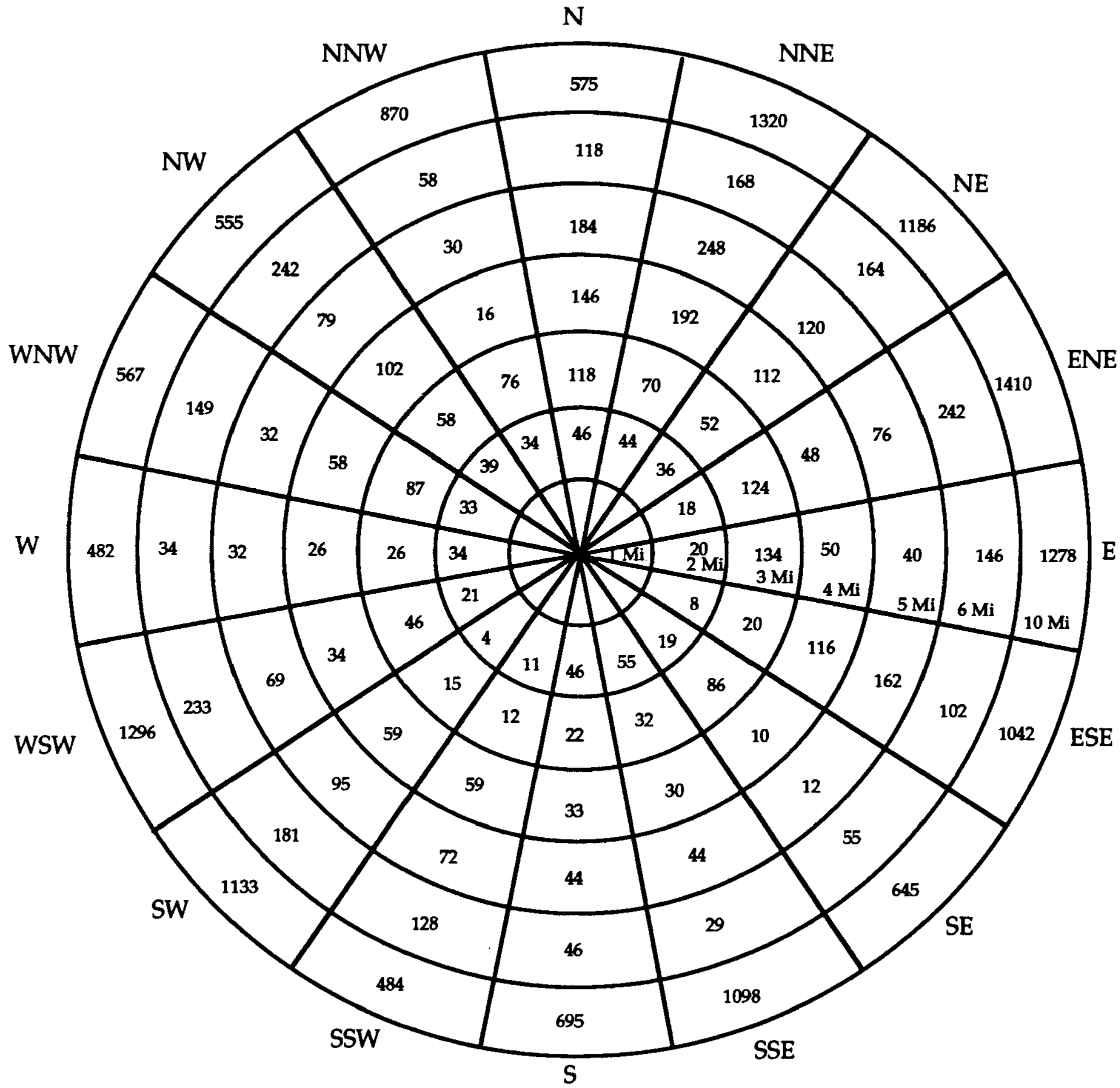
N0201007

POPULATION BY ANNULUS

ANNULUS	0 TO 1	1 TO 2	2 TO 3	3 TO 4	4 TO 5	5 TO 6	6 TO 10	TOTAL
POPULATION	10	428	886	990	1,212	1,902	13,158	18,587

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Figure 2.1-8
TEN MILE POPULATION DISTRIBUTION—2030



POPULATION INSIDE ONE MILE

N	NNE	NE	ENE	E	ESE	SE	SSE
0	2	2	0	0	2	0	3
0	0	0	0	0	0	1	0
S	SSW	SW	WSW	W	WNW	NW	NNW

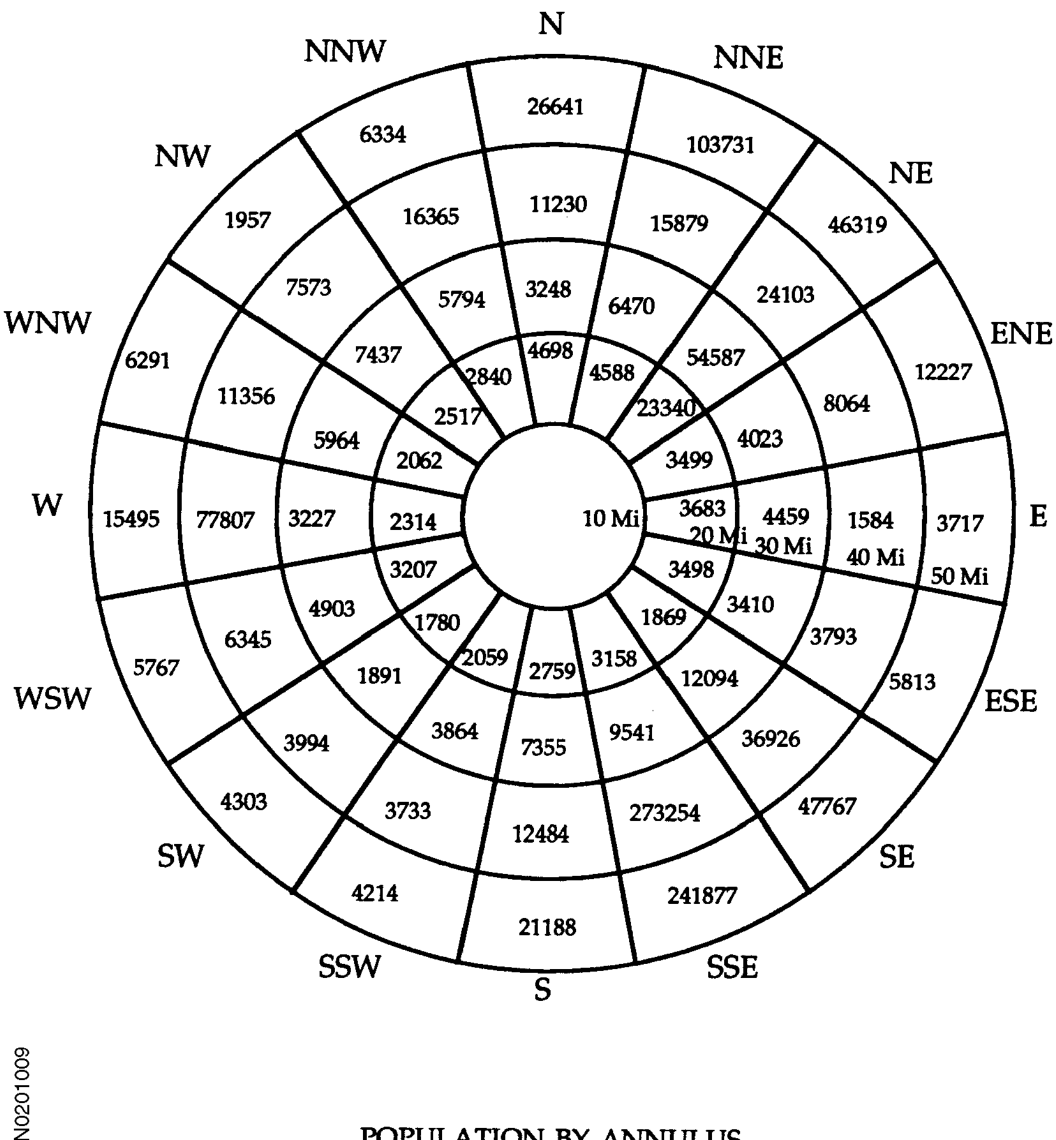
N0201008

POPULATION BY ANNULUS

ANNULUS	0 TO 1	1 TO 2	2 TO 3	3 TO 4	4 TO 5	5 TO 6	6 TO 10	TOTAL
POPULATION	10	469	979	1,094	1,340	2,098	14,636	20,625

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Figure 2.1-9
FIFTY MILE POPULATION DISTRIBUTION—1990

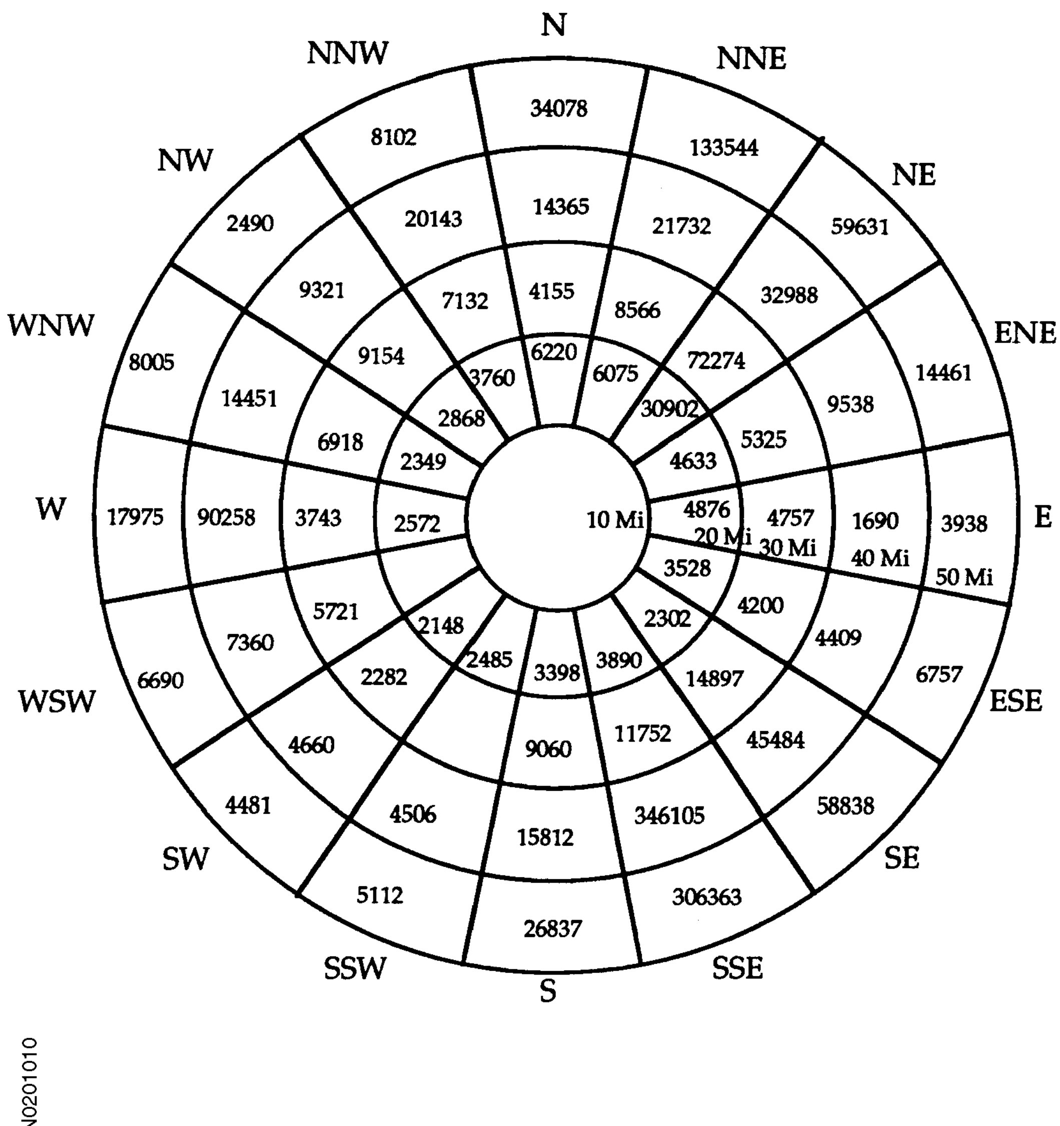


POPULATION BY ANNULUS

ANNULUS	0 TO 10	10 TO 20	20 TO 30	30 TO 40	40 TO 50	TOTAL
POPULATION	11,887	67,871	138,267	514,490	553,641	1,286,156

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Figure 2.1-10
FIFTY MILE POPULATION DISTRIBUTION—2000

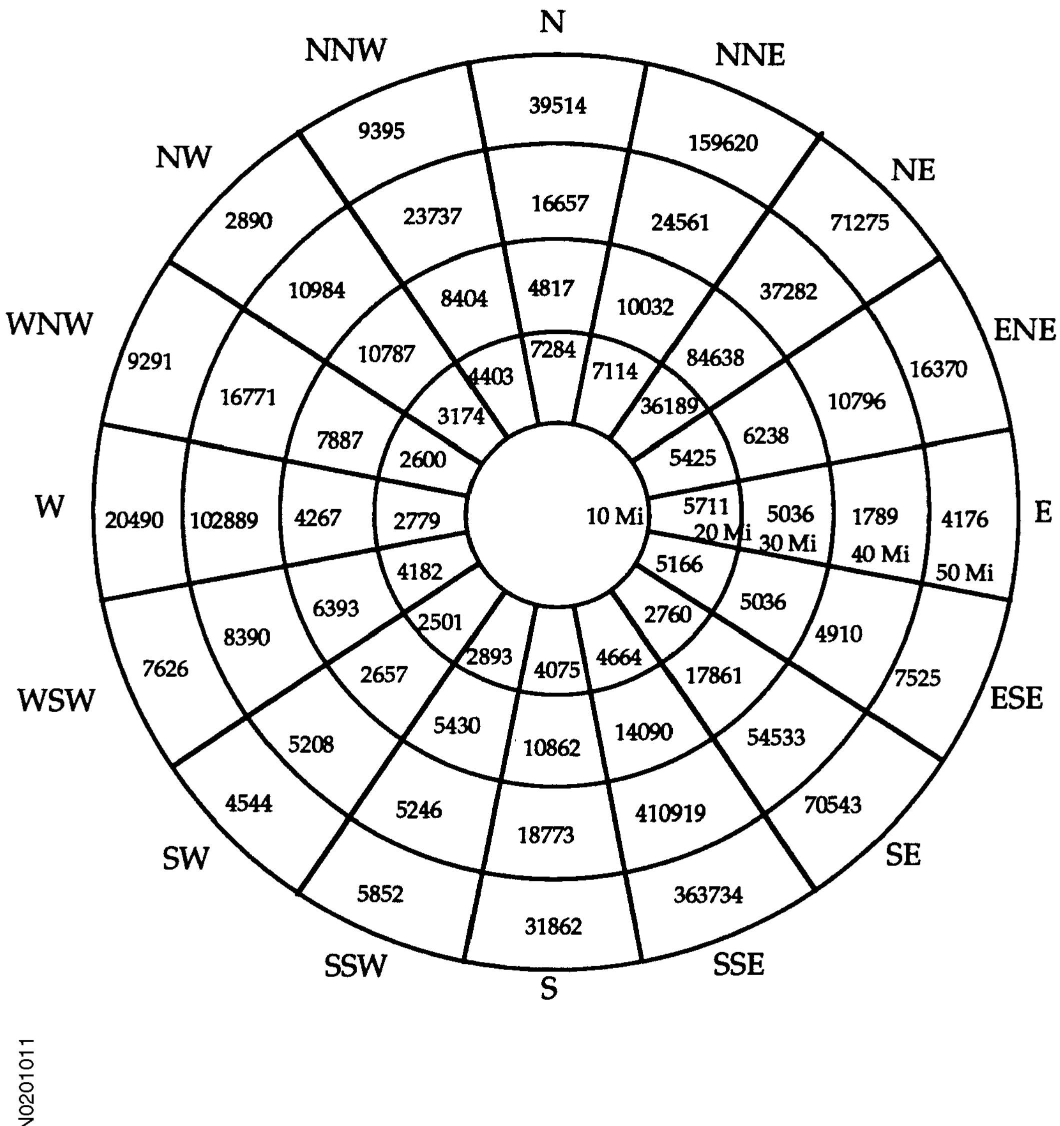


POPULATION BY ANNULUS

ANNULUS	0 TO 10	10 TO 20	20 TO 30	30 TO 40	40 TO 50	TOTAL
POPULATION	14,506	85,749	174,602	642,823	697,303	1,614,983

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Figure 2.1-11
FIFTY MILE POPULATION DISTRIBUTION—2010

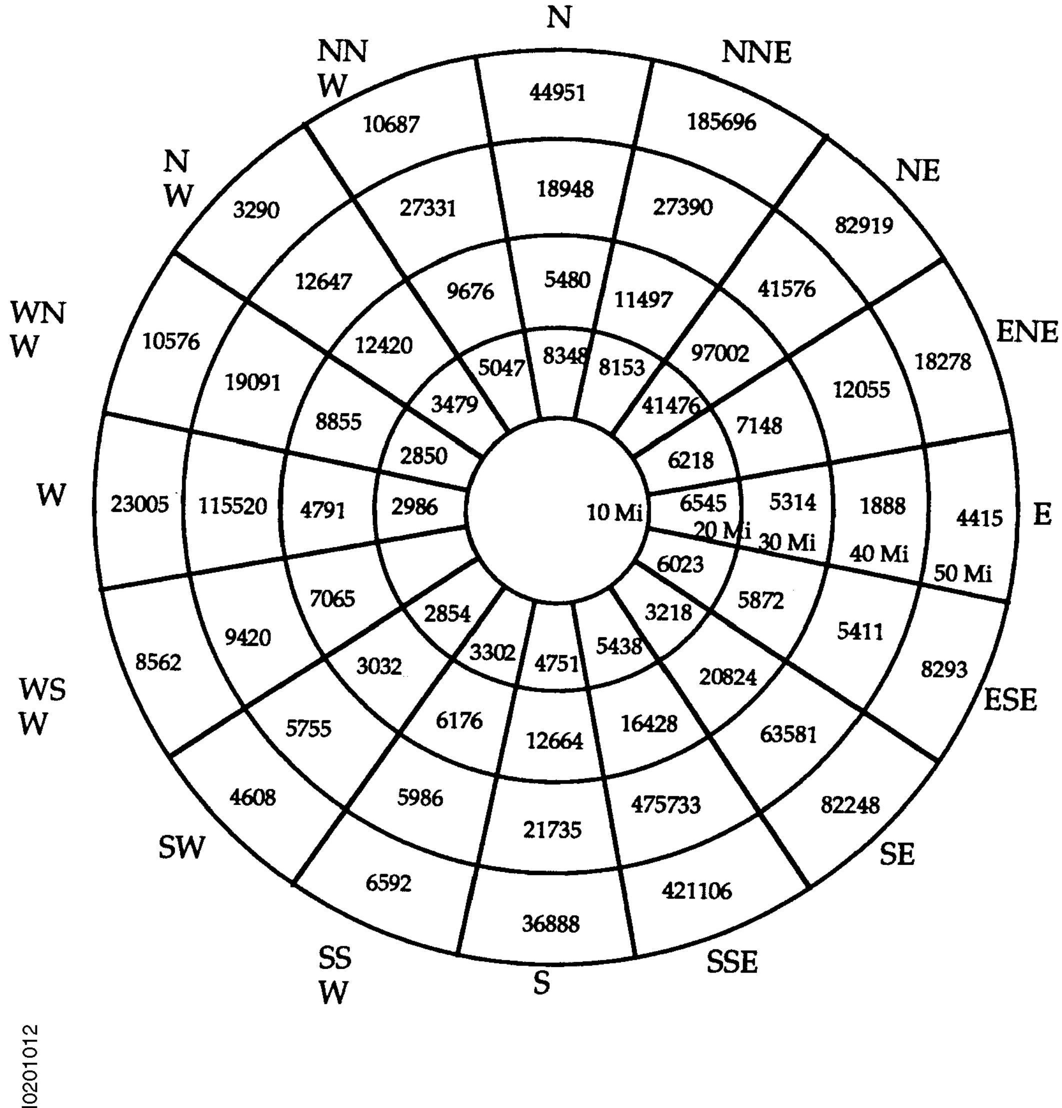


POPULATION BY ANNULUS

ANNULUS	0 TO 10	10 TO 20	20 TO 30	30 TO 40	40 TO 50	TOTAL
POPULATION	16,549	100,919	204,434	753,445	824,708	1,900,056

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Figure 2.1-12
FIFTY MILE POPULATION DISTRIBUTION—2020

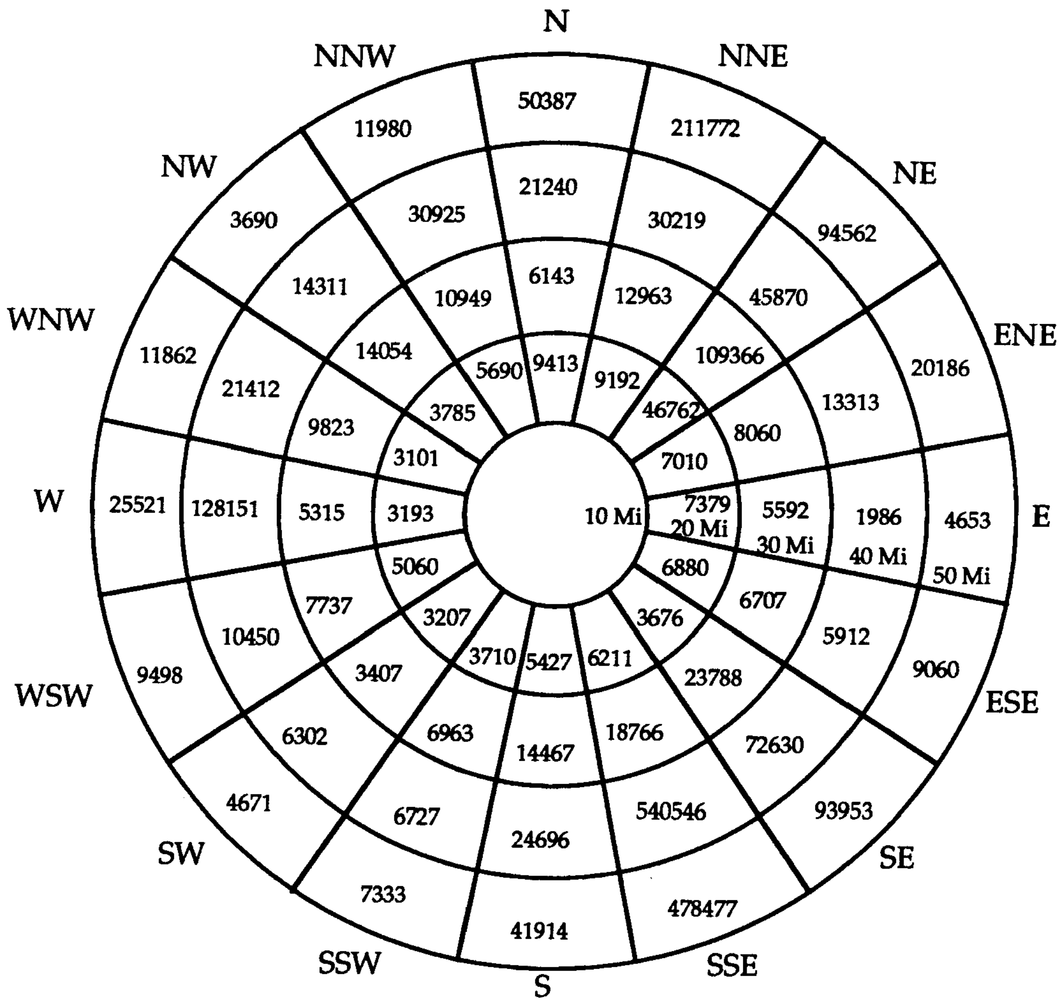


POPULATION BY ANNULUS

ANNULUS	0 TO 10	10 TO 20	20 TO 30	30 TO 40	40 TO 50	TOTAL
POPULATION	18,587	115,309	234,267	864,067	952,113	2,184,342

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Figure 2.1-13
FIFTY MILE POPULATION DISTRIBUTION—2030



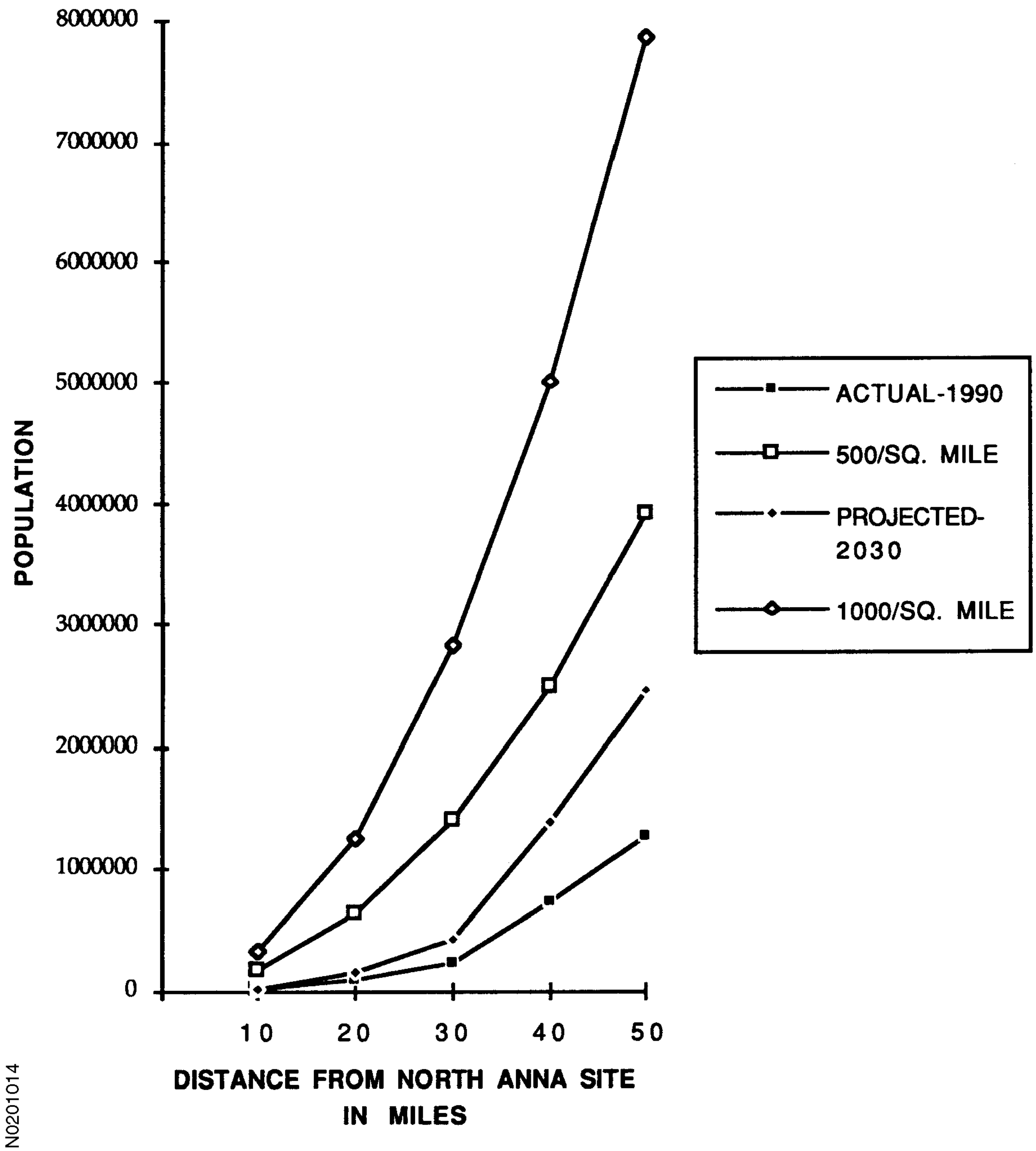
N0201013

POPULATION BY ANNULUS

ANNULUS	0 TO 10	10 TO 20	20 TO 30	30 TO 40	40 TO 50	TOTAL
POPULATION	20,625	129,698	264,099	974,689	1,079,518	2,468,629

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

Figure 2.1-14
POPULATION DENSITY



2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

2.2.1 Locations and Routes

In 1994, no military bases, missile sites, manufacturing plants, chemical plants and storage facilities, airports, major railroad lines, major water transportation routes, or oil and gas pipelines were located within 5 miles of the plant site.

2.2.1.1 **Industrial Facilities**

There were no significant industrial activities within 5 miles of the plant site. Based on trends of industrial growth and projected population figures, it is not expected that any major industrial expansion will occur in the area. The Louisa County Board of Supervisors has approved a zoning ordinance allowing industrial development of approximately 620 acres near the site exclusion boundary. There were no plans, however, for the development of this area. Within 10 miles of the site, there are several other areas zoned for industrial development, the largest one being 150 acres near Pendleton.

2.2.1.2 **Mining Activities**

There were no mining activities within 5 miles of the plant site.

2.2.1.3 **Roads**

The roads within 10 miles of the plant site are shown in Figure 2.1-1.

Virginia State Route 700 provides access to the plant site and State Routes 601 and 652 run parallel with the Lake Anna shoreline and pass about 2.2 miles northeast and 1.5 miles south of the plant site, respectively. Primary State Route 208 crosses Lake Anna at a point about 2 miles northwest of the site and joins U.S. Route 522 about 5 miles west-northwest of the site.

2.2.1.4 **Railroads**

The railroad line closest to the plant site is the main line of the Chesapeake and Ohio Railway from Newport News to Chicago. It passes through the towns of Louisa, Mineral, Fredericks Hall, and Bumpass; its closest approach to the North Anna Power Station is about 5.5 miles southwest of the site. A spur line connects the plant site with this line.

2.2.1.5 **Marine Transportation**

There are six marinas in the vicinity of the plant site. The closest is 1.4 miles north-northeast of the site. The remaining marinas are from 2 to 2.5 miles distant. The nearest marina stores gasoline in amounts up to about 4000 gallons. These marinas, including wet slips, and other boat ramps provide access for up to 1600 pleasure craft on the North Anna Reservoir in a day. There are no large boats or barges on Lake Anna.

2.2.1.6 **Airports and Airways**

2.2.1.6.1 Airports

Airports within 15 miles of the plant site as of 1994 are listed in Table 2.2-1. There are only two airports within 10 miles of the site: Lake Anna (Rest-A-While) Airport and Cub Field. The Louisa County Airport, located 11 miles west-southwest of the site, began operation after the North Anna Station was licensed. Their locations are indicated in Figure 2.2-1. Operations primarily involve single engine, light aircraft. None of the airports are expected to grow significantly in the foreseeable future.

The Lake Anna Airport, near Bumpass, is 7 miles south-southeast of the site. Landing facilities consist of a 3000-foot paved runway with landing lights and an auxiliary, unlighted 2000-foot turf strip. The airport has no listed phone number and limited facilities. A flight instructor at the Louisa County Airport stated that traffic at the Lake Anna Airport was very light and consisted primarily of practice landings (Reference 1). Only one aircraft was based at this airport as of March 1994.

Cub Field, a private landing strip with an unlighted 1400-foot turf runway, is 10 miles southwest of the plant site. It is not licensed. Present volume of traffic is very light. No aircraft are currently based at this field.

The Louisa County Airport, which began operation in the 1980s, serves as the base for 20 light aircraft. It is a modern well maintained facility. Operations are estimated at 200 per week. The Louisa County Airport can accommodate small business jets (Reference 1).

Data on these airports are provided on Table 2.2-1.

2.2.1.6.2 Airways

One civil airway, V223, and three military training routes IR714, IR760 and VR1754 pass near the plant site. (See Figure 2.2-1.) The centerline of V223 is 5.5 miles west of the plant site and the corridor width is four miles on either side of the centerline. No data are kept on traffic in this airway. The FAA at Richmond International Airport characterized the airway as “not heavily used” and estimated traffic at no more than 200 aircraft per day (Reference 2).

The centerlines of the military training routes, which are 10 miles across, lie within one mile of the plant site. These routes are controlled by the Oceana Naval Air Station in Virginia Beach, Virginia, which provided data on their use (Reference 3). Pilots are directed to avoid the actual plant site by flying at the edge of the corridor. An officer at Oceana stated that the aircraft pass no closer than 3 to 4 miles to the plant site. The combined number of flights using the three routes has remained fairly constant over the past three years ranging from 2582, 2348, and 2623 for 1991, 1992, and 1993, respectively. No records are kept on the total number of aircraft involved; however, flights are typically one or two and, rarely, four aircraft.

Data on these airways are provided on Table 2.2-1.

2.2.1.7 **Natural Gas or Petroleum Pipelines**

There are no oil or gas pipelines within 5 miles of the site.

2.2.1.8 **Military Facilities**

There are no military facilities within 5 miles of the site.

2.2.2 Evaluations of Potential Accidents

Withheld under 10 CFR 2.390 (d) (1)

[redacted]

2.2.2.1.2 Marine Traffic

The only marine transportation expected on Lake Anna is small sport and pleasure craft. The fuel capacity of such craft is too small to pose a hazard to the plant. The effect of gasoline stored at the nearest marina is bounded by the tank truck analysis in the previous Section.

2.2.2.1.3 Pipelines

No natural gas pipelines or mining activities are located within 10 miles of the plant. Therefore, the potential for explosions from these sources is minimal.

2.2.2.2 **Aircraft Related**

2.2.2.2.1 Airports

None of the airports within 10 miles of the site, as described in Section 2.2.1.6.1 and Table 2.2-1, support operations in excess of the threshold criteria in Reg. Guide 1.70.

2.2.2.2.2 Airways

The probabilities (P_{FA}) per year of an aircraft in the nearby airways crashing into the plant were estimated using the relationship:

$$P_{FA} = \frac{C \times N \times A}{W}$$

specified in NUREG-0800 (Reference 6). An effective plant area "A" of 0.006 sq. miles was used in the evaluation.

For V223:

$C = 4 \times 10^{-10}$ (From NUREG-0800)

W = airway width plus 2x distance from edge of airway to site (miles)
$= 8 + (2 \times 1.5) = 11$ miles

$N = 200 \times 365 = 73,000$ aircraft/year

$P_{FA} = 1.6 \times 10^{-8}$

For the Military Routes:

$C = 0.2 \times 10^{-8}$ (From NUREG-0800)

W = 10 miles

N = 3000 flights/year x 2 aircraft/flight = 6000 aircraft/year

$P_{FA} = 0.7 \times 10^{-8}$

These accident probabilities are within the NUREG-0800 guidelines.

2.2.2.3 **Toxic Chemicals**

Potentially toxic chemicals currently stored onsite that could impact Control Room Habitability are listed in Table 2.2-3. The list is comparable to that used for the Toxic Release Evaluation reported in Reference 7.

2.2.2.4 **Other Potential Hazards**

The only marine transportation expected on Lake Anna is small sport and pleasure craft. Therefore, no ships or large barges will impinge on the circulating water intake structure.

2.2 REFERENCES

1. Louisa County Airport; Larry Simpkins, Flight Instructor; Meeting on March 13, 1994 with D. Hostetler, Grove Engineering.
2. FAA, Richmond International Airport; Ron Flatt, Controller; Telecons with D. Hostetler, Grove Engineering, dated March 17, 1994 and March 21, 1994.
3. Oceana Naval Air Station; Lt. Commander Hernden; Fax 3/15/94; Telecon with D. Hostetler, Grove Engineering, dated March 17, 1994.
4. W. C. Brasie and D. W. Simpson, *Guidelines for Estimating Damage from Explosions*, Chemical Engineering Process, American Institute of Chemical Engineers, 1968.
5. U.S. Nuclear Regulatory Commission, *Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants,* Regulatory Guide 1.91, Rev. 1, February 1978.
6. U.S. Nuclear Regulatory Commission, Reactor Safety Study, *An Assessment of Accident Risks in U. S. Commercial Nuclear Power Plants,* NUREG-0800, July, 1981.
7. *Control Room Habitability Study (Supplement To Onsite Control Room Habitability Study) North Anna Power Station Units Nos. 1 and 2*; January 1982.

Table 2.2-1
AIRPORTS WITHIN 15 MILES OF THE SITE

				No. of Operations			Longest Runway		
Airport	Type	Distance (miles)	Sector	Comm. (1993)	Total (1993)	kd^2 (a)	Orientation	Length (feet)	Comments
Lake Anna	Civil	6	SSE	None	≈3000	12,500	WSW-ENE	3000	Occasional use for practice landings. One plane based there.
Cub	Private	10	WSW	None	Few	100,000	SSW-NNE	1400	Unpaved strip, no facilities, no planes based there.
Louisa County	Civil	11	WSW	None	≈11,000	121,000	W-E	3800	20 planes based.

a. Reg. Guide. 1.70
<10 miles k = 500
>10 miles k = 1000

Table 2.2-2
AIRWAYS WITHIN 10 MILES OF THE SITE

Airway	Type	C.L. Distance From Site (miles)	Altitude (1000 ft.)	Width (nautical miles)	Traffic flights/Year (1993)	Comments
V223	Civil	5.5	3 to 18	8	<73,000	No operations data. Estimate provided by Richmond FAA. Usual minimum altitude for jets is 7000 ft.
IR714*	Military Training	0.5	Low Alt. >2	10	942 (a)	Instrument Training. Pilots are directed to “avoid the plant”
IR760	Military Training	0.5	Low Alt. >2	10	906 (a)	Instrument Training. Pilots are directed to “avoid the plant”
VR1754	Military Training	0.5	Low Alt. >1.5	10	775 (a)	Visual training. Pilots are directed to “avoid the plant”

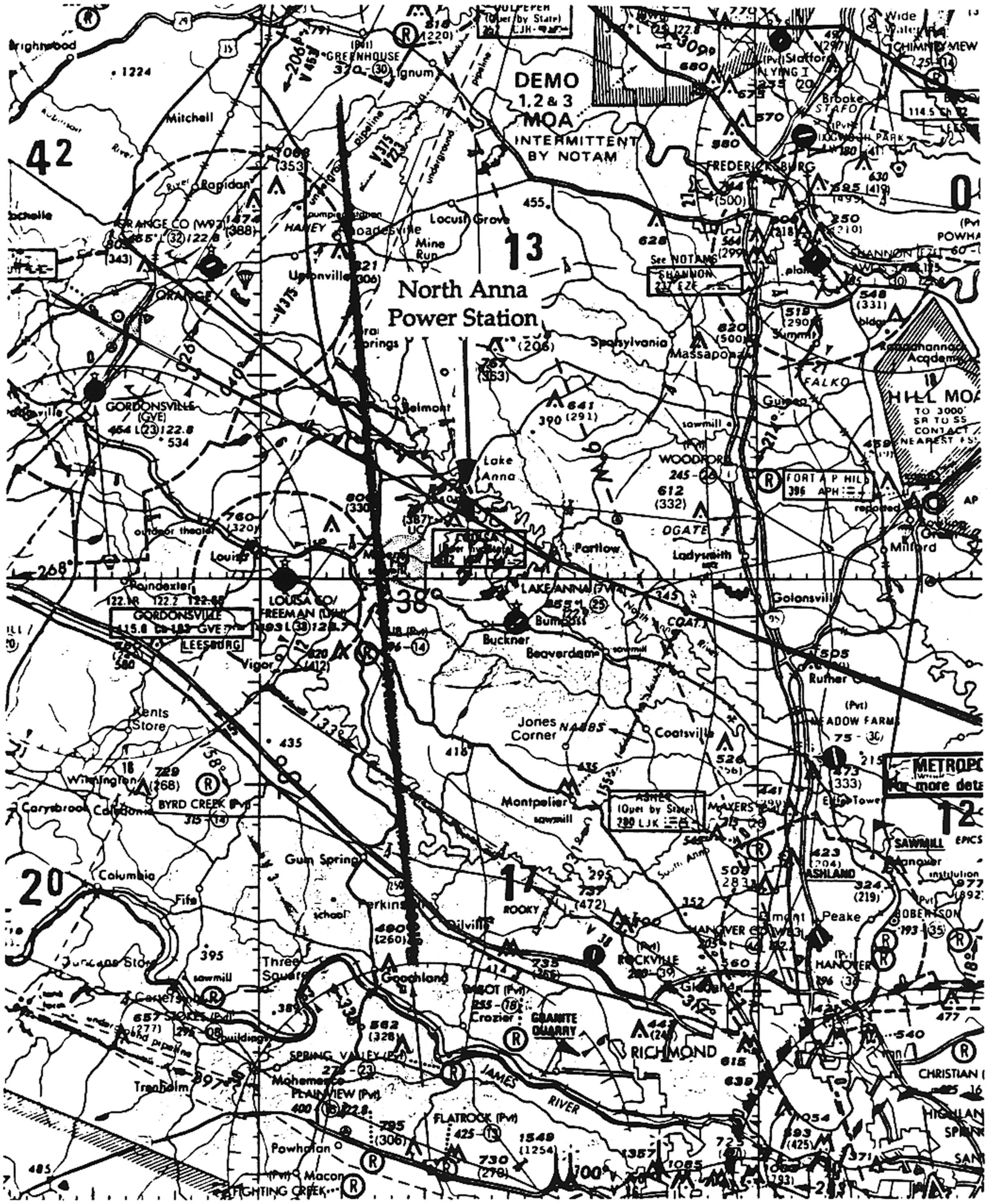
a. Flights are 1 or 2 and occasionally 4 aircraft. Total flights in the three airways were 2582, 2348 and 2623 for 1991, 1992 and 1993, respectively. Data provided by Oceana Naval Air Station, the “owner” of the three airways. Includes use by the Virginia Air National Guard.

Table 2.2-3
ONSITE TOXIC MATERIALS (LARGEST SINGLE CONTAINER)

Chemical	Quantity
Ammonium Hydroxide	55 gal
Carbon Dioxide	17 tons
Hydrazine	300 gal
Sodium Hydroxide	700 gal

Note: Related materials listed in Table 6.4-1

Figure 2.2-1
LOCATION OF AIRPORTS AND AIRWAYS



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2.3 METEOROLOGY

2.3.1 Regional Climatology

2.3.1.1 Data Sources

Data acquired by the National Weather Service (NWS) and summarized by the Environmental Data Service (EDS) were used to determined the regional climatology pertinent to the North Anna site.

The *1987 Local Climatological Data (LCD), Annual Summary with Comparative Data (*Reference 1*)* was used for Richmond, Virginia, to determine the climatological characteristics of the region.

Extreme wind data were obtained from studies by Thom (Reference 2) and Huss (Reference 3). Severe weather data were obtained from a variety of sources. Severe storm, tornado, and hurricane data were obtained from monthly *Storm Data* (Reference 4), *Climatological Data, National Summary* (Reference 5), Thom (Reference 6), Cry (Reference 7), *The Central Virginian* (Reference 8), and *Climatological Data, Virginia, June 1982* (Reference 9).

Data for meteorological extremes were obtained for Richmond from the 1987 *Local Climatological Data, Annual Summary* (Reference 1). Temperature and precipitation extremes for other meteorological stations in the site region were obtained from the 1987 *Climatological Data*, *Virginia, Annual Summary (*Reference 10*)* and from climatological summaries (References 11 through 15) for each station.

Monthly *Storm Data (*Reference 4*)* were used for the number of occurrences of hail and ice storms.

Data for thunderstorms were obtained from the 1987 Richmond LCD (Reference 1).

Climatological data for restrictive dilution conditions were obtained from a variety of sources dealing with stagnating conditions in the United States (References 16 through 19).

2.3.1.2 General Climate

Climate in the Piedmont region of Virginia, in which the North Anna site is located, is modified continental. Summers are warm and humid and winters are generally mild. The Blue Ridge Mountains to the west act as partial barriers to winter storms (modifying their intensity as they move across the rolling Piedmont to the Tidewater region adjacent to the Atlantic Ocean) and on an annual basis tend to channel winds along a general north-south orientation. Temperatures in the site region rarely exceed 95°F or fall below 10°F.

The area around the site receives a total annual average rainfall of approximately 44.0 inches (Reference 1). Rainfall is fairly well distributed over the entire year, with the exception of the months of July and August, when thunderstorm activity raises monthly totals to

about 5.0 inches (Reference 1). Extratropical storms may also contribute significantly to precipitation during September.

Snowfalls of 4 inches or more occur on an average of once a year, and snow usually only remains on the ground from 1 to 4 days at a time. Richmond averages about 14.6 inches of snow a year (Reference 1).

2.3.1.2.1 Interaction Between Synoptic Scale Processes and Local Conditions

Synoptic scale processes are usually examined with respect to the general circulation and general climatological characteristics of a region. Therefore, synoptic scale processes usually involve examination of gross meteorological conditions such as prevailing wind patterns, temperature variability, precipitation patterns, and the occurrence of meteorological phenomena (e.g., fog, severe storms) in the site region. The analysis of the micrometeorology (local conditions) of a region usually encompasses the examination of the gross climatic characteristics of the region, but with respect to how local conditions can alter or can influence a change in the general climatology of the region at a specific location. There are times when certain meteorological variables will deviate from the expected normal due to topographic effects or man-made interference.

In general, during light wind conditions, the local environmental conditions will predominate, resulting in a channeling effect of winds such that the air flow patterns will follow the contour lines of the region. Also, local environmental conditions can cause a moderating effect with respect to extreme temperatures in the immediate vicinity of the site region because of the presence of Lake Anna. For the most part, the general synoptic conditions will predominate in regard to climatic characteristics of the site region; however, during periods of extreme temperatures or light wind conditions, the local conditions will have an influence on the micrometeorology.

2.3.1.3 **Severe Weather**

2.3.1.3.1 Extreme Winds

According to the latest compilation by Thom (Reference 2) for characterizing extreme winds, the extreme 1-mile wind speed at 30 feet above the ground, which is predicted to occur once in 100 years, is 80 mph. The values for other recurrence intervals are listed in Table 2.3-1 with the extrapolated value of 105 mph for the 1000-year recurrence interval (Reference 2). The extreme mile wind speed is defined as the 1-mile passage of wind with the highest speed for the day. The fastest mile wind recorded at Richmond, based on the 1951-1987 period of record, was 68 mph from the southeast in October 1954.

2.3.1.3.2 Tornados

In the period of January 1916 through December 1987, a total of 65 tornados have been reported within a 50-mile radius of the North Anna site (References 4 & 5). This averages out to 0.915 tornados per year within this radius.

According to statistical methods proposed by Thom (Reference 6), the probability of a tornado striking a point within a given area may be estimated as follows:

$$P = \frac{z \times t}{A} \tag{2.3-1}$$

where:

P = the mean probability per year

z = the geometric mean tornado path area

t = the mean number of tornados per year

A = the area of concern

For the region surrounding the North Anna site, the mean tornado path length reported was about 2 miles and the mean path width reported was about 240 yards (References 4 & 5). These values yield a z of 0.28 mi^2 based on the January 1951 through December 1987 period of record. Using a 50-mile radius as a basis for A and a value of 0.915 tornados per year for t yields a probability of 3.25×10^{-5} per year, or a recurrence interval of 30,800 years.

2.3.1.3.3 Tropical Storms and Hurricanes

Since 1871, when more complete weather recordkeeping began, through 1987, a total of 51 tropical storms or hurricane centers passed within 100 nautical miles of the North Anna site (Reference 4). After 1885, weather records differentiated between tropical storms (less than 73 mph) and hurricanes (more than 74 mph). From 1886 through 1987, there have been passages of 33 tropical storms and 7 hurricanes within 100 nautical miles of the site. The last storm to affect the site was Hurricane Charley, which passed along the Virginia Capes on August 18, 1986. The precipitation shield associated with Charley brought 1 to 3 inches of rain to the region. The above experience results in an average of approximately two tropical storms or hurricanes every 5 years within 100 nautical miles of the site.

2.3.1.3.4 Precipitation Extremes

Table 2.3-2 lists some extremes of meteorological measurements for Richmond and Charlottesville. The maximum amount of precipitation recorded for a 24-hour period was 8.79 inches, which occurred at Richmond in August 1955. This occurred during the passage of several thunderstorms associated with a frontal passage. The maximum monthly snowfall measured in the region was 29.8 inches at Charlottesville in March 1960. The maximum 24-hour snowfall observed at Richmond was 21.6 inches in January 1940 (Reference 1).

2.3.1.3.5 Hail and Ice Storms

Hail can occasionally occur at the North Anna site (associated with well-developed thunderstorms) and at times may be intense.

A review of data for the 10-year period, 1977-1987, indicates that there were 16 reported cases of hail in Louisa County (where North Anna is located) and in the immediately surrounding counties of Hanover, Caroline, Spotsylvania, and Orange (Reference 4). There was one case of 0.5-inch-sized hailstones, one case of 1-inch hail. The other cases documented had smaller sizes hailstones recorded.

An examination of the 10-year period, 1977-1987, indicates that there were only six documented cases of ice storms in Louisa and the immediately surrounding counties (Reference 4). Of these, two were reported to have caused serious damage (including damage to power lines and trees). All six cases were associated with a number of traffic accidents, mostly minor, because of glaze ice on the highway.

2.3.1.3.6 Thunderstorms

Richmond averages 37 thunderstorm days a year, with July having the highest frequency of occurrence of thunderstorms, 9 days (Reference 1).

2.3.1.3.7 Restrictive Dilution Conditions

The frequency of occurrence of low-level inversions or isothermal layers based at or below a 500-foot elevation in the site region is approximately 30% of the total hours on an annual basis according to Hosler (Reference 16). Seasonally, the greatest frequencies of inversions based on the percent of total hours occur during the fall and winter, 34% and 33%, respectively. Spring and summer have the lowest inversion frequencies (only 28% of the time for each season). Most of these inversions are nocturnal in nature.

The mean maximum mixing depth (MMMD) is another restriction to atmospheric dilution. The mixing depth is the thickness of the atmospheric layer, measured from the surface upward, in which convective overturning is taking place caused by the daytime heating at the surface (Reference 17). The mixing depth is usually shallowest during the early morning hours just after sunrise when the nocturnal inversion is being modified by solar heating at the surface. The mixing layer is at its greatest depth during the latter part of the afternoon, 3:00 p.m. to 4:00 p.m., when the maximum surface temperature of the day is reached. The annual afternoon MMMD value for the site region, according to Holzworth (Reference 18), is 4650 feet. The seasonal afternoon MMMD value is 3250 feet (fall) (Reference 18). Shallow mixing depths have a greater frequency of occurrence during the fall and winter seasons in association with the higher frequency of inversions for these seasons.

Periods of high air pollution potential are usually related to a stagnating anticyclone with the average wind speed less than 9.0 mph (4.0 m/s), no precipitation, and a shallow mixing depth

(1600 feet or 500 m) (Reference 19).

The greatest air pollution potential in the site region occurs during the fall and winter seasons when the tendency is greatest for a quasistationary anticyclone to develop in association with wind speeds less than or equal to 5 mph and a shallow mixing depth.

2.3.2 Local Meteorology

2.3.2.1 **Data Sources**

Data acquired by the National Weather Service (NWS) and summarized by the Environmental Data Service were used to determine the normals, means, and extremes of temperature, precipitation, relative humidity, and fog applicable to the North Anna site region.

The 1987 Richmond LCD (Reference 1) and *Summary of Hourly Observations* (Reference 20) provide detailed climatological data for this first-order observation station, while *Climatological Data, Virginia, Annual Summary (*Reference 10*)* and climatological summaries (References 11 through 15) provide data for other stations in the area, although not as complete as for Richmond.

Direction and distance of the NWS stations closest to the North Anna nuclear power plant are as follows:

NWS station	Distance (miles)	Direction
Richmond	44	Southeast
Fredericksburg	25	Northeast
Charlottesville	41	West
Gordonsville	25	West-Northwest
Louisa	14	West
Partlow	8	East

2.3.2.2 **Normal and Extreme Values of Meteorological Parameters**

2.3.2.2.1 Local Climatological Data

Climatological extremes for Richmond and Charlottesville are presented in Table 2.3-2. Normal and extremes of available temperature, precipitation, relative humidity, and fog are presented for Richmond in Table 2.3-3.

Temperature and precipitation means for other applicable stations are presented in Table 2.3-4.

The closest available fog data for the North Anna site region are from the NWS observation station at Byrd Field in Richmond. The LCD for Richmond through 1987 (Reference 1) indicate an average of 28 days per year of heavy fog based on 58 years of records. Heavy fog is defined by the National Weather Service as fog that reduces visibility to 1/4 of a mile or less. The frequency

of fog conditions at North Anna would be expected to be somewhat different from Richmond. The North Anna site is characterized by gently rolling terrain that rises to an average height of 50 to 150 feet above Lake Anna's level. Therefore, low regions at the site and also in the vicinity of the lake would be expected to have a higher frequency of fog occurrences attributed to the accumulation of relatively cool surface air due to drainage flows from higher elevations compared to the relatively flat region at Byrd Field.

2.3.2.2.1.1 *Average Wind Direction and Speed.* The distribution of wind direction and speed is an important consideration when evaluating transport conditions relevant to site diffusion climatology.

The topographic features of the site region are a factor in influencing the wind direction distribution at North Anna. The wind direction distribution for any region is usually characterized by the topographic features of the site region and/or the general circulation of the atmosphere (i.e., movement of pressure systems and location of semipermanent zones) within the site region. For the North Anna site, the prevailing wind is from the south-southwest during the summer season and from the northwest and north during the winter season. This is primarily attributed to two factors: (1) the location of the Bermuda High off the eastern coast of the United States during the summer season, and (2) the development of a cold high-pressure zone over the eastern portion of the United States during the winter season.

However, the topographic features of the site region in conjunction with the movement of pressure systems and the location of the semipermanent pressure zones have a definite influence on the wind direction distribution. The Blue Ridge Mountains, which are oriented in a south-southwest to north-northeast direction, are located approximately 30 to 40 miles northwest of the North Anna power plant. Consequently, the prevailing winds during the summer season are from the south and south-southwest instead of the south-southeast because of a channeling effect created by the presence of the Blue Ridge Mountains. In addition, the Blue Ridge Mountains act as a barrier to the prevailing westerly winds at the surface; but even more so, they act as a barrier to the movement of low-pressure cells from the Gulf region to the northeast portion of the United States. Consequently, low-pressure cells that are spawned in the Gulf are frequently forced to move up the east coast on the back (west) side of the Blue Ridge Mountains; therefore, resulting in a southerly flow of air in the site region instead of a southeast or easterly wind.

Topographic features will also have a definite influence with respect to the wind direction distribution during periods of light winds. Usually, during episodes of near calm, the pressure gradient is weak and there is no organization in the general circulation. However, due to topographic effects such as the presence of Lake Anna (formerly the North Anna River), the flow of air will more than likely follow the contour lines (valley and ridges) of the land. Air will be channeled along Lake Anna and the North Anna River Valley during light wind conditions. If there is a sufficient temperature gradient between the ambient air over the lake and surrounding land, there exists the possibility of a formation of a weak lake breeze. However, only the area in the immediate vicinity of the lake (less than 1 mile) would be affected by the lake breeze.

The seasonal and average distributions of wind direction based on site data are presented in Figures 2.3-2 through 2.3-21 for the lower and upper tower levels. Winds occur on an annual basis along a north-south orientation with a general westerly component. Wind direction distributions based on the lower level data are similar to those based on the upper level data. However, the upper level data indicate a more distinct north-south orientation of wind flows. Wind data presented in the PSAR indicate a general flow along a south-southwest/north-northwest orientation at Richmond (Reference 21). This distribution is similar to the general wind flow at North Anna. However, the local site topography and the change in orientation of the Blue Ridge Mountains (which also corresponds to the difference in wind patterns between North Anna and Richmond) indicate the basis for these respective wind distributions.

Wind direction distributions show seasonal variations. The frequencies of northerly and southerly winds are generally equivalent during the fall season. Winds from the northwest and south-southwest sectors characterize wind flows during the winter. During the spring months, the wind flow is predominantly from the northwest at the lower level. During the summer months, the predominant wind is from the south-southwest.

Atmospheric dilution is directly proportional to the wind speed (other factors remaining constant). The seasonal and annual median wind speeds for North Anna are presented in Table 2.3-6. Seasonal variations of mean wind speeds do occur as indicated in Table 2.3-6.

The mean annual winds speed at North Anna are 6.3 mph and 8.6 mph at the lower and upper tower levels, respectively. The frequency of calms is 0.37% and 0.75% of the time for the lower and upper tower levels, respectively.

2.3.2.2.1.2 *Wind Direction Persistence.* Wind persistence is extremely important when considering potential effects from a containment release. Wind persistence is defined as a continuous flow from a given direction or range of directions.

The maximum 22.5-degree range direction persistence episodes recorded during the period of record at North Anna from the data for the lower level was a 26-hour wind from the north. The maximum persistence period at the upper level was 33 hours from the west-northwest. In general, extreme persistence periods (greater than 18 hours) at North Anna are associated with moderately high winds and relatively low or moderate turbulence. Episodes of maximum wind persistence in 22.5-degree sectors are presented in Figure 2.3-25 through Figure 2.3-28.

2.3.2.2.1.3 *Atmospheric Stability.* Atmospheric stability, as used in this report, is classified into horizontal and vertical stability categories. The degree of wind variance or standard deviation of direction (S_t) is used to determine horizontal stability, and the vertical thermal structure (delta T) is used to determine vertical stability. The classification of S_t data is presented in Table 2.3-7 and the classification of delta T data is presented in Table 2.3-8.

The seasonal and annual frequency of S_t stability classes and associated wind speeds for North Anna are presented in Tables 2.3-9 and 2.3-10 and similar summaries for delta T data are presented in 2.3-11. An examination of horizontal stability data (Tables 2.3-9 and 2.3-10) indicates that neutral conditions are prevalent at the lower level and neutral and slightly stable conditions are prevalent at the upper level. This situation illustrates the general decrease in horizontal turbulence with increasing height due to the reduction of surface friction and roughness effects. The vertical stability data based on delta T site measurements (Table 2.3-11) indicate the predominance of neutral and slightly stable conditions similar to the upper level S_t data.

The seasonal variations of horizontal (S_t) atmospheric stability class distributions as presented in Tables 2.3-9 and 2.3-10 are relatively minor. The neutral stability class (delta T) distributions show a more pronounced seasonal dependence than the S_t data. Extremely unstable delta T conditions (A) are more frequent and extremely stable delta T conditions (G) are less frequent during the summer than during the winter. This situation is attributed to the greater solar heating of the surface during the summer and the large-scale restrictive dilution conditions (discussed in Section 2.3.1.3.7) that generally occur during the winter. Also, ground snow cover is conducive to the formation of stable (or inversion) delta T conditions.

An examination of the joint delta T and S_t (lower level) data (Table 2.3-12) indicates that prevalent S_t condition (D) is associated with neutral (D) and slightly stable (E) delta T conditions.

Instrumentation is available in the main control room by which personnel can determine atmosphere stability. This instrumentation is discussed in Section 2.3.3.2.5. From the temperature recorder discussed in Section 2.3.3.2.3, a delta T can be ascertained. With this delta T value, the North Anna Emergency Plan Implementing Procedures can be entered to determine the appropriate atmospheric stability category. The North Anna Emergency Plan Implementing Procedures identify station specific instructions and appropriate temperature values for determining Regulatory Guide 1.23, Table 2 atmospheric stability classifications. This will allow for the rapid assessment of pertinent meteorological parameters by control room personnel in the event of an accidental release of radioactive material to the atmosphere.

2.3.2.3 **Potential Influence of the Plant and the Facilities on Local Meteorology**

The North Anna impoundment lake is expected to have some effects on diffusion climatology, with those effects mainly confined to the immediate area of the lake. Slade (Reference 24) has documented that on the average a 50% reduction of S_t values and a 25% increase in wind speeds occurred after over-water trajectories of 7 miles. Because of the complex configuration of the North Anna impoundment, over-water trajectories would generally be less than 4 km, although it is difficult to extrapolate Slade's results to other distances. However, since the average water temperature at North Anna will be higher than the average air temperature, enhanced low-level atmospheric turbulent mixing in the vertical can be expected. Also, Slade has indicated that the reduction of S_t values (i.e., the comparison of over-water to overland flows) is

minimal and the increase in wind speeds is at a maximum when the water temperature exceeds the air temperature.

The offsite impact due to the effect of the lake on local diffusion climatology is expected to be minimal. Van der Hoven (Reference 23) has stated that the transition from the relatively nonturbulent regime of an over-water flow to the relatively turbulent regime of an overland flow is quite rapid.

2.3.2.4 **Topographic Description**

The North Anna Power Station site and exclusion area consist of approximately 1075 acres located in the northeastern portion of Virginia in Louisa County along the North Anna River. The site region is characterized by gently rolling terrain that rises to an average height of 50 to 150 feet above Lake Anna's level and is cut by the North Anna River. The topography in the site region is characteristic of the Central Piedmont Plateau, which has a gently undulating surface that varies from 200 to 500 feet above sea level. Figures 2.3-24 and 2.3-25 present the topographic features of the site. Section 2.3.2.2.1.1 discusses how the topographic features of the site influence wind direction distribution.

An earth dam about 5 miles southeast of the site forms Lake Anna, which extends approximately 17 miles along the old North Anna riverbed. The North Anna Reservoir and Waste Heat Treatment Facilities cover a surface area of 13,000 acres and contain approximately 100×10^9 gallons of water.

Because of the gently rolling terrain, there will be cold air drainage into low-lying areas at night. Some wind channeling along Lake Anna is expected during low wind speed conditions. However, this same effect occurred in the natural lowland area before the lake was filled.

2.3.3 Onsite Meteorological Measurement Programs

2.3.3.1 **Original Onsite Meteorological Measurement Program**

2.3.3.1.1 Meteorological Facility Operations

The original onsite meteorological program at North Anna consisted of temperature and wind instrumentation on a tower at levels of 35 feet and 150 feet above grade, and wind instrumentation at a satellite tower. The 150-foot tower was located 1000 feet north-northeast of the Unit 1 containment location on a peninsula that extends out into the North Anna impoundment (an area map with tower locations is provided in Figure 2.3-26). The nearest structure was the turbine building, approximately 800 feet southwest of the tower, which did not have any significant effect on the measurements from the southwest sector. A three-bladed Bendix Aerovane wind sensor was located at the 150-foot level. A supplement six-bladed unit was located at the 35-foot level of the main tower. Both units used standard Model 141 Bendix analog recorders. The temperature system made use of highly sensitive platinum resistance bulbs (accuracy of 0.10%) mounted at both the 35- and 150-foot tower levels. Each sensor was housed

in an aspirator to minimize radiation error (±0.2°F). The recorders were housed in a shelter with a controlled environment at the base of the tower. The entire meteorological system was calibrated every 4 months during the data recovery period to ensure data reliability. Low-threshold (less than 1-mph) wind speed and direction instrumentation was installed during June 1971 on a 35-foot satellite tower on the same peninsula as the 150-foot tower. This additional equipment became operational during September 1971 and provided reliable 35-foot data during low wind speed conditions. A Model 141 Bendix analog recorder was used to provide a basis for manual chart data reduction. Data obtained from the low-threshold system were used for computations and analyses in lieu of the less representative wind data (because of the higher starting speed and the exposure of the instrument) from the 35-foot level on the main tower.

Performance characteristics of the Bendix wind instrumentation installed at North Anna are provided in Table 2.3-13.

2.3.3.1.2 Meteorological Data Reduction

Meteorological data collected at the North Anna site were routinely forwarded to NUS Corporation for inspection (i.e., to determine equipment malfunctions, calibration drift, and invalid data) and for manual data reduction. One 15-minute sample was used for each 1-hour data period available. Average values of wind direction and wind speed were obtained by visually estimating a median for the 15-minute sample of the analog traces. A similar approach was used to reduce the digital traces from the multipoint recorder to obtain average temperature and temperature differential (delta T) data. The range of the wind direction trace was also manually reduced (by examining the extreme of the direction trace peaks) in order to obtain a measure of horizontal stability (σθ- the wind direction standard deviation). Horizontal stability (σθ) data were manually determined for "noncalm" conditions by dividing the wind direction range for the 15-minute period by a constant of 6.0 as follows (References 6 & 24):

$$\sigma_\Theta = \frac{A_1 + A_2}{6} \qquad (2.3\text{-}2)$$

where:

$A_1 = \theta max - \theta avg$ if $\theta max > \theta avg$

$A_1 = 360 + \theta avg$ if $\theta max < \theta avg$

$A_2 = tavg - \theta min$ if $\theta min < \theta avg$

$A_2 = 360 + \theta avg - \theta min$ if $\theta min > \theta avg$

where:

θmax = maximum deflection angle

θmin = minimum deflection angle

θavg = average wind direction

The manually reduced data were transcribed on cards and were used as computer input to codes developed by NUS for data analysis and summary. The NUS computer code WINDVANE (Reference 25) was used to proceed meteorological data to determine significant meteorological statistics and distributions for further analysis. WINDVANE output included the following information on a monthly, seasonal, and annual basis:

1. Total number of observations used for calculations.
2. Hourly stability index distribution in percent of total observations of each hour.
3. Distribution for each stability index in percent of total observations.
4. Average wind speed for each stability index.
5. Distribution of stability indices for each of 16 wind directions.
6. Distribution of wind directions (16) for each stability index.
7. Dilution factors, χ/Q (sec/m^3), as a function of release height, wind direction, and downward distance weighted by stability class and wind rose frequencies.
8. Wind persistence frequency calculations for various ranges of wind direction and a listing of persistence episodes greater than 2 hours.
9. Wind speed distribution versus stability classes for each wind direction individually.
10. Wind speed distribution versus stability classes summed over all directions.
11. Wind speed distribution versus direction summed over all stability classes.

Atmospheric stability in WINDVANE is classified into categories proposed by Pasquill (Reference 26). These classes range from “A,” the most unstable, to “F,” stable. An additional category, “G,” has been established by the U.S. Atomic Energy Commission (AEC) (Reference 27). A low degree of wind turbulence can be expected for stable conditions, resulting in relatively suppressed diffusion conditions. Conversely, during periods of instability, a high degree of wind turbulence can be associated with relatively enhanced diffusion conditions.

The horizontal stability indices are based on Pasquill categories as indicated in Table 2.3-9. Calm conditions are classified into an “E” horizontal stability category (S_t), if they occur during the night, and into a “C” category if they occur during the day, as suggested by Slade (Reference 22).

Vertical stability indices are based on the temperature lapse rate and classified according to Table 2.3-10. Calm conditions are also classified into vertical stability categories (dT) according to the associated lapse rates for each occurrence. Tables 2.3-9 and 2.3-10 are based on AEC Safety Guide 23 recommendations for stability classification (Reference 28). The temperature

lapse rate in °F/1000 feet is determined from delta T data as follows:

$$dT(°F/1000\ ft) = \frac{(1000)(dT_{2-1})}{dZ_{2-1}} \tag{2.3-3}$$

where:

dT_{2-1} = difference in ambient temperature between Tower Level 2 (higher) and Tower Level 1 (lower), °F

dZ_{2-1} = vertical distance between two levels of temperature instrumentation, ft.

2.3.3.2 Upgraded Onsite Meteorological Measurements Program for Station Operation

2.3.3.2.1 General Program Description

The current, upgraded onsite meteorological measurements program for the North Anna Power Station meets the requirements of 10 CFR 50.47 and the criteria set forth in NUREG 0696, NUREG 0737, and NUREG 0654, Appendix 2. The basic functions provided by the upgraded meteorological program are:

1. A capability for making meteorological measurements.
2. A capability for making real-time predictions of atmospheric effluent transport and diffusion.
3. A capability for remote interrogation of the atmospheric measurements and predictions by appropriate organizations.

Meteorological measurements are available from both a primary and backup system, as required in 10 CFR 50, Appendix E. The backup system will function when the primary system is out of service, thus providing assurance that basic meteorological information is available during and immediately following an accidental airborne radioactivity release.

The primary meteorological monitoring site at North Anna consists of a Rohn Model 80, guyed, 160-foot tower located approximately 1900 feet east of the Unit 1 reactor containment. Sensors are located at the 10-meter, 48.4-meter, and ground levels. Wind speed, wind direction, horizontal wind direction fluctuation (S_t), ambient temperature, one-half of differential temperature, and relative humidity are measured at the 10-meter elevation. Wind speed, wind direction, horizontal wind direction fluctuation (S_t), and one-half of differential temperature are measured at the 48.4-meter elevation. Precipitation is monitored at the ground level. Signal cables are routed through conduit from each location into the instrument shelter at the base of the tower. Inside the shelter, the signals are routed to the appropriate signal-conditioning equipment whose outputs go to: (1) digital data recorders, and (2) an interface with the intelligent remote multiplex system.

The North Anna backup meteorological monitoring site consists of a Rohn Model 25, free-standing 10-meter tower. This tower is located approximately 1300 feet northeast of the Unit 1 reactor containment and serves as the backup meteorological monitoring site. A sensor at the top of the mast monitors wind speed, wind direction, and horizontal wind direction fluctuation (S_t). The signal path, instrument shelter and data recording are identical to those described at the primary tower. All three parameters are interfaced to the intelligent remote multiplexing system equipment.

Total solar and sky radiation was recorded at the original meteorological monitoring facility until that meteorological program was terminated as described below.

The original and upgraded meteorological systems were operated concurrently before phasing out the original system. The majority of the upgraded facility went into operation by June 1977.

The upgraded onsite meteorological monitoring program is conducted in accordance with the criteria of Regulatory Guide 1.23, Section C.3. Proposed Revision 1 to Regulatory Guide 1.23 was used for guidance in designing the primary meteorological measurements system.

Data from the original and upgraded systems were compared in November 1978, at the end of the first year of concurrent operation. The meteorological data collected from the upgraded tower site were found to be completely representative of the data collected at the original tower site, and the dispersion characteristics of the North Anna Power Station as reflected in the original tower data were duplicated. Furthermore, the main dispersion parameters, wind flow and wind persistence, were practically identical.

2.3.3.2.2 Location, Elevation, and Exposure of Instruments

The location of the original, upgraded, and back-up meteorological towers are shown on the topographical map, Figure 2.3-26. Distances and bearings to ground features in the vicinity of the tower are shown on Figure 2.3-28. The nearest major structures is the Training Center building (completed in 1982) located 740 feet from the tower on a line of bearing of 205° from true North. The minor structures, forming the recreational facility in the immediate vicinity of the tower have been evaluated as having no adverse effect on the measurements taken at the tower. Trees in the immediate vicinity of the tower have been topped to heights of 10-15 feet. The nearest contiguous tree line is more than 500 feet away from the tower and tree heights are 40 to 50 feet.

These towers and the original satellite tower have the same relative proximity to Lake Anna.

Ground cover at the location is characteristically native grasses. Comparable cover is maintained at the base of the tower.

The primary tower is a guyed, triaxial, open-lattice structure. The lower level instrumentation is at 10 m above ground level. The upper instrumentation is at 158.9 feet above the finished plant grade of 271 feet above mean sea level.

The wind sensors are positioned so that the tower will not influence the prevailing south-southwest wind flow detected by the sensors.

The wind speed, wind direction, and (S_t) sensors are mounted on booms longer than one times the tower face width.

Temperature and differential temperature sensors are housed in motor-aspirated shields to insulate them from thermal radiation. These shields have a less than 0.2°F error at a maximum solar radiation of 1.6 gm-cal/cm^2/min. The relative humidity sensor is housed in a naturally-aspirated shield; under conditions of low air movement, 2.2 mph, error is within 2.7°F of ambient improving to 0.7°F at wind speed greater than 6.7 mph.

2.3.3.2.3 Meteorological Sensor Type and Performance Specifications

Wind speed, wind direction, and (S_t) are measured at both the lower and upper tower levels. Sonic wind sensor instruments are used to measure wind speed and wind direction, and (S_t) is calculated by the digital data acquisition system.

Temperature is measured at the 10-m level and differential temperature is measured between the 10-m and 158.9-foot level. The sensors consist of one single-element high-precision platinum resistance temperature sensor to be located at the 158.9-foot level for measuring part of the differential temperature; one single-element precision platinum resistance sensor to be located at 10-m level for measuring ambient temperature and the other part of differential temperature. The sensors' signals are input into a temperature/delta temperature processor to provide output signals proportional to one ambient and one differential (delta T) temperature.

Relative humidity is measured at the 10-m level. The sensor signals input into data acquisition equipment that provides data proportional to 0 to 100% relative humidity.

2.3.3.2.4 Instrument Calibration and Maintenance

The meteorological monitoring installation is calibrated not less than semiannually. Inspection, service, and maintenance is performed as required to ensure not less than 90% data recovery. A body of instrument technicians have the requisite expertise to service and, in the event of a system failure, repair the monitoring equipment. These technicians are provided by the onsite instrument group.

An inventory of spare sensors and parts are maintained for the replacement of major components in the event of a system outage. Redundant recording systems are incorporated into the program to further minimize data loss due to recorder failure.

2.3.3.2.5 Data Recording Systems

2.3.3.2.5.1 *Control Room Systems*. Data from the primary and backup meteorological towers are sent to the station's control room as 4-20 ma current signals over individual shielded pair cables. Once there, the parameters are collected by the plant computer system (PCS), via the intelligent remote multiplex system. The PCS meets the overall 99% availability requirement in NUREG 0696. Once collected by the multiplex system, the parameters are placed in the PCS data base, thus making the site meteorological field data available for display in the station's Technical Support Center (TSC), and Local Emergency Operations Facility (LEOF), or the Corporate Emergency Response Center (CERC), or the Central Emergency Operations Facility (CEOF) located in the CERC at Virginia Power's Innsbrook Technical Center. Certain input sensor information in the control rooms is also hardwired for display on the main control room meteorological panels. Tables 2.3-15 and 2.3-16 list each meteorological input parameter and its transmitted location.

Tables 2.3-15 and 2.3-16 describe data that can be made available for remote interrogation at any time. During emergency conditions, selected meteorological parameters can be made available to the NRC through the Emergency Response Data system. Once activated by Virginia Power, this meteorological data is transmitted from the PCS, via modem, to the NRC operation center.

2.3.3.2.5.2 *Tower Base Shelter Systems*. A nominally 8 ft x 8 ft x 18 ft shelter is at the tower base. The shelter is insulated and thermostatically controlled heat and air conditioning maintain an interior temperature within a range appropriate for proper equipment operation. The enclosure is located so as to minimize any micrometeorological effects on the tower instrumentation.

Equipment and circuitry for two separate data recording systems are housed in the enclosure.

Microprocessor-based Data Acquisition Systems are the primary method of data acquisition. The sensor analog signals are collected, processed, and telemetered to a system computer.

The data acquisition systems have a built-in battery which maintains the time and date and initialized parameters. In addition to the power-up diagnostic checks, memory diagnostic tests are continually being performed to insure data integrity.

Virginia Power submits that the instruments and data acquisition systems as detailed herein are consistent with the current level of technology for meteorological monitoring and that the accuracy of the components is adequate to ensure system accuracy with Regulatory Guide 1.23.

2.3.3.2.6 Meteorological Data Analysis Procedure

The data values are used to generate a sequential file of 1-hour values for each parameter. The average values are calculated by the digital data collection system.

In addition to being transmitted real-time to the PCS, the data are telemetered daily to a computer in the corporate office. The data are reviewed each work day by personnel in the Air Quality Department who check it for representativeness and reasonability. The data are compared with other Company meteorological tower sites as well as with the real-time data received at the corporate Meteorological Operations Center. The current calendar month of data is maintained on a personal computer. At the end of each month, the data are transferred to the corporate mainframe computer for inclusion in the historical database.

This sequential file is used as the data base for all subsequent data summaries and historical calculations.

Routine data summaries are generated for each day, each calendar month, and each calendar year from certain meteorological parameters recorded on strip charts in the control room. An annual summary is provided to Health Physics by the Air Quality Department. Other data summaries are prepared by Air Quality Department upon request.

The format of the onsite data summaries conforms to the recommended format found in Regulatory Guide 1.23, Table 1. To enhance comparison, the joint frequency distributions of wind speed and wind direction for each stability class as defined by horizontal wind sigma and differential temperature are displayed side by side. Joint frequency distributions for each wind sensor are presented.

2.3.4 Short-Term (Accident) Diffusion Estimates

2.3.4.1 **Basis**

Onsite data have been used to evaluate the hypothetical accident meteorology for the North Anna site. This hypothetical accident is postulated to predict upper-limit concentrations and dosages that might occur in the event of a containment release. A basic input to the accident analysis is the meteorological conditions that determine the dilution capacity of the atmosphere. The meteorological conditions postulated for the hypothetical accident are based on a consideration of AEC Safety Guide 4 (Reference 31) and an analysis of available site and regional meteorological data.

Site data were used for a quantitative evaluation of the hypothetical accident at North Anna. Although it would have been more desirable to use the longer (5-year) period of record of Richmond data presented in the PSAR, these measurements are not commensurate with evaluation requirements of site dilution meteorology during low-wind-speed regimes (i.e., the wind instrumentation at Richmond does not have the required sensitivity for these analyses, and atmospheric stability is determined by an indirect approach). Also, onsite data provide more representative measurements of local dilution conditions appropriate to North Anna. However, the average wind speed at Richmond (for the report period from September 16, 1971, to September 15, 1972) of 7.5 mph closely approximates the climatic normal of 7.6 mph. Therefore,

these site meteorological data are considered to be reasonably representative of long-term conditions.

Meteorological data were examined to determine 0 minute to 60 minute hypothetical accident conditions. These postulate accident conditions were determined on a quantitative statistical basis. The frequency of occurrence of each stability class is tabulated for various wind speed ranges. The associated χ/Q values for each wind speed and stability class combination are ranked in descending order of magnitude to determine the fifth percentile value (i.e., the χ/Q that is exceeded in value 5% of the time) at the exclusion distance. Data are classified into horizontal stability categories based on 35-foot-level σ_θ data and into vertical stability categories based on delta $T_{150\text{-}35\ ft}$ data. Calms are included in the analysis and are assigned an arbitrary wind speed of 0.25 mph and a stability category based on delta T data. Credit is taken for increased dilution due to building wake effects. The building wake factor is assumed to be 0.5 times the smallest cross-sectional area of the containment structure. A building wake factor of 758 m^2 was used for this analysis.

As illustrated in Table 2.3-17 and Figure 2.3-29, the fifth percentile value of χ/Q is 2.0×10^{-4} sec/m^3, which is equivalent to an "F" stability and a 1.5-m/sec (3.4-mph) wind condition at the exclusion distance of 1350 m.

This indicates more favorable dilution conditions than the "F" stability and the 1-m/sec (2.2-mph) wind condition postulated in AEC Safety Guide 4. However, for conservatism, the "F" stability 1-m/sec wind condition is postulated also for a 0-minute to 60-minute hypothetical accident period at North Anna. Conditions for this hypothetical accident are presented in Table 2.3-18. This results in a χ/Q value of 3.0×10^{-4} sec/m^3 at the exclusion distance for the 0-minute to 60-minute period. For dose analysis calculations the slightly more conservative value 3.1×10^{-4} sec/m^3 was used.

A graph depicting dilution factors based on the postulated meteorological model for a hypothetical accident and a comparison with the fifth percentile condition is presented in Figure 2.3-30, with discrete data given in Table 2.3-19.

The 50th percentile χ/Q value is 2.40×10^{-5} sec/m^3.

2.3.4.2 **Calculations**

Centerline dilution factors (χ/Q) can be calculated using Equation 2.3-7 (References 32 & 33) for invariant winds. The diffusion is assumed to be Gaussian; that is, horizontal and vertical distributions perpendicular to the centerline have Gaussian properties. A correction term to account for the initial diffusion resulting from the building wake effect is included for invariant wind conditions.

$$\frac{\chi}{Q} = \frac{1}{(\pi\sigma_y\sigma_z + cA)\bar{u}} \qquad (2.3\text{-}7)$$

where:

χ = concentration, units per m^3

Q = source strength, units per sec

σ_y, σ_z = horizontal and vertical dispersion parameters, m

$\bar{u}$ = mean wind speed, m/sec

c = building shape factor (0.5), dimensionless

A = smallest cross-sectional area of the containment structure, m^2

This relationship, which is usually associated with continuous-release sources, is also applicable to North Anna. These releases can be treated as continuous sources (i.e., with regard to using the same diffusion equations) when the travel time of the plume is less than 10 times the duration of release (Reference 34).

2.3.4.3 **Atmospheric Transport and Diffusion Assessment Model**

A real-time, site-specific atmospheric transport and diffusion model for assessing accidental airborne radioactive releases is available for use with a dedicated computer system, as required in NUREG 0654. The model uses actual 15-minute average meteorological field data obtained from the station's meteorological system. The model provides relative concentrations (χ/Q) and transit times within the plume exposure EPZ. Atmospheric diffusion rates are based on atmospheric stability as a function of site-specific conditions. Source characteristics (release mode, and building complex influence) are factored into the model. The output from the model includes plume dimensions and positions, and the location, magnitude, and arrival time of (1) the peak relative concentration and (2) the relative concentrations at approximate locations. The calculated output of the model will be suitable for display at workstations in the station's TSC, Health Physics Count Room, Local Emergency Operation Facility, and also the Corporate Emergency Operations Facility.

2.3.5 Long-Term (Routine) Diffusion Estimates

2.3.5.1 **Basis**

Annual average atmospheric dilution factors (χ/Q) were determined for the North Anna site. Again, site data were used in lieu of the longer period of record available for Richmond data because the North Anna measurements were more representative of site dilution conditions. However, the average wind speed of 7.5 mph at Richmond for the report period (September 16, 1971 to September 15, 1972) closely approximates the climatic normal of 7.6 mph. Therefore, site meteorological data for the September 16, 1971 to September 15, 1972 period are considered reasonably representative of long-term conditions. Figure 2.3-31 shows the distribution of χ/Q in sec/m^3 based on North Anna 35-foot wind data. The configurations of χ/Q isopleths reflect the distribution of wind direction, wind speed, and vertical (delta $T_{150\text{-}35\ ft}$)

atmospheric stability for the period. The maximum χ/Q at the exclusion distance radius (4430 feet (1350 m)) is 3.30×10^{-6} sec/m^3. At the low population zone radius (6 miles (9656 m)), the value is 1.7×10^{-7} sec/m^3, and at the population center radius (23.5 miles (37,821 m)), 2.8×10^{-9} sec/m^3, based on available site data. These maximum values are associated with winds from the west-northwest and were conservatively based on the analysis of all wind directions.

The average χ/Q value calculated for the nearest residence (1770 m to the west-northwest of the plant) is 1.0×10^{-6} sec/m^3. These χ/Q values are somewhat higher than those presented in the PSAR based on Richmond data (the maximum annual χ/Q at 1350 m was 2.5×10^{-6} sec/m^3 and the annual χ/Q at the nearest residence was 5.0×10^{-7} sec/m^3).

2.3.5.2 Calculations

Annual average atmospheric dilution factors (χ/Q) were determined for the North Anna site on a directional basis. The results represent the sector average concentrations from Equation 2.3-8 for a ground-level release.

Calm conditions are not included, since they are not associated with a sector average in these directional analyses. However, because of the relatively low frequency of calm conditions, the exclusion of these occurrences does not significantly affect calculated χ/Q values.

$$\frac{\chi}{Q} = \frac{2}{\pi}\frac{1}{2}\frac{8}{\pi} f \sum_{i=1}^{n} \frac{F_i}{\sigma_z \bar{u}_i x} \qquad (2.3\text{-}8)$$

where

χ = concentration, units per m^3

Q = source strength, units per sec

σ_z = vertical dispersion parameter, m

i = stability categories A-G (numerically 1-7)

$\bar{u}_i$ = mean wind speed for stability category i, m/sec

F_i = relative fraction of time stability condition i for sector of interest

f = fraction of time winds occur from sector of interest

x = downwind distance, m

n = number of stability categories (seven, from A-G)

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Table 2.3-1
EXTREME 1-MILE WIND PASSAGE AT RICHMOND, VIRGINIA

Probability	Speed (mph)	Recurrence Interval (years)
0.5	48	2
0.1	60	10
0.04	68	25
0.02	72	50
0.01	80	100
0.001	105	1000

Table 2.3-2
SELECTED NATIONAL WEATHER SERVICE STATIONS
FOR METEOROLOGICAL EXTREMES IN THE NORTH ANNA SITE REGION
(DATE OF OCCURRENCE)

	Charlottesville		Richmond	
Maximum temperature	107°F	(9/54)	105°F	(7/77)
Minimum temperature	-9°F	(1/85)	-12°F	(1/40)
Maximum monthly rainfall	16.96 in.	(10/44)	18.87 in.	(7/45)
Maximum monthly snowfall	29.8 in.	(3/60)	28.5 in.	(1/40)
Maximum 24-hr rainfall	8.00 in.	(9/44)	8.79 in.	(8/55)
Maximum 24-hr snowfall	N/A		21.6 in.	(1/40)
Fastest mile wind, direction	N/A		68 mph SE	(10/54)

N/A - Data not available.

Table 2.3-3
NORMALS, MEANS, AND EXTREMES
RICHMOND, VIRGINIA

LATITUDE: 37°30'N LONGITUDE: 77°20' W ELEVATION: FT GRND 164 BARO 178 TIME ZONE: EASTERN WBAN: 13740

	(a)	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE °F:														
Normals														
-Daily Maximum		46.7	49.6	58.5	70.6	77.9	84.8	88.4	87.1	81.0	70.5	60.5	50.2	68.8
-Daily Minimum		26.5	28.1	35.8	45.1	54.2	62.2	67.2	66.4	59.3	46.7	37.3	29.6	46.5
-Monthly		36.6	38.9	47.2	57.9	66.1	73.5	77.8	76.8	70.2	58.6	48.9	39.9	57.7
Extremes														
-Record Highest	58	80	83	93	96	100	104	105	102	103	99	86	80	105
-Year		1950	1932	1938	1985	1941	1952	1977	1983	1954	1941	1974	1971	JUL 1977
-Record Lowest	58	-12	-10	11	23	31	40	51	46	35	21	10	-1	-12
-Year		1940	1936	1960	1985	1956	1967	1965	1934	1974	1962	1933	1942	JAN 1940
NORMAL DEGREE DAYS:														
Heating (base 65°F)		880	731	552	226	65	0	0	0	24	221	483	778	3960
Cooling (base 65°F)		0	0	0	13	99	258	397	366	180	23	0	0	1336
% OF POSSIBLE SUNSHINE	37	54	58	61	65	65	63	67	66	64	62	58	53	62
MEAN SKY COVER (tenths)														
Sunrise - Sunset	42	6.4	6.2	6.2	6.1	6.3	6.0	6.1	6.0	5.8	5.4	5.8	6.2	6.0
MEAN NUMBER OF DAYS:														
Sunrise to Sunset														
-Clear	42	8.4	8.4	8.3	8.0	7.1	6.7	7.0	7.3	9.4	11.5	9.5	9.6	101.1
-Partly Cloudy	42	6.7	6.3	8.2	9.1	10.1	12.0	11.5	11.8	8.6	7.2	7.6	6.3	105.5
-Cloudy	42	15.9	13.5	14.5	12.8	13.8	11.4	12.5	11.9	12.0	12.3	12.9	15.1	158.6
Precipitation														
.01 inches or more	50	10.3	9.1	10.6	9.2	10.7	9.5	11.0	9.8	7.9	7.3	8.3	8.8	112.8
Snow, Ice pellets														
1.0 inches or more	50	1.4	1.2	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	4.0
Thunderstorms	50	0.2	0.4	1.5	2.5	5.5	6.7	8.7	6.7	3.0	1.0	0.5	0.3	37.1
Heavy Fog Visibility														
1/4 mile or less	58	2.7	2.1	1.7	1.7	1.9	1.5	2.2	2.5	3.0	3.3	2.4	2.8	27.8
Temperature °F														
-Maximum														
90° and above	58	0.0	0.0	0.1	0.8	2.7	9.4	13.7	11.0	4.5	0.4	0.0	0.0	42.7
32° and below	58	3.3	1.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.*	1.6	6.6
-Minimum														
32° and below	58	21.7	18.9	10.3	2.2	0.1	0.0	0.0	0.0	0.0	1.8	10.1	20.1	85.1
0° and below	58	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.*	0.5
AVG. STATION PRESS. (mb)	15	1012.1	1012.2	1010.4	1009.1	1009.1	1009.5	1010.1	1011.3	1012.1	1013.4	1013.4	1013.3	1011.3
RELATIVE HUMIDITY (%)														
Hour 01	53	77	74	73	74	83	86	88	90	90	87	80	77	82
Hour 07 (Local Time)	53	80	79	78	76	80	82	85	89	90	89	84	81	83
Hour 13	53	57	53	49	45	51	53	56	57	56	53	51	55	53
Hour 19	53	68	63	58	55	64	67	71	75	78	77	70	70	68
PRECIPITATION (inches):														
Water Equivalent														
-Normal		3.23	3.13	3.57	2.90	3.55	3.60	5.14	5.01	3.52	3.74	3.29	3.39	44.07
-Maximum Monthly	50	7.97	5.97	8.65	7.31	8.87	9.24	18.87	14.10	10.98	9.39	7.64	7.07	18.87
-Year		1978	1979	1984	1987	1972	1938	1945	1955	1975	1971	1959	1973	JUL 1945
-Minimum Monthly	50	0.64	0.48	0.94	0.64	0.87	0.38	0.51	0.52	0.26	0.30	0.36	0.40	0.26
-Year		1981	1978	1966	1963	1965	1980	1983	1943	1978	1963	1965	1980	SEP 1978
-Maximum in 24 hrs	50	3.31	2.67	2.54	2.97	3.08	4.61	5.73	8.79	4.02	6.50	4.07	3.16	8.79
-Year		1962	1979	1984	1987	1981	1963	1969	1955	1985	1961	1956	1958	AUG 1955
Snow, Ice pellets														
-Maximum Monthly	50	28.5	21.4	19.7	2.0						T	7.3	12.5	28.5
-Year		1940	1983	1960	1940						1979	1953	1958	JAN 1940
-Maximum in 24 hrs	50	21.6	16.8	12.1	2.0						T	7.3	7.5	21.6
-Year		1940	1983	1962	1940						1979	1953	1966	JAN 1940
WIND:														
Mean Speed (mph)	39	8.1	8.5	9.0	8.9	7.8	7.3	6.7	6.4	6.6	6.9	7.4	7.7	7.6
Prevailing Direction through 1963		S	NNE	W	S	SSW	S	SSW	S	S	NNE	S	SW	S
Fastest Mile														
-Direction (!!!)	32	NW	SW	SE	NW	N	NW	NW	W	SE	SE	NW	SW	SE
-Speed (MPH)	32	43	45	42	40	45	52	56	54	45	68	38	40	68
-Year		1971	1951	1952	1972	1962	1952	1955	1964	1952	1954	1977	1968	OCT 1954
Peak Gust														
-Direction (!!!)	3	NW	NW	NE	W	SW	NW	N	NW	SW	SW	SE	W	N
-Speed (mph)	3	48	48	43	48	55	53	61	44	36	40	43	41	61
-Date		1985	1987	1987	1984	1984	1987	1986	1986	1987	1987	1985	1985	JUL 1986

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Table 2.3-4
MEAN ANNUAL METEOROLOGICAL DATA FOR STATIONS IN THE SITE REGION

	Mean Annual Temperature (°F)	Mean Annual Precipitation (in.)	Mean Annual Snowfall (in.)
Charlottesville	56.8	45.72	24.2
Fredericksburg	56.2	40.99	17.7
Louisa	56.3	41.62	19.9
Piedmont Research Station	55.9	38.68	22.0
Partlow	55.2	42.24	18.6

Table 2.3-5
COMPARISON OF MEAN TEMPERATURE DATA FOR NORTH ANNA, RICHMOND, PARTLOW, AND LOUISA (°F) (SEPTEMBER 16, 1971–SEPTEMBER 15, 1972)

Month	North Anna	Richmond	Partlow	Louisa
January (1972)	36.6	40.7	37.6	39.5
February (1972)	33.6	37.6	35.5	36.2
March (1972)	43.0[a]	47.2	45.1	46.3[a]
April (1972)	54.7[a]	56.2	54.1	55.0
May (1972)	62.4	64.6	62.4	62.1
June (1972)	68.3	70.1	69.5	68.1
July (1972)	75.0	77.1	77.0	74.8
August (1972)	72.9	75.2	73.1	72.8
September (16-30, 1971; 1-15, 1972)	68.2[a]	69.6	(b)	(b)
October (1971)	62.8	64.6	63.9	63.0[a]
November (1971)	45.8[a]	48.5	46.6[a]	47.1
December (1971)	46.3[a]	48.0	46.8	46.2

a. One or more days of data missing.

b. Data not available.

Table 2.3-6
NORTH ANNA MEAN WIND SPEEDS (MPH) 1974-1987

Elevation	Spring (Mar, Apr, May)	Summer (Jun, Jul, Aug)	Fall (Sept, Oct, Nov)	Winter (Dec, Jan, Feb)	Annual
Upper Level	9.6	7.5	8.3	9.2	8.6
Lower Level	7.1	5.4	5.9	6.6	6.3

Table 2.3-7
HORIZONTAL (σ_θ RH) STABILITY CATEGORIES

Stability Category	Range of Standard Deviation (degrees)	Atmospheric Turbulence
A = extremely unstable	$\sigma_\theta \geq 22.5$	High
B = unstable	$22.5 > \sigma_\theta \geq 17.5$	High
C = slightly unstable	$17.5 > \sigma_\theta \geq 12.5$	High
D = neutral	$12.5 > \sigma_\theta \geq 7.5$	Moderate
E = slightly stable	$7.5 > \sigma_\theta \geq 3.8$	Low
F = stable	$3.8 > \sigma_\theta \geq 1.3$	Low
G = extremely stable	$1.3 > \sigma_\theta$	Low

Table 2.3-8
VERTICAL (ΔT) STABILITY CATEGORIES

Stability Category	Range of Vertical Temperature Gradient (°C/100 m)	(°F/1000 ft)	Atmospheric Turbulence
A = very unstable	$\Delta T < -1.9$	$\Delta T < -10.4$	High
B = moderately unstable	$-1.9 \leq \Delta T < -1.7$	$-10.4 \leq \Delta T < -9.3$	High
C = slightly unstable	$-1.7 \leq \Delta T < -1.5$	$-9.3 \leq \Delta T < -8.2$	High
D = neutral	$-1.5 \leq \Delta T < -0.5$	$-8.2 \leq \Delta T < -2.7$	Moderate
E = slightly stable	$-0.5 \leq \Delta T < 1.5$	$-2.7 \leq \Delta T < 8.2$	Low
F = moderately stable	$1.5 \leq \Delta T < 4.0$	$8.2 \leq \Delta T < 22.0$	Low
G = very stable	$4.0 \leq \Delta T$	$22.0 \leq \Delta T$	Low

Table 2.3-9
NORTH ANNA LOWER LEVEL HORIZONTAL (S_t) STABILITY
AND WIND SPEED DISTRIBUTION 1978-1987

	Horizontal Stability Categories						
Period	A	B	C	D	E	F	G
Spring							
Frequency (%)	5.92	6.81	22.82	34.08	23.20	6.00	1.18
Wind speed (mph)	(6.1)	(9.0)	(10.9)	(10.1)	(8.9)	(7.8)	(7.1)
Summer							
Frequency (%)	8.64	10.02	27.10	34.01	17.05	2.93	0.73
Wind speed (mph)	(5.6)	(7.0)	(7.9)	(7.4)	(7.1)	(6.8)	(6.4)
Fall							
Frequency (%)	6.75	8.71	25.93	37.79	19.05	1.96	0.30
Wind speed (mph)	(5.8)	(7.5)	(8.8)	(8.5)	(7.6)	(5.6)	(5.2)
Winter							
Frequency (%)	4.61	7.42	28.64	39.10	18.51	1.95	0.25
Wind speed (mph)	(6.0)	(8.7)	(10.1)	(9.3)	(8.8)	(5.1)	(3.6)
Annual							
Frequency (%)	6.47	8.23	26.07	36.15	19.39	3.20	0.61
Wind speed (mph)	(5.8)	(7.9)	(9.4)	(8.8)	(8.2)	(6.8)	(6.3)

Table 2.3-10
NORTH ANNA UPPER LEVEL HORIZONTAL (S_t) STABILITY
AND WIND SPEED DISTRIBUTION 1978-1987

	Horizontal Stability Categories						
Period	A	B	C	D	E	F	G
Spring							
Frequency (%)	3.03	2.35	6.55	29.54	38.99	13.75	5.79
Wind speed (mph)	(5.2)	(5.8)	(7.5)	(10.1)	(10.2)	(8.9)	(8.3)
Summer							
Frequency (%)	4.67	3.72	9.84	35.49	35.64	7.98	3.12
Wind speed (mph)	(5.1)	(5.3)	(6.0)	(7.6)	(7.9)	(7.7)	(6.9)
Fall							
Frequency (%)	3.16	2.70	8.31	35.49	38.96	8.04	3.78
Wind speed (mph)	(4.8)	(5.3)	(6.1)	(8.5)	(8.6)	(7.1)	(6.9)
Winter							
Frequency (%)	2.07	2.07	6.20	37.13	40.25	8.60	4.14
Wind speed (mph)	(4.9)	(4.9)	(5.8)	(9.5)	(10.1)	(8.3)	(7.5)
Annual							
Frequency (%)	3.22	2.70	7.71	34.35	39.38	9.55	4.19
Wind speed (mph)	(5.0)	(5.3)	(6.3)	(8.9)	(9.3)	(8.1)	(7.5)

Table 2.3-11
NORTH ANNA VERTICAL STABILITY (dT) AND
LOWER LEVEL WIND SPEED DISTRIBUTION 1974-1987

	Vertical Stability Categories						
Period	A	B	C	D	E	F	G
Spring							
Frequency (%)	20.04	5.41	4.86	29.87	24.18	7.92	7.71
Wind speed (mph)	(8.6)	(8.4)	(8.6)	(7.9)	(6.3)	(4.0)	(2.9)
Summer							
Frequency (%)	25.33	5.38	5.10	29.52	27.21	6.42	1.44
Wind speed (mph)	(6.1)	(6.2)	(6.2)	(5.7)	(4.3)	(3.2)	(2.9)
Fall							
Frequency (%)	21.28	4.16	4.25	28.71	25.57	10.26	6.14
Wind speed (mph)	(6.9)	(7.1)	(7.4)	(6.8)	(4.9)	(3.4)	(3.2)
Winter							
Frequency (%)	13.39	4.82	4.85	35.10	27.55	8.09	6.60
Wind speed (mph)	(7.6)	(7.8)	(8.2)	(7.4)	(5.6)	(3.5)	(2.8)
Annual							
Frequency (%)	20.00	4.91	4.74	30.69	26.08	8.22	5.46
Wind speed (mph)	(7.2)	(7.4)	(7.6)	(7.0)	(5.2)	(3.5)	(3.0)

Table 2.3-12
NORTH ANNA JOINT FREQUENCY OF LOWER LEVEL HORIZONTAL (S_t)
STABILITY AND VERTICAL (dT) STABILITY GIVEN IN PERCENT 1978-1987

		Vertical (dT) Stability						
		A	B	C	D	E	F	G
Lower Level	A	1.49	0.32	0.35	2.01	1.71	0.58	0.39
Horizontal (S_t)	B	2.66	0.45	0.44	2.49	1.87	0.39	0.25
Stability	C	7.16	1.38	1.51	8.71	6.61	1.11	0.52
	D	7.59	1.94	1.75	11.25	9.55	2.63	1.27
	E	1.83	0.66	0.78	5.14	4.99	2.42	2.09
	F	0.29	0.06	0.07	0.60	0.87	0.59	0.60
	G	0.07	0.02	0.01	0.09	0.21	0.12	0.11

Table 2.3-13
BENDIX WIND INSTRUMENTATION PERFORMANCE CHARACTERISTICS

	Threshold		Accuracy		Distance Constant		Damping Ratio
Instrumentation	Speed	Direction	Speed	Direction	Speed	Direction	
Aerovane Model 120 transmitter							
3-bladed prop	2.5-3.0 mph	(a)	From 3-45 mph, ±1.75 mph; from 45-100 mph, ±3 mph	±1.5°	15 ft	34 ft	0.3
6-bladed prop	1.75-2.0 mph	(a)	From 2-45 mph, ±1.75 mph; from 45-100 mph, ±3 mph	±1.5°	15 ft	34 ft	0.3
Low threshold system	0.5 mph	<1.0 mph	±1% linearity (full scale)	±1.5°	6 ft	6 ft	0.5
Model 141 recorder			±1% (full scale)	±1.5°			

a. Data not available.

Table 2.3-14
METEOROLOGICAL DATA RECOVERY RATE (%)
(NORTH ANNA, SEPTEMBER 16, 1971–SEPTEMBER 15, 1972)

	150-ft Wind Data	35-ft Low-Threshold Wind Data	Combined 35-ft Wind Data and $\Delta T_{150\text{-}35\ ft}$ Data	$\Delta T_{150\text{-}35\ ft}$ Data	$\Delta T_{35\ ft}$ Data
Spring	94	90	82	91	92
Summer	98	95	94	99	99
Fall	99	93	74	78	89
Winter	76	99	88	90	90
Annual	92	94	84	90	92

Table 2.3-15
PRIMARY TOWER PARAMETERS

	Transmitted Locations		
Parameter	PCS Data Base	Control Room	Remote Interrogation
Wind direction (upper)	X	X	X
Wind speed (upper)	X	X	X
Sigma theta (upper)			X
Wind direction (lower)	X	X	X
Wind speed (lower)	X	X	X
Sigma theta (lower)			X
Ambient temperature (lower)	X	X	X
Relative humidity (lower)			X
Delta ambient temperature (upper-lower)	X	X	X
Precipitation			X

Note: All parameters going to the PCS data base are available for printout in the TSC and EOF. The control room parameters are hardwired.

Table 2.3-16
BACKUP TOWER PARAMETERS

Parameter	PCS Data Base	Control Room	Remote Interrogation
Wind speed	X	X	X
Wind direction	X	X	X
Sigma theta	X	X	X

Note: All parameters going to the PCS data base will be available for printout in the TSC and EOF. The control room parameters are hardwired.

Table 2.3-17
0 TO 2 HR χ/Q PROBABILITY AT EXCLUSION DISTANCE (1350 M)
(NORTH ANNA, SEPTEMBER 16, 1971–SEPTEMBER 15, 1972)

χ/Q (sec/m^3)[a]	Wind Speed at 35 ft (mph)	σ_y (σ_θ 35 ft)[b]	σ_z (ΔT $_{150\text{-}35\ ft}$)[b]	F(%)	∑ F(%)
4.99×10^{-3}	Calm[c]	G[d]	G	0.28	0.28
2.64×10^{-3}	Calm[c]	F[d]	F	0.19	0.47
1.24×10^{-3}	Calm[c]	E[d]	E	0.16	0.63
1.24×10^{-3}	1.0	G	G	0.00	-
9.28×10^{-4}	1.0	G	F	0.00	-
9.28×10^{-4}	1.0	F	G	0.03	0.66
7.18×10^{-4}	Calm[c]	D[d]	D	0.04	0.70
7.03×10^{-4}	1.0	E	G	0.15	0.85
6.61×10^{-4}	1.0	F	F	0.01	0.86
6.35×10^{-4}	1.0	G	E	0.01	0.87
6.22×10^{-4}	2.0	G	G	0.00	-
5.70×10^{-4}	1.0	D	G	0.30	1.17
4.88×10^{-4}	1.0	G	D	0.00	-
4.85×10^{-4}	1.0	E	F	0.01	1.18
4.64×10^{-4}	2.0	G	F	0.01	1.19
4.64×10^{-4}	2.0	F	G	0.05	1.24
4.34×10^{-4}	1.0	F	E	0.00	-
4.15×10^{-4}	3.0	G	G	0.00	-
4.01×10^{-4}	1.0	C	G	0.25	1.49
3.86×10^{-4}	1.0	D	F	0.26	1.75
3.52×10^{-4}	2.0	E	G	0.30	2.05
3.30×10^{-4}	2.0	F	F	0.10	2.15
3.27×10^{-4}	1.0	F	D	0.01	2.16
3.17×10^{-4}	2.0	G	E	0.00	-
3.11×10^{-4}	4.0	G	G	0.00	-
3.10×10^{-4}	1.0	E	E	0.12	2.28
3.09×10^{-4}	3.0	G	F	0.00	-

a. Includes a building wake factor (758 m^2).
b. Key: A = extremely unstable; B = unstable; C = slightly unstable; D = neutral; E = slightly stable; F = stable; G = extremely stable.
c. An arbitrary wind speed of 0.25 mph is assumed.
d. Based on delta T data.

Table 2.3-17 (continued)
0 TO 2 HR χ/Q PROBABILITY AT EXCLUSION DISTANCE (1350 M)
(NORTH ANNA, SEPTEMBER 16, 1971–SEPTEMBER 15, 1972)

χ/Q (sec/m^3)[a]	Wind Speed at 35 ft (mph)	σ_y (σ_θ 35 ft)[b]	σ_z ($\Delta T_{150\text{-}35\ ft}$)[b]	F(%)	∑ F(%)
3.09×10^{-4}	3.0	F	G	0.15	2.43
2.92×10^{-4}	1.0	B	G	0.22	2.65
2.85×10^{-4}	2.0	D	G	0.64	3.29
2.65×10^{-4}	1.0	C	F	0.12	3.41
2.49×10^{-4}	5.0	G	G	0.00	-
2.44×10^{-4}	2.0	G	D	0.00	-
2.43×10^{-4}	1.0	D	E	0.25	3.66
2.43×10^{-4}	1.0	G	C	0.00	-
2.43×10^{-4}	2.0	E	F	0.30	3.96
2.34×10^{-4}	3.0	E	G	0.38	4.34
2.32×10^{-4}	4.0	G	F	0.00	-
2.32×10^{-4}	4.0	F	G	0.08	4.42
2.31×10^{-4}	1.0	E	D	0.03	4.45
2.26×10^{-4}	1.0	A	G	0.39	4.84
2.24×10^{-4}	Calm[c]	C[d]	C	0.01	4.85
2.20×10^{-4}	3.0	F	F	0.09	4.94
2.17×10^{-4}	2.0	F	E	0.01	4.95
2.12×10^{-4}	3.0	G	F	0.01	4.96
2.07×10^{-4}	6.0	G	G	0.00	-
2.00×10^{-4}	2.0	C	G	0.36	5.32

a. Includes a building wake factor (758 m^2).
b. Key: A = extremely unstable; B = unstable; C = slightly unstable; D = neutral; E = slightly stable; F = stable; G = extremely stable.
c. An arbitrary wind speed of 0.25 mph is assumed.
d. Based on delta T data.

Table 2.3-18
CONDITIONS FOR A 0-MIN TO 60-MIN HYPOTHETICAL ACCIDENT
(NORTH ANNA, SEPTEMBER 16, 1971–SEPTEMBER 15, 1972)

Time Interval	Stability Category	Wind Speed	Wind Conditions
0-60 min.	F	1.0 m/sec	Invariant

Table 2.3-19
SITE HYPOTHETICAL ACCIDENT DILUTION FACTORS (χ/Q SEC/M^3)
(NORTH ANNA, SEPTEMBER 16, 1971–SEPTEMBER 15, 1972)

Distance from Structure (m)	Postulated "F" 1-m/sec Condition[a]	5th Percentile "F" 1.5-m/sec Condition[a]
100	1.27×10^{-3}	8.58×10^{-4}
200	1.16×10^{-3}	7.81×10^{-4}
400	8.84×10^{-4}	5.97×10^{-4}
700	5.86×10^{-4}	3.96×10^{-4}
1000	4.16×10^{-4}	2.81×10^{-4}
1350	2.96×10^{-4}	2.00×10^{-4}
1609	2.38×10^{-4}	1.61×10^{-4}
1770	2.10×10^{-4}	1.42×10^{-4}
2000	1.79×10^{-4}	1.21×10^{-4}
4000	7.45×10^{-5}	5.03×10^{-5}
7000	3.77×10^{-5}	2.55×10^{-5}
9656	2.56×10^{-5}	1.74×10^{-5}
10,000	2.43×10^{-5}	1.64×10^{-5}
20,000	1.10×10^{-5}	7.43×10^{-6}
37,821	5.29×10^{-6}	3.58×10^{-6}
40,000	4.96×10^{-6}	3.35×10^{-6}
70,000	2.77×10^{-6}	1.87×10^{-6}
100,000	1.86×10^{-6}	1.26×10^{-6}

a. 0-60 minutes with building wake factor (758 m^2).

Figure 2.3-1
RAINFALL RECORDED IN THE PLANT SITE AREA
DURING TROPICAL STORM AGNES

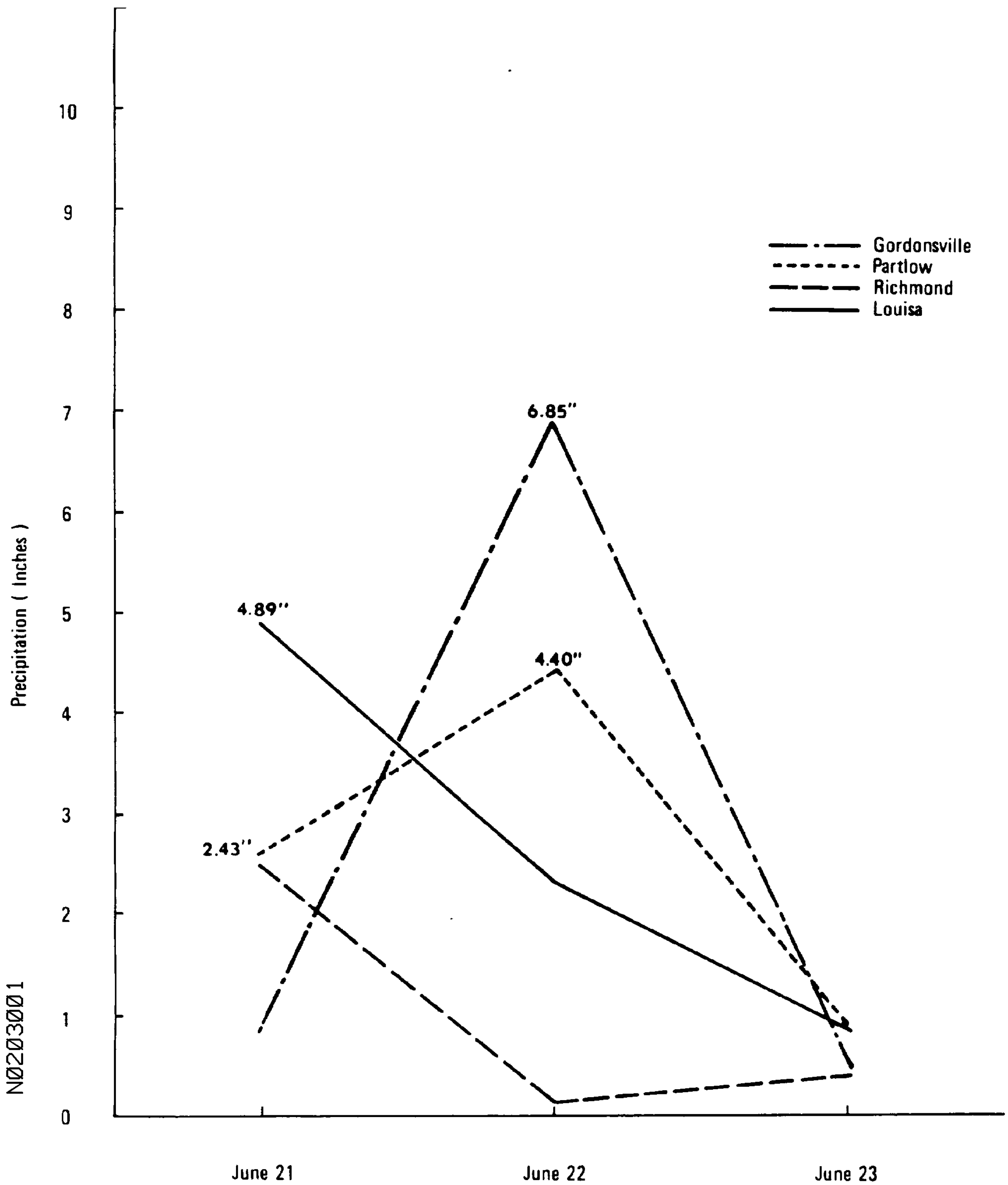
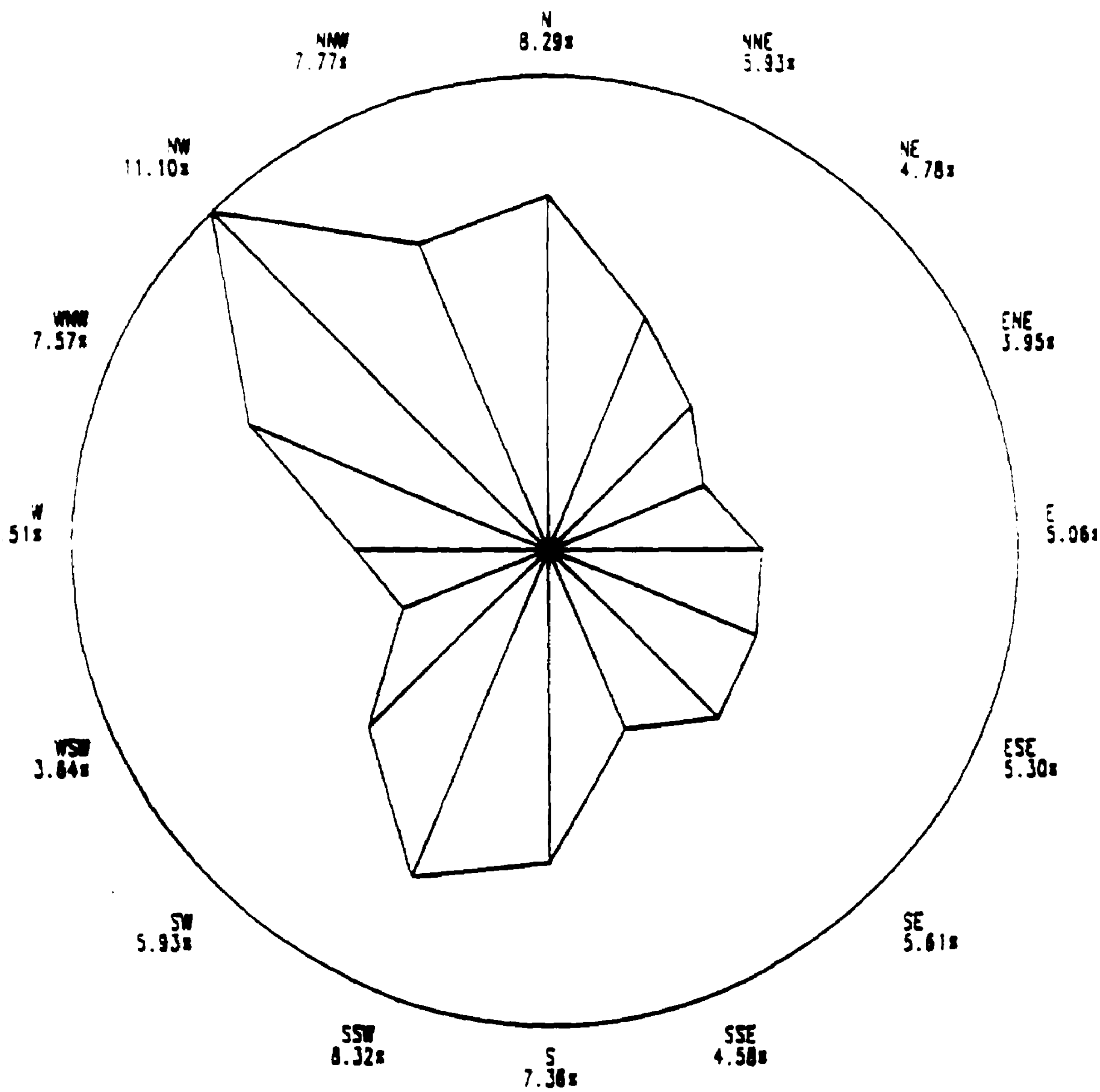
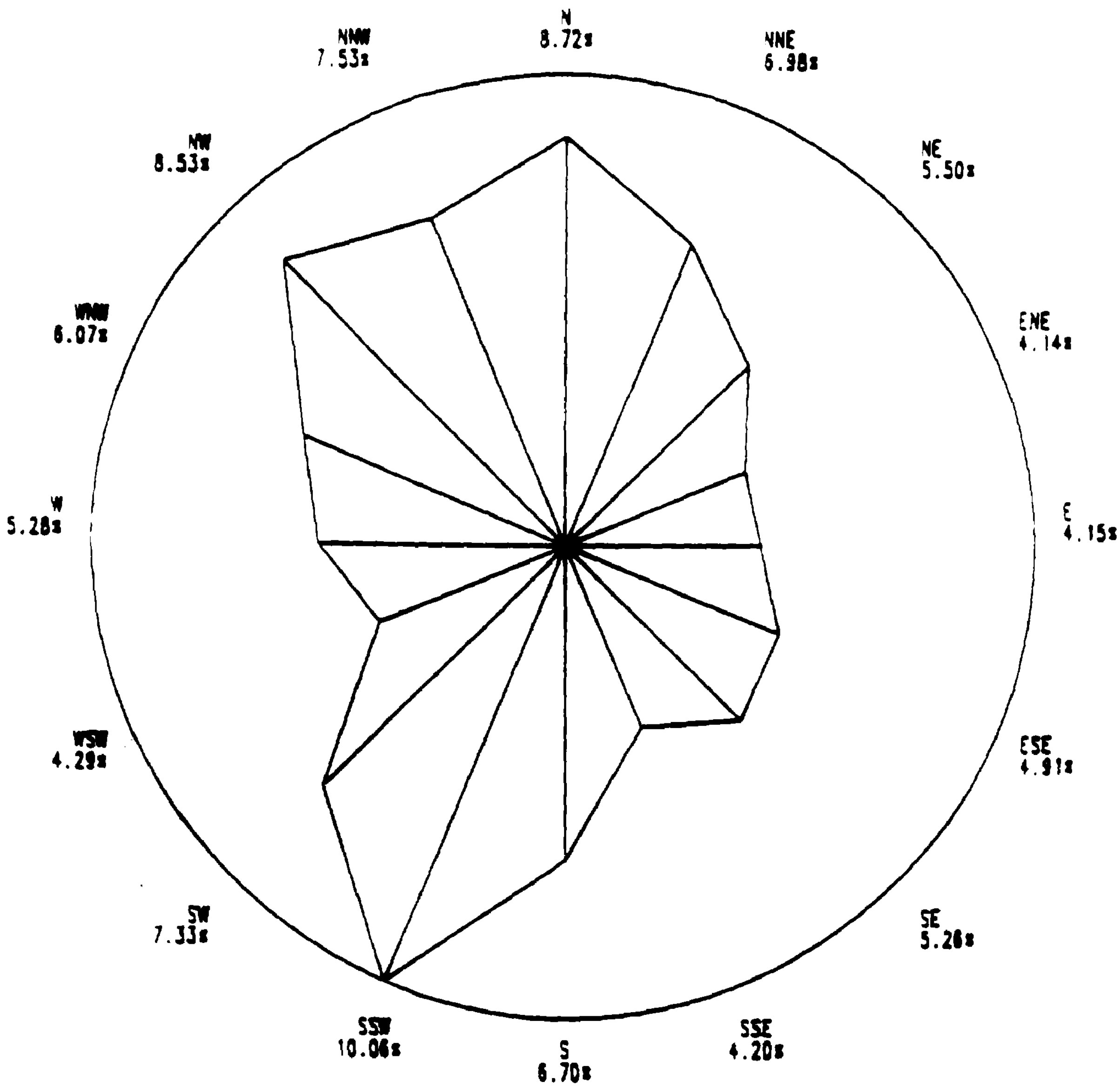


Figure 2.3-2
NORTH ANNA SEASONAL WIND DIRECTION ROSES
LOW LEVEL WINDS 1974–1987 SEASON = SPRING



Hours Calm = 60
Total Hours = 28,686
Percent Calm = 0.21 %

Figure 2.3-3
NORTH ANNA SEASONAL WIND DIRECTION ROSES
HIGH LEVEL WINDS 1974–1987 SEASON = SPRING



Hours Calm = 62
Total Hours = 23,572
Percent Calm = 0.26 %

Figure 2.3-4
NORTH ANNA SEASONAL WIND PERSISTENCE ROSES
LOW LEVEL WINDS 1974–1987 SEASON = SPRING

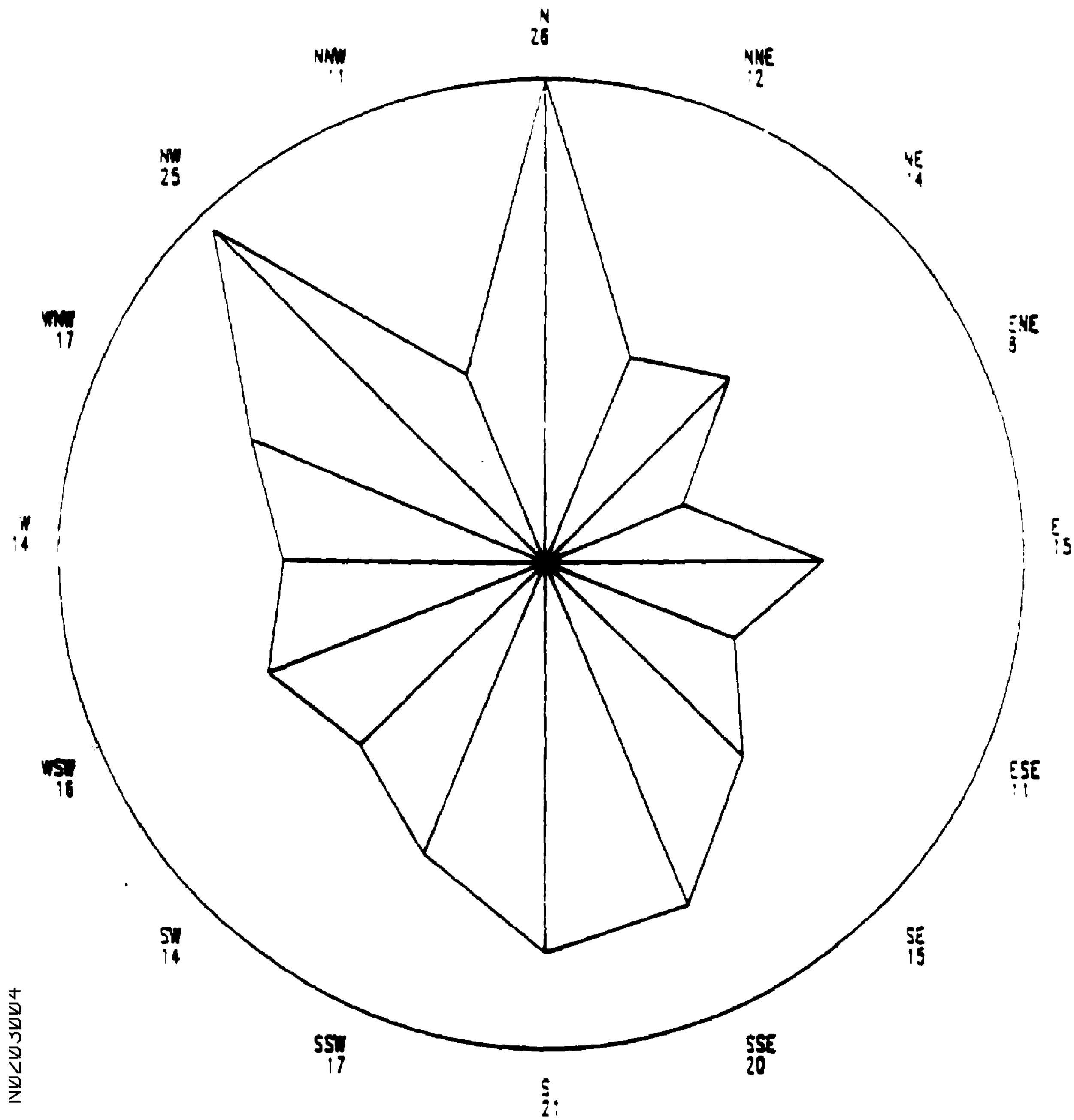


Figure 2.3-5
NORTH ANNA SEASONAL WIND PERSISTENCE ROSES
HIGH LEVEL WINDS 1974–1987 SEASON = SPRING

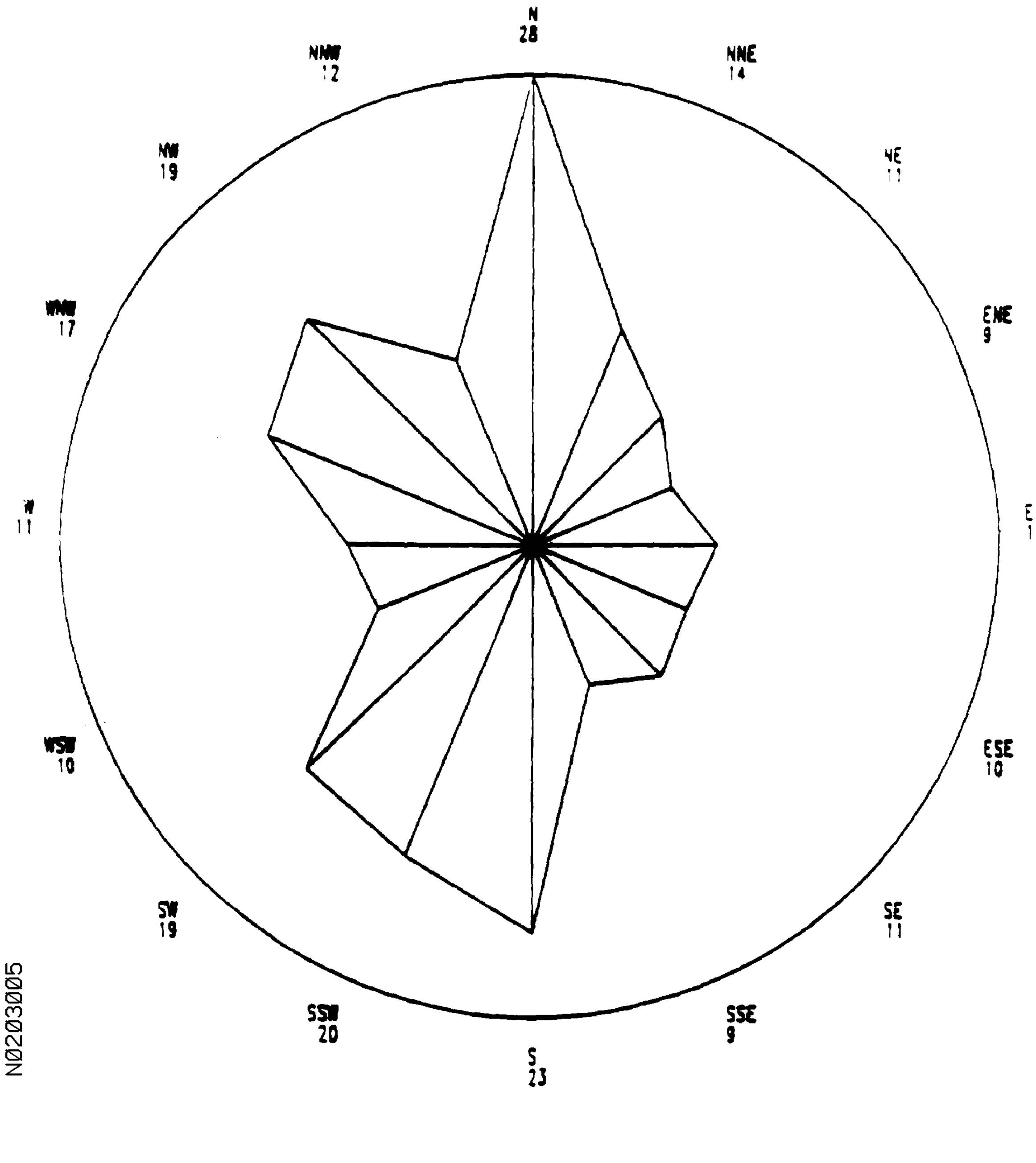
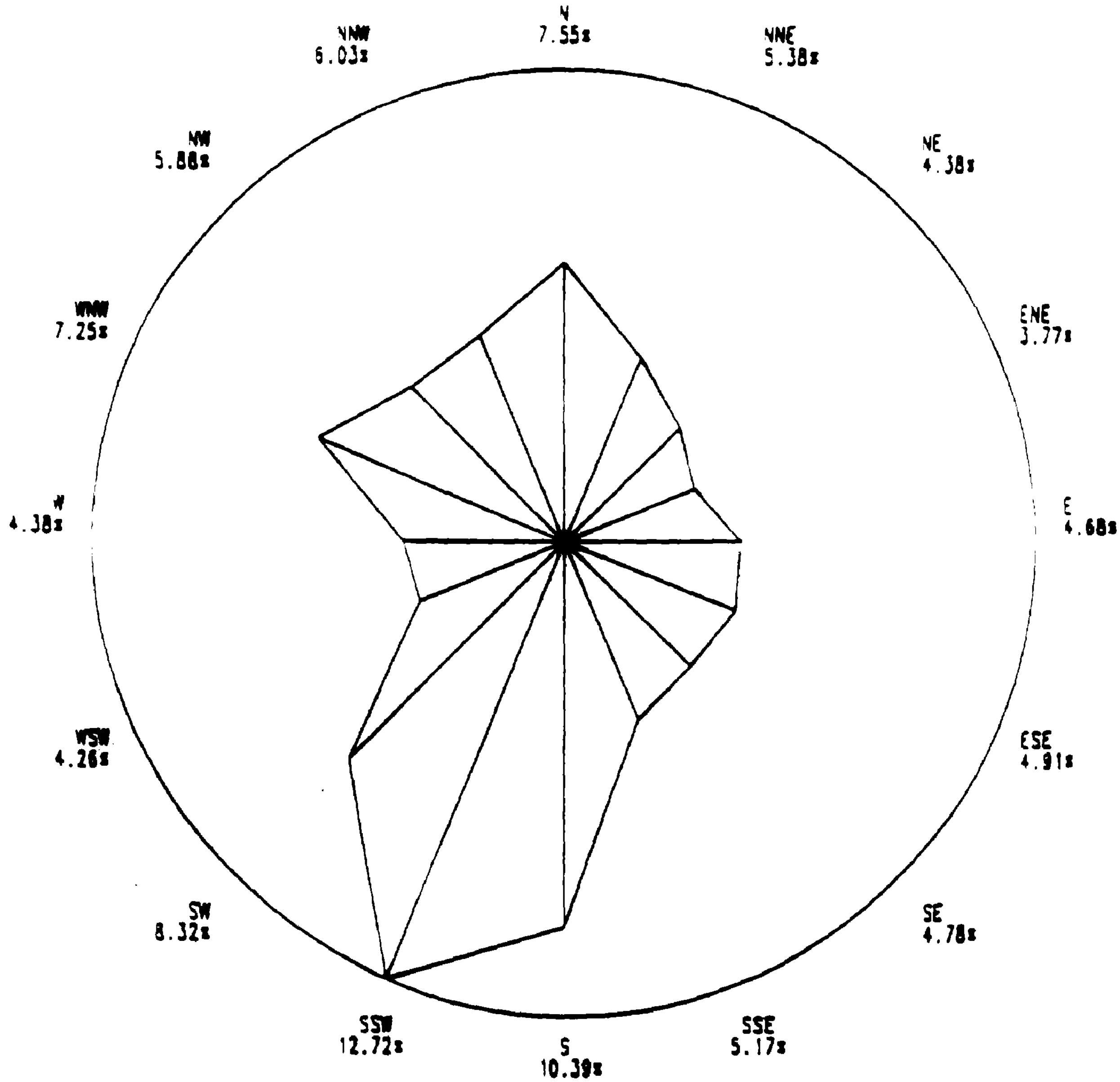


Figure 2.3-6
NORTH ANNA SEASONAL WIND DIRECTION ROSES
LOW LEVEL WINDS 1974–1987 SEASON = SUMMER



N0203006

Hours Calm = 22
Total Hours = 26,380
Percent Calm = 0.08 %

Figure 2.3-7
NORTH ANNA SEASONAL WIND DIRECTION ROSES
HIGH LEVEL WINDS 1974–1987 SEASON = SUMMER

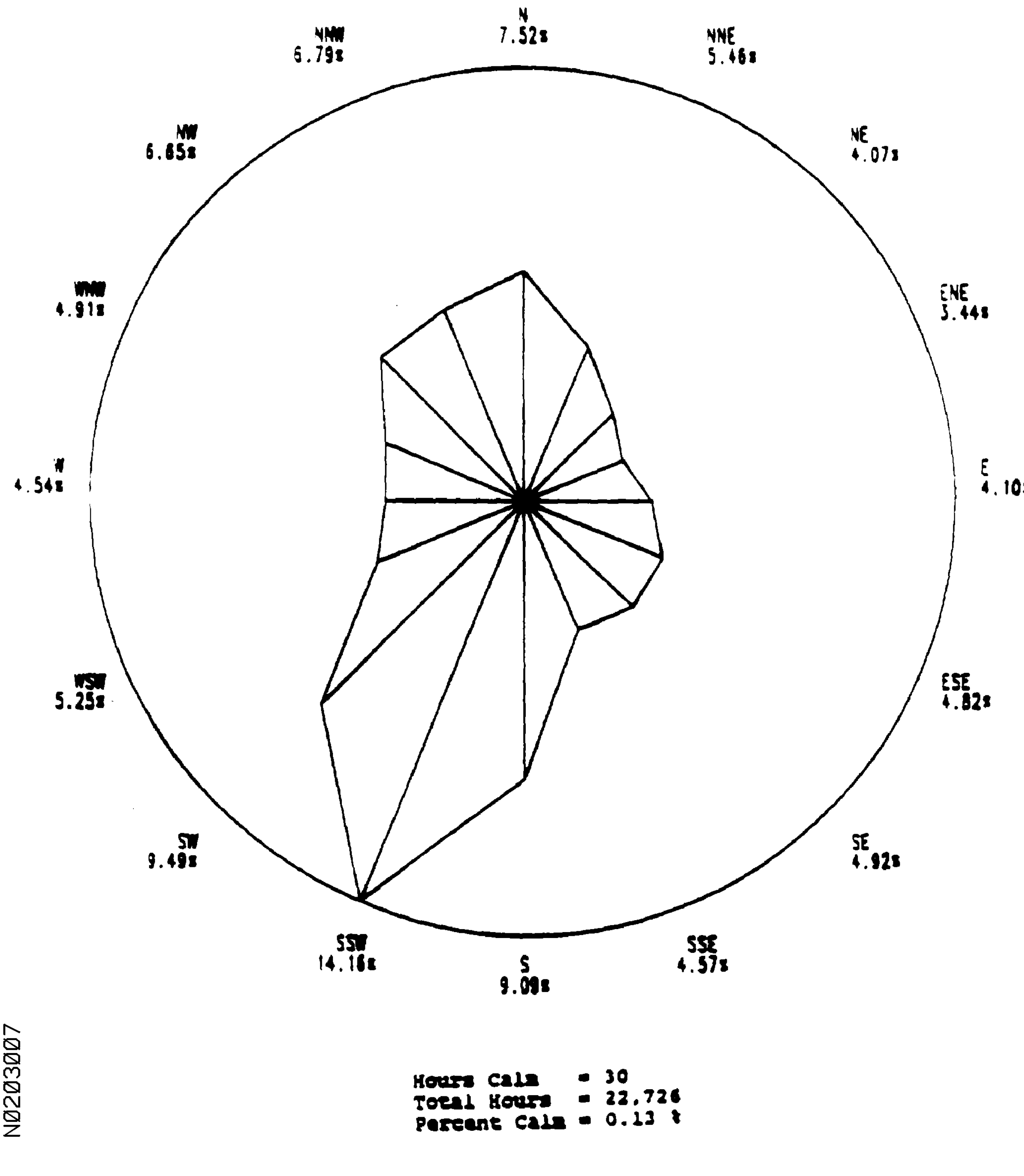
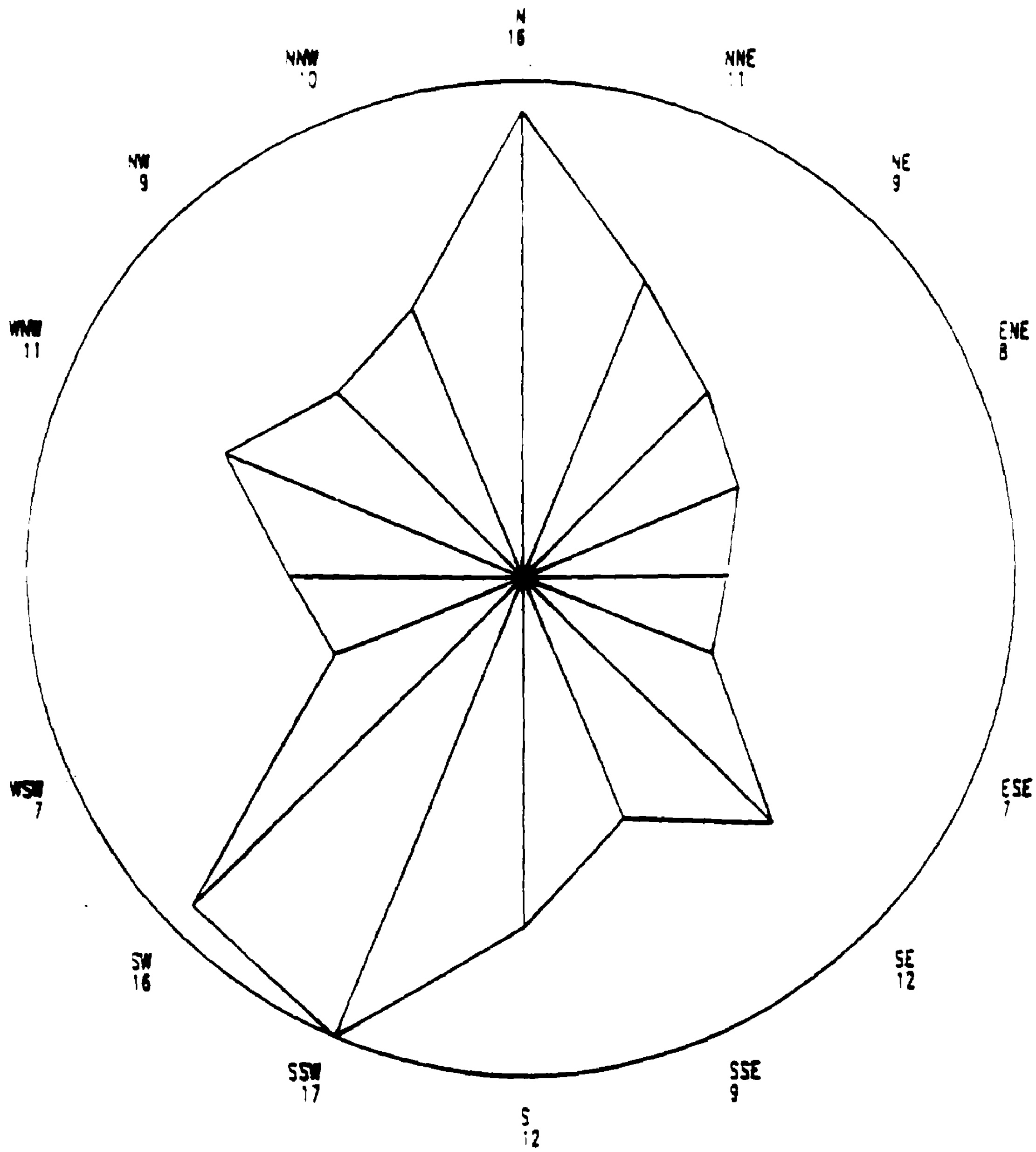


Figure 2.3-8
NORTH ANNA SEASONAL WIND PERSISTENCE ROSES
LOW LEVEL WINDS 1974–1987 SEASON = SUMMER



N0203008

Figure 2.3-9
NORTH ANNA SEASONAL WIND PERSISTENCE ROSES
HIGH LEVEL WINDS 1974–1987 SEASON = SUMMER

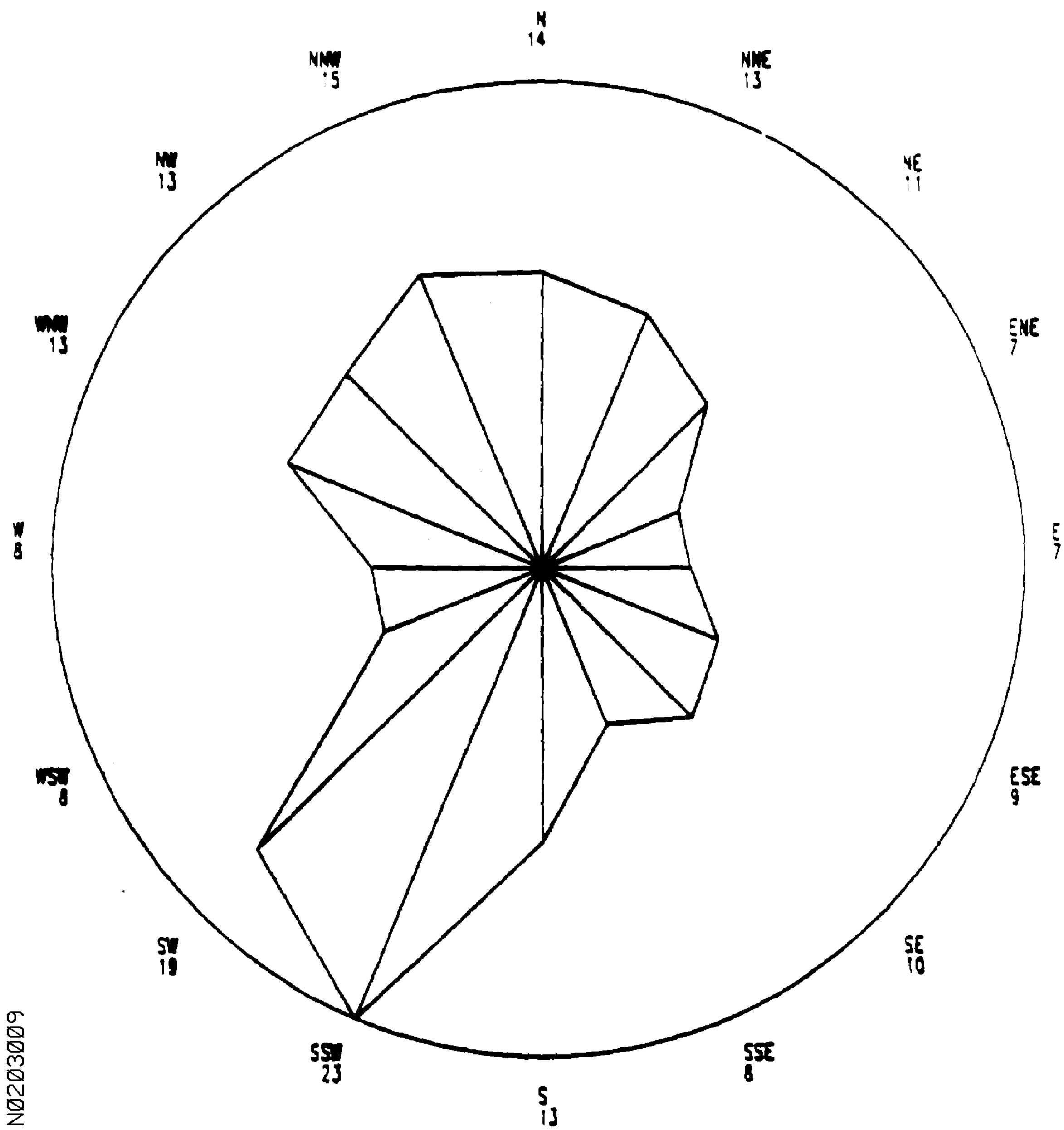
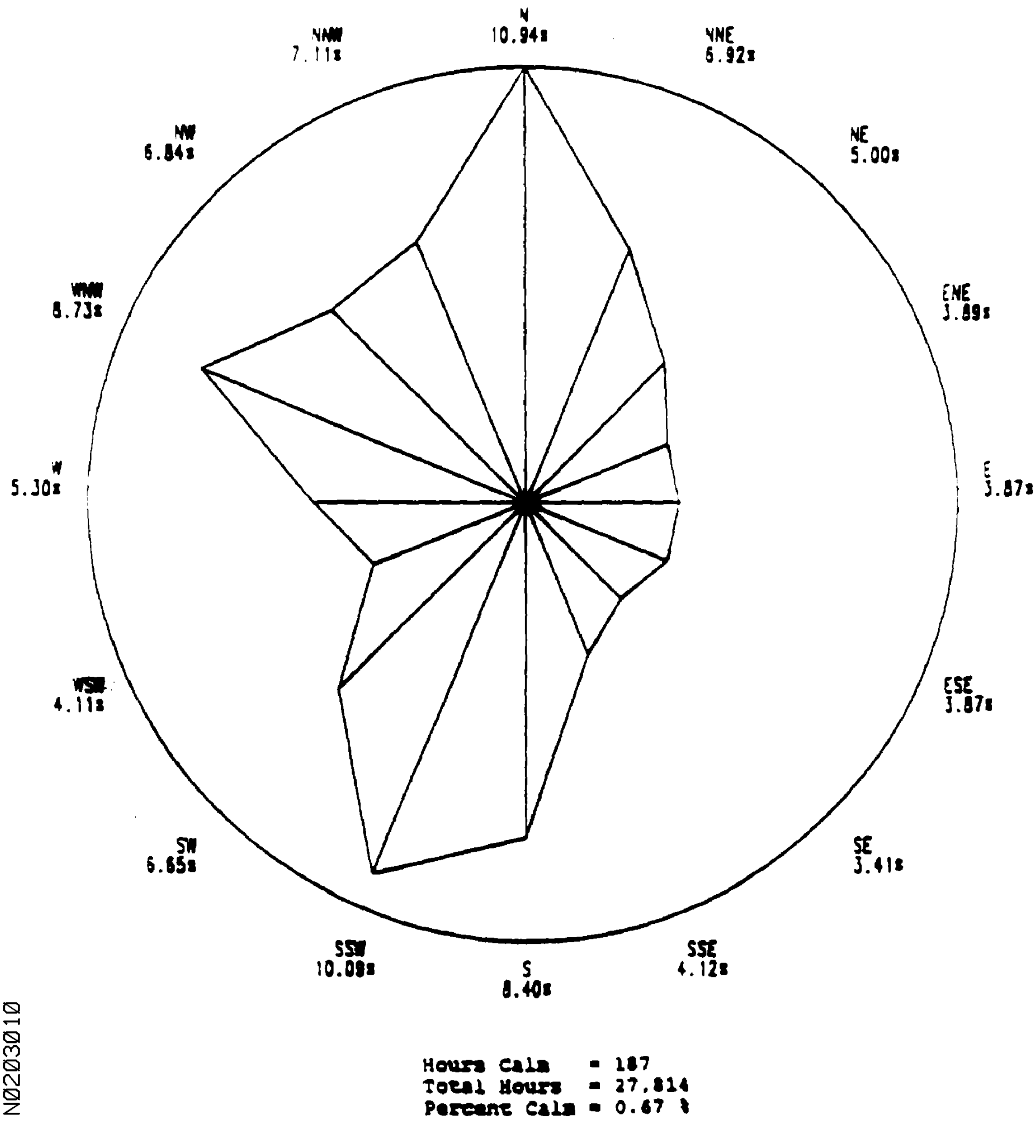
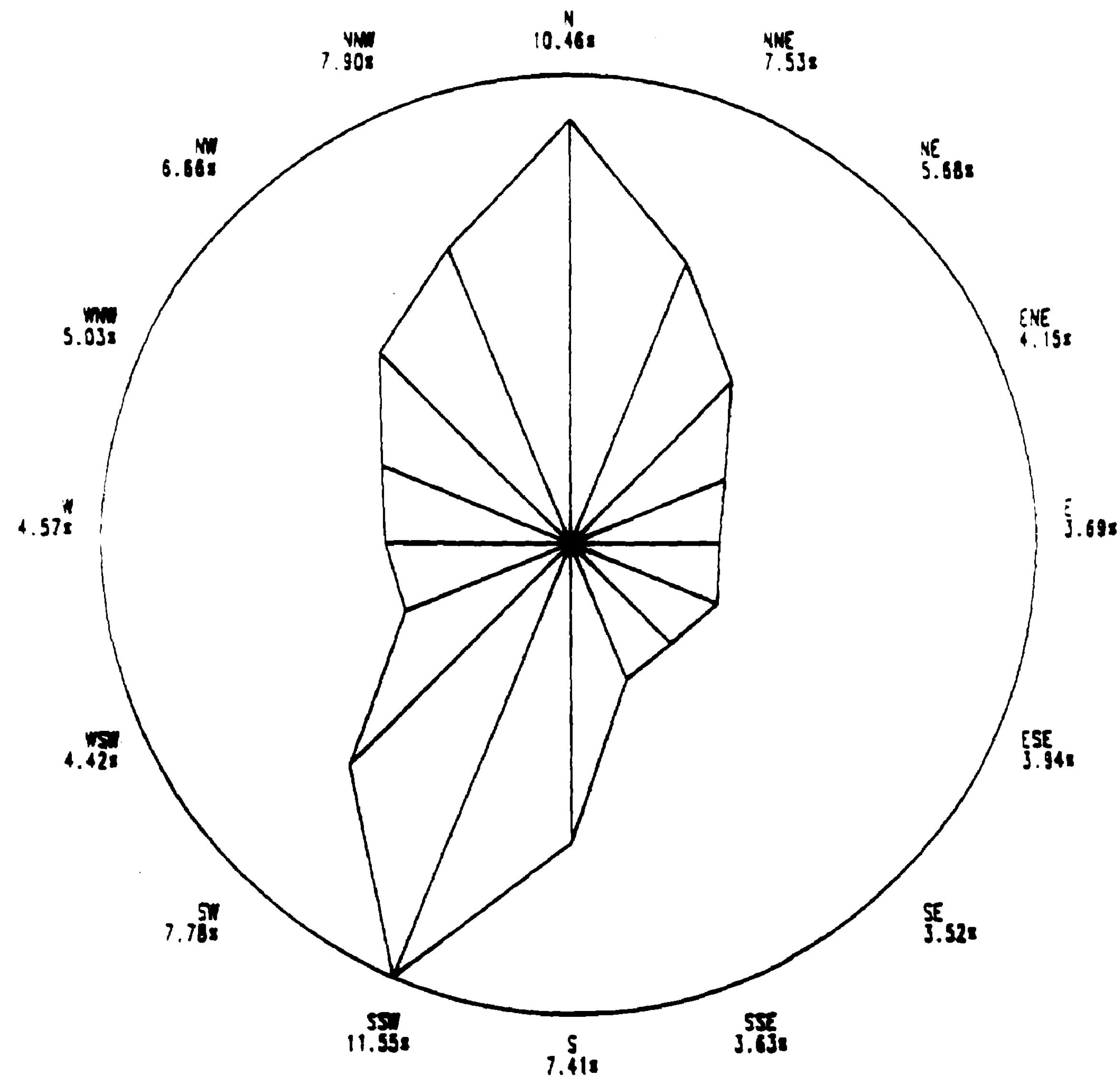


Figure 2.3-10
NORTH ANNA SEASONAL WIND DIRECTION ROSES
LOW LEVEL WINDS 1974–1987 SEASON = FALL



N0203010

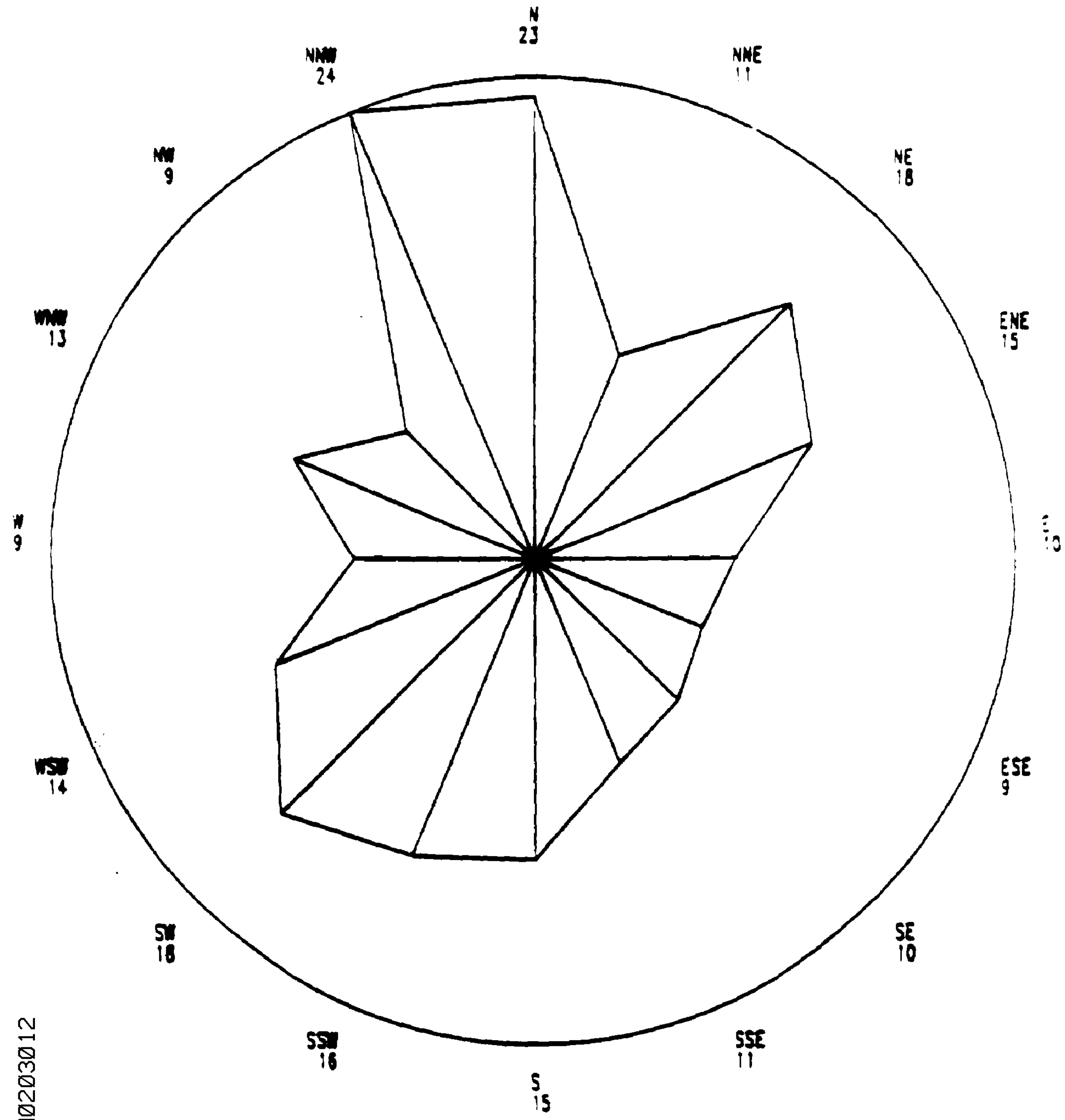
Figure 2.3-11
NORTH ANNA SEASONAL WIND DIRECTION ROSES
HIGH LEVEL WINDS 1974–1987 SEASON = FALL



N0203011

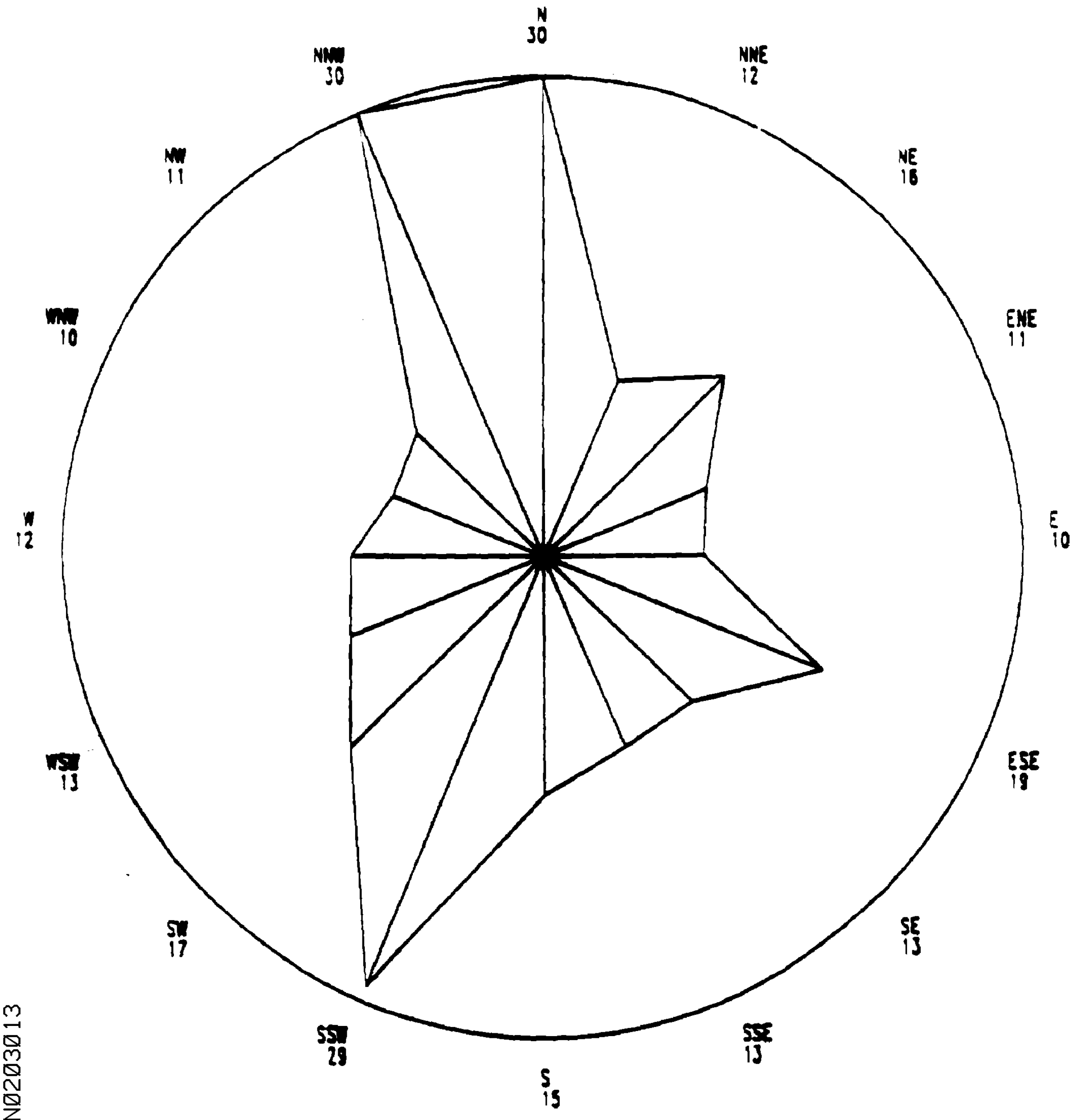
Hours Calm = 476
Total Hours = 23,649
Percent Calm = 2.01 %

Figure 2.3-12
NORTH ANNA SEASONAL WIND PERSISTENCE ROSES
LOW LEVEL WINDS 1974–1987 SEASON = FALL



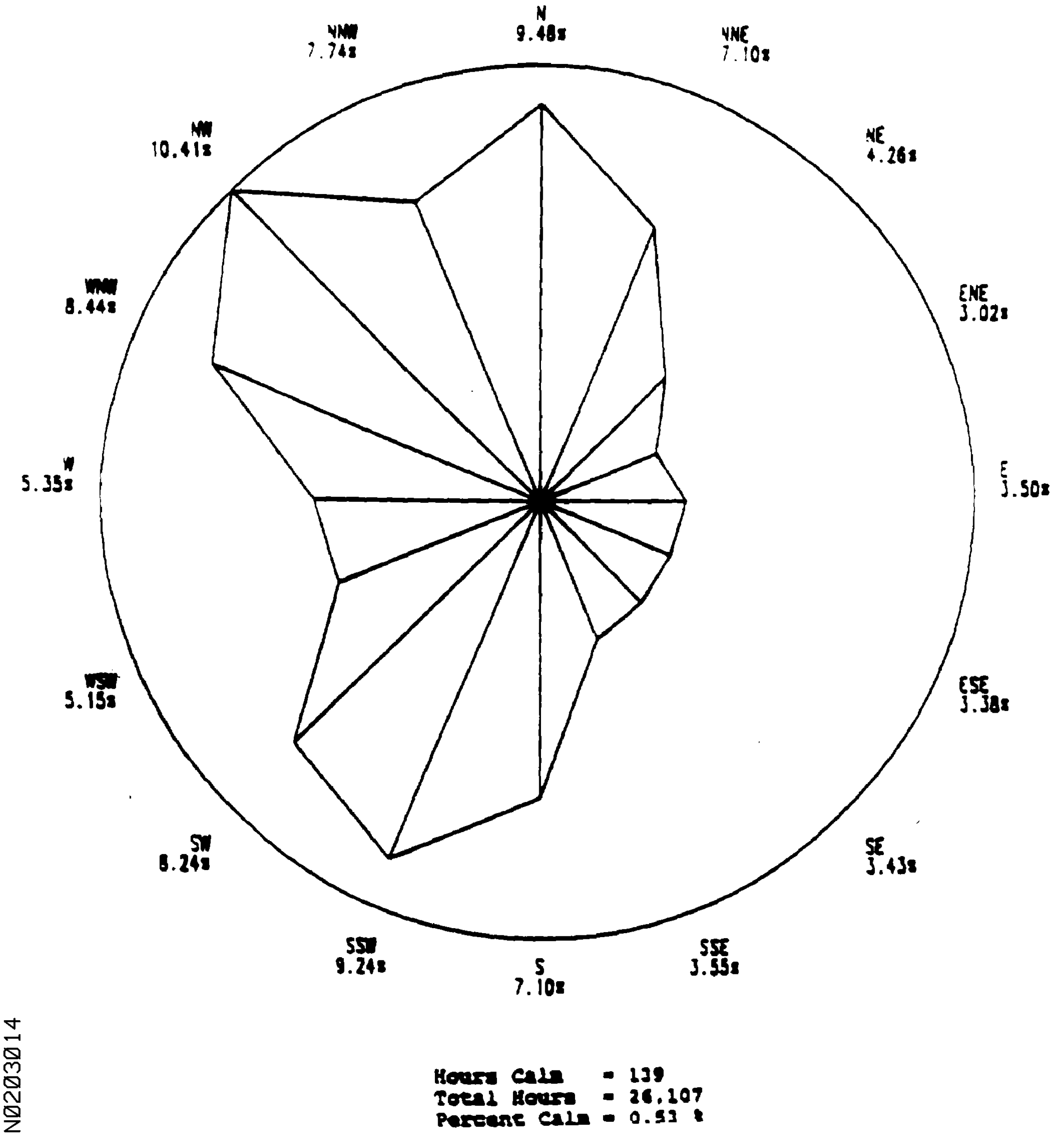
N0203012

Figure 2.3-13
NORTH ANNA SEASONAL WIND PERSISTENCE ROSES
HIGH LEVEL WINDS 1974–1987 SEASON = FALL



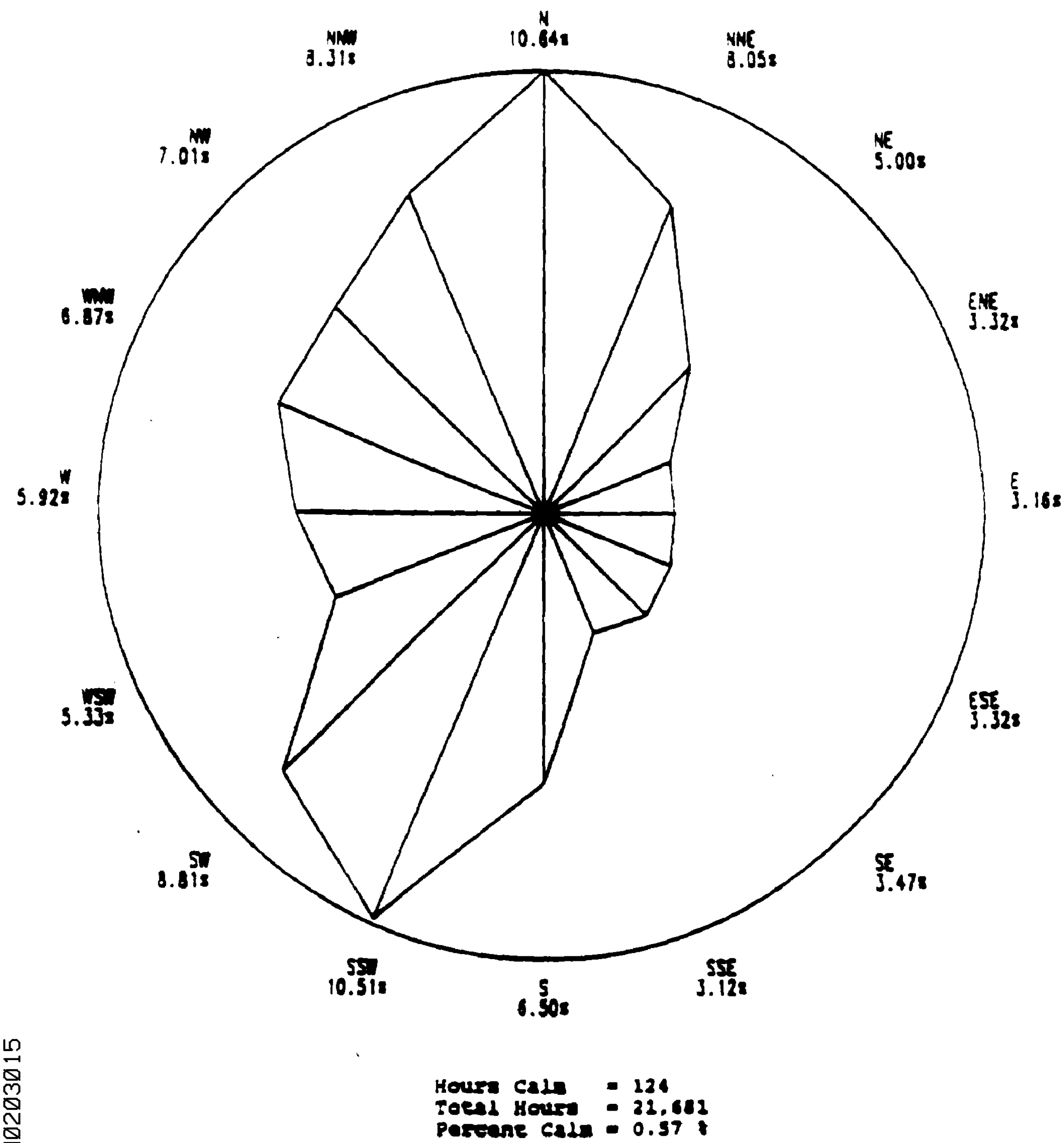
N0203013

Figure 2.3-14
NORTH ANNA SEASONAL WIND DIRECTION ROSES
LOW LEVEL WINDS 1974–1987 SEASON = WINTER



Hours Calm = 139
Total Hours = 26,107
Percent Calm = 0.53 %

Figure 2.3-15
NORTH ANNA SEASONAL WIND DIRECTION ROSES
HIGH LEVEL WINDS 1974–1987 SEASON = WINTER



N0203015

Figure 2.3-16
NORTH ANNA SEASONAL WIND PERSISTENCE ROSES
LOW LEVEL WINDS 1974–1987 SEASON = WINTER

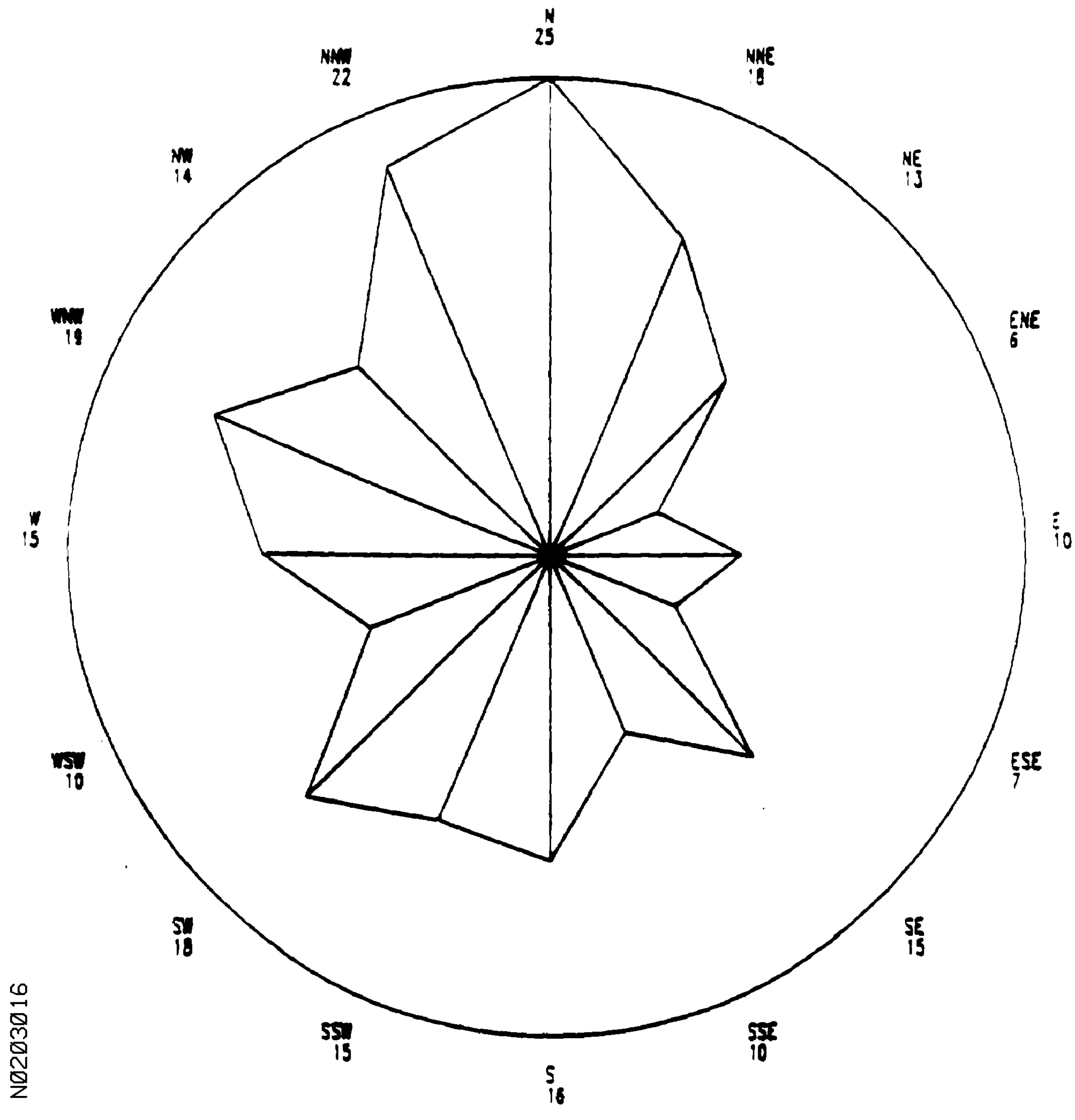


Figure 2.3-17
NORTH ANNA SEASONAL WIND PERSISTENCE ROSES
HIGH LEVEL WINDS 1974–1987 SEASON = WINTER

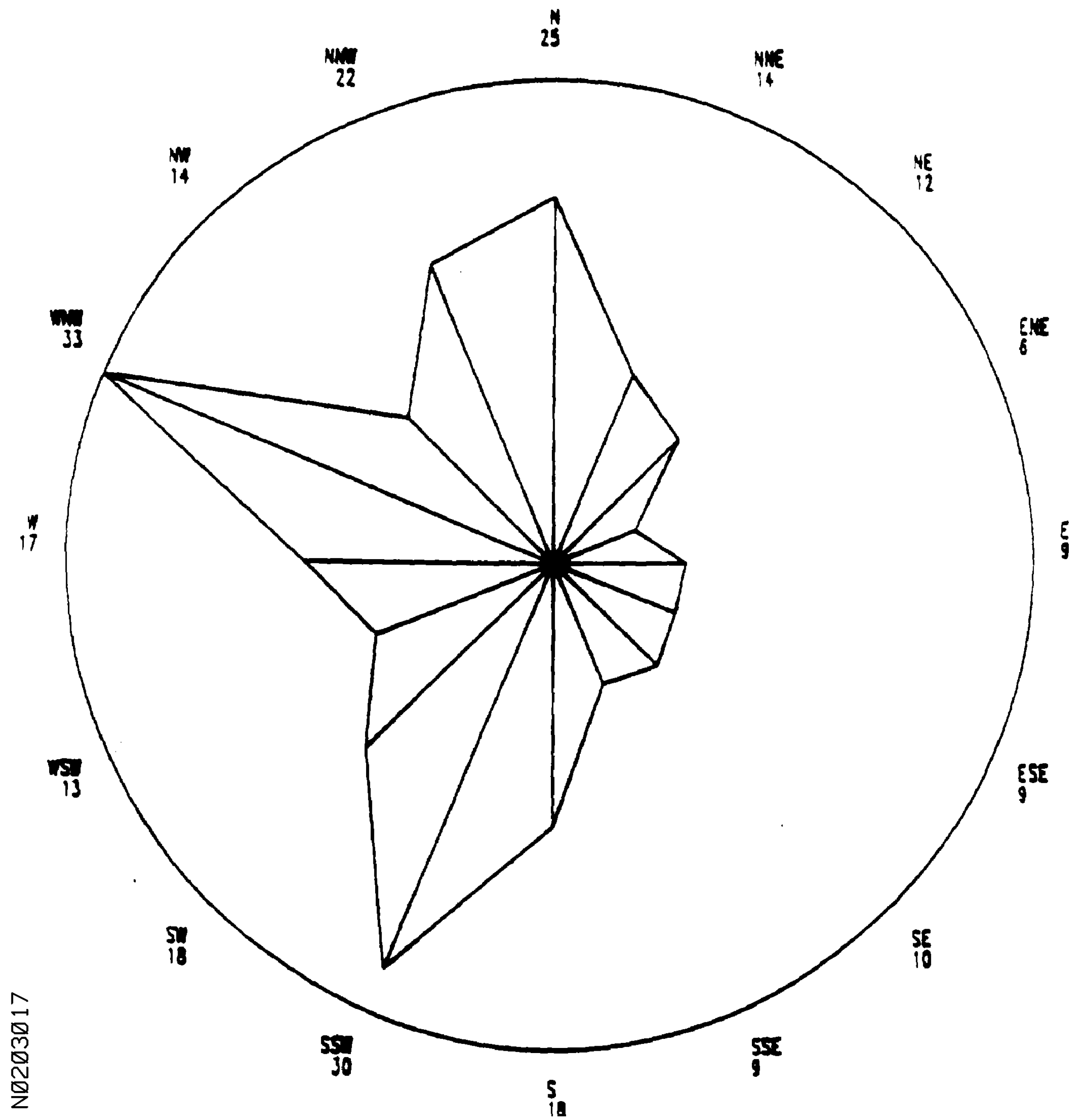
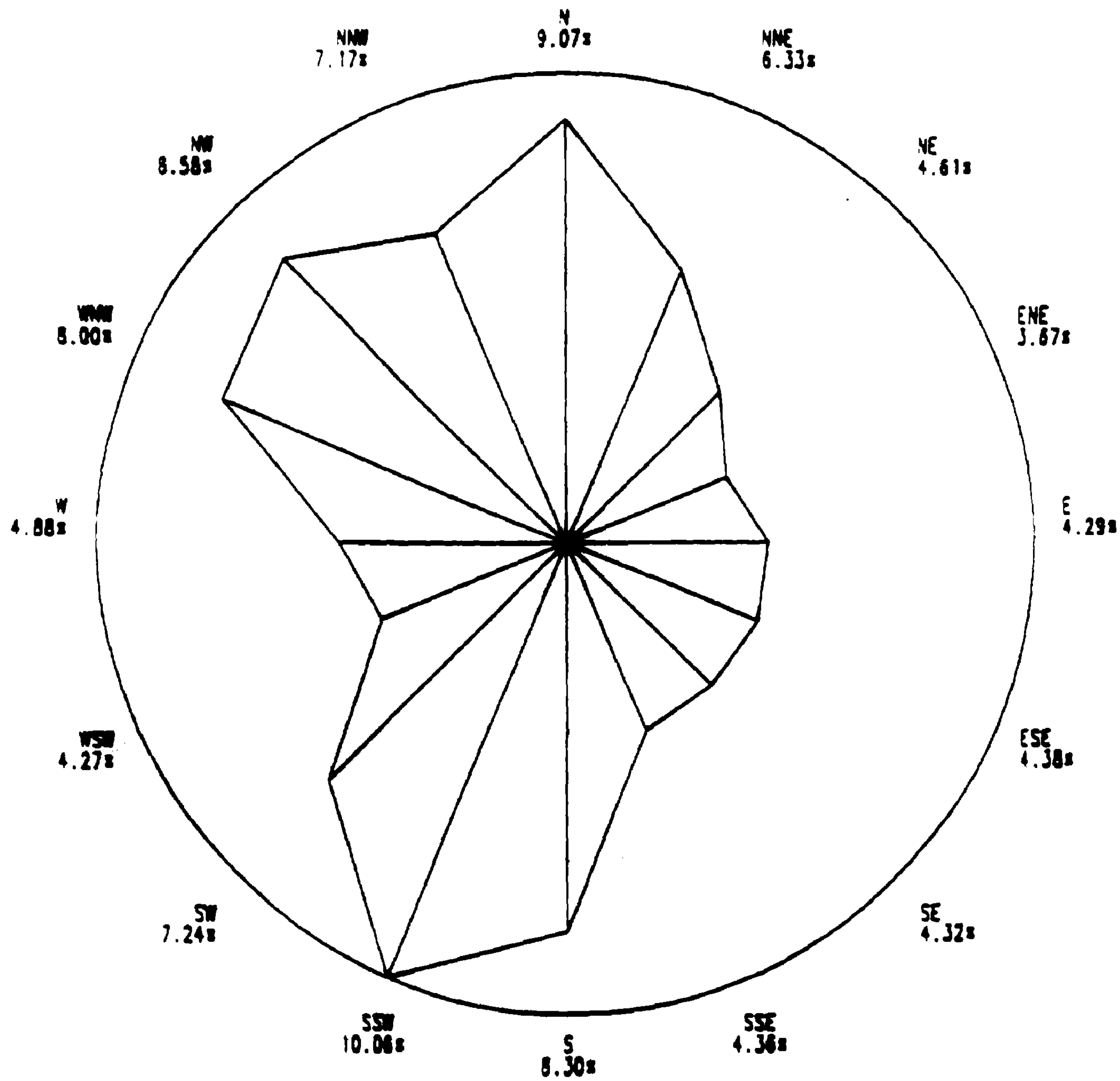


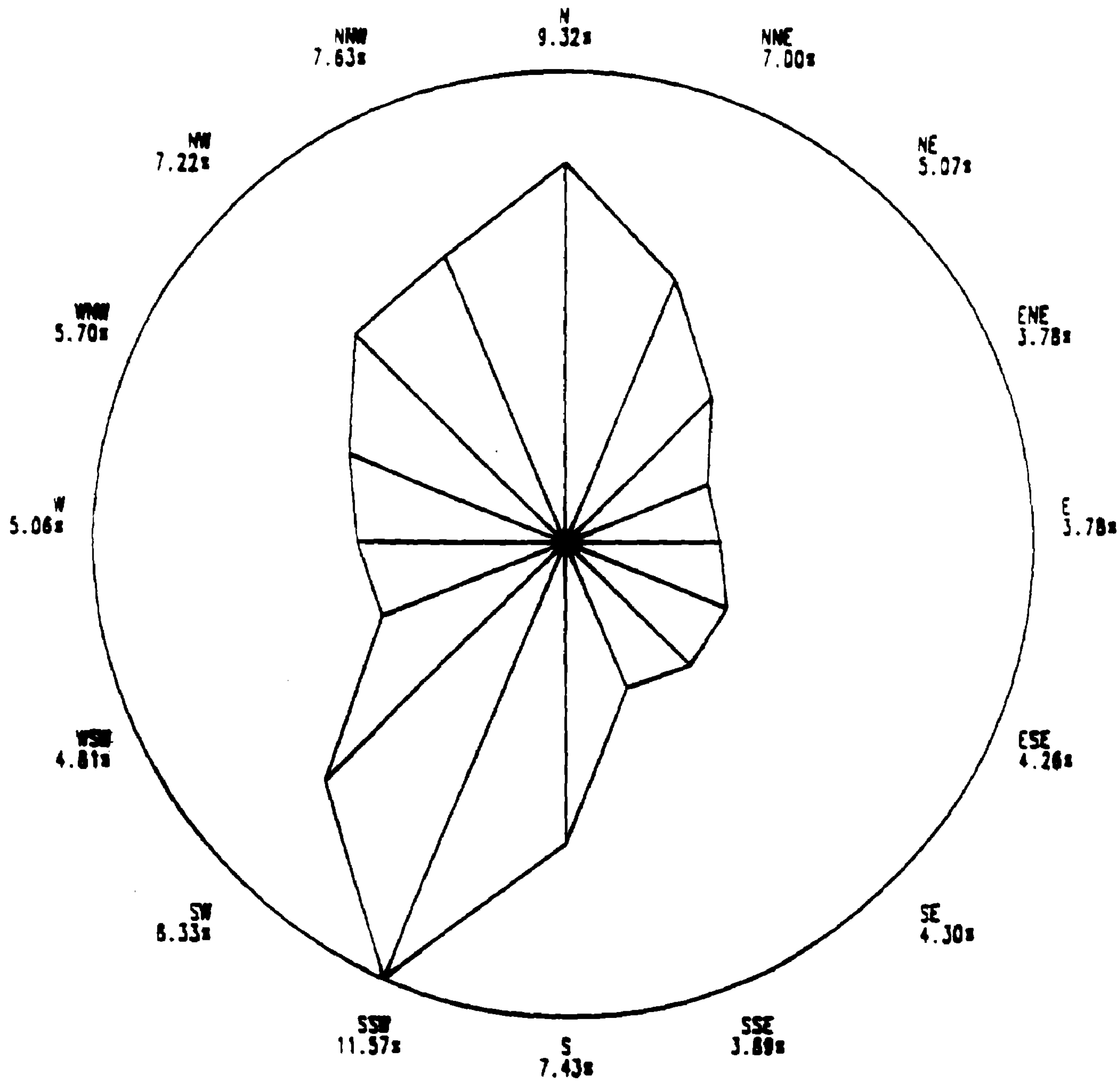
Figure 2.3-18
NORTH ANNA SEASONAL WIND DIRECTION ROSES
LOW LEVEL WINDS 1974–1987 SEASON = OVERALL



Hours Calm = 408
Total Hours = 108,987
Percent Calm = 0.37 %

N0203018

Figure 2.3-19
NORTH ANNA SEASONAL WIND DIRECTION ROSES
HIGH LEVEL WINDS 1974–1987 SEASON = OVERALL



Hours Calm = 692
Total Hours = 91,628
Percent Calm = 0.75 %

N0203019

Figure 2.3-20
NORTH ANNA SEASONAL WIND PERSISTENCE ROSES
LOW LEVEL WINDS 1974–1987 SEASON = OVERALL

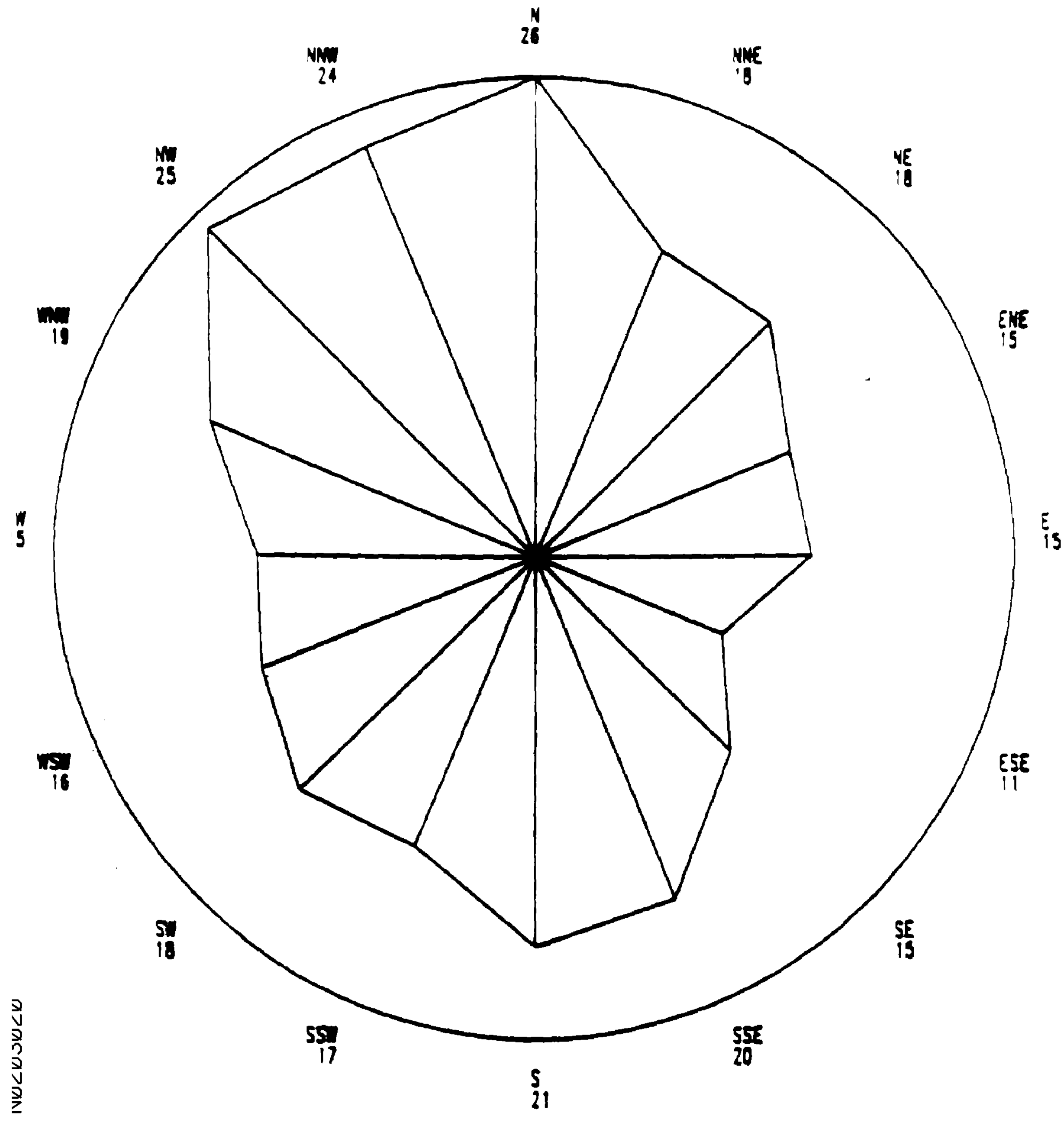


Figure 2.3-21
NORTH ANNA SEASONAL WIND PERSISTENCE ROSES
HIGH LEVEL WINDS 1974–1987 SEASON = OVERALL

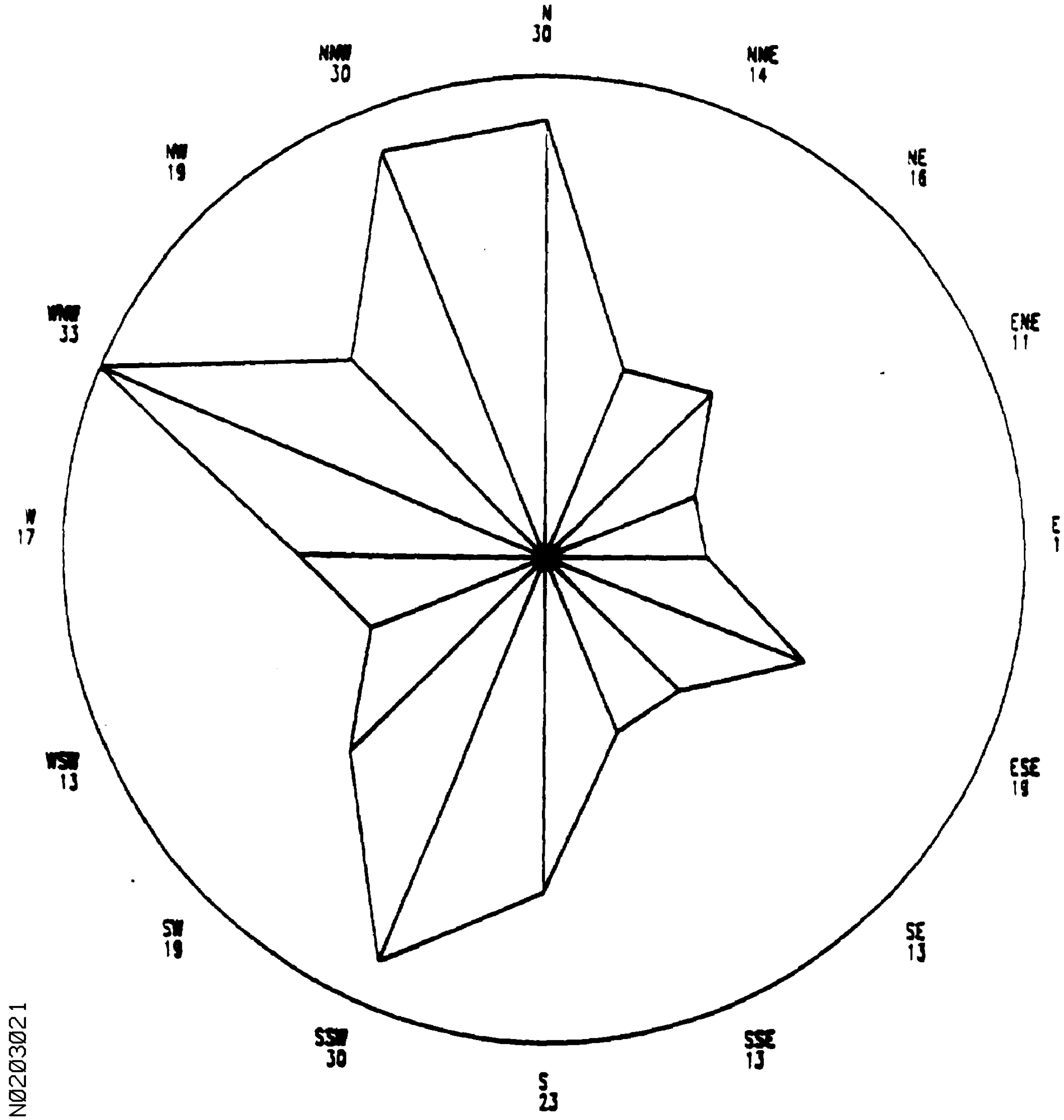


Figure 2.3-22
NORTH ANNA WIND DIRECTION PERSISTENCE
(9/16/71-9/15/72)

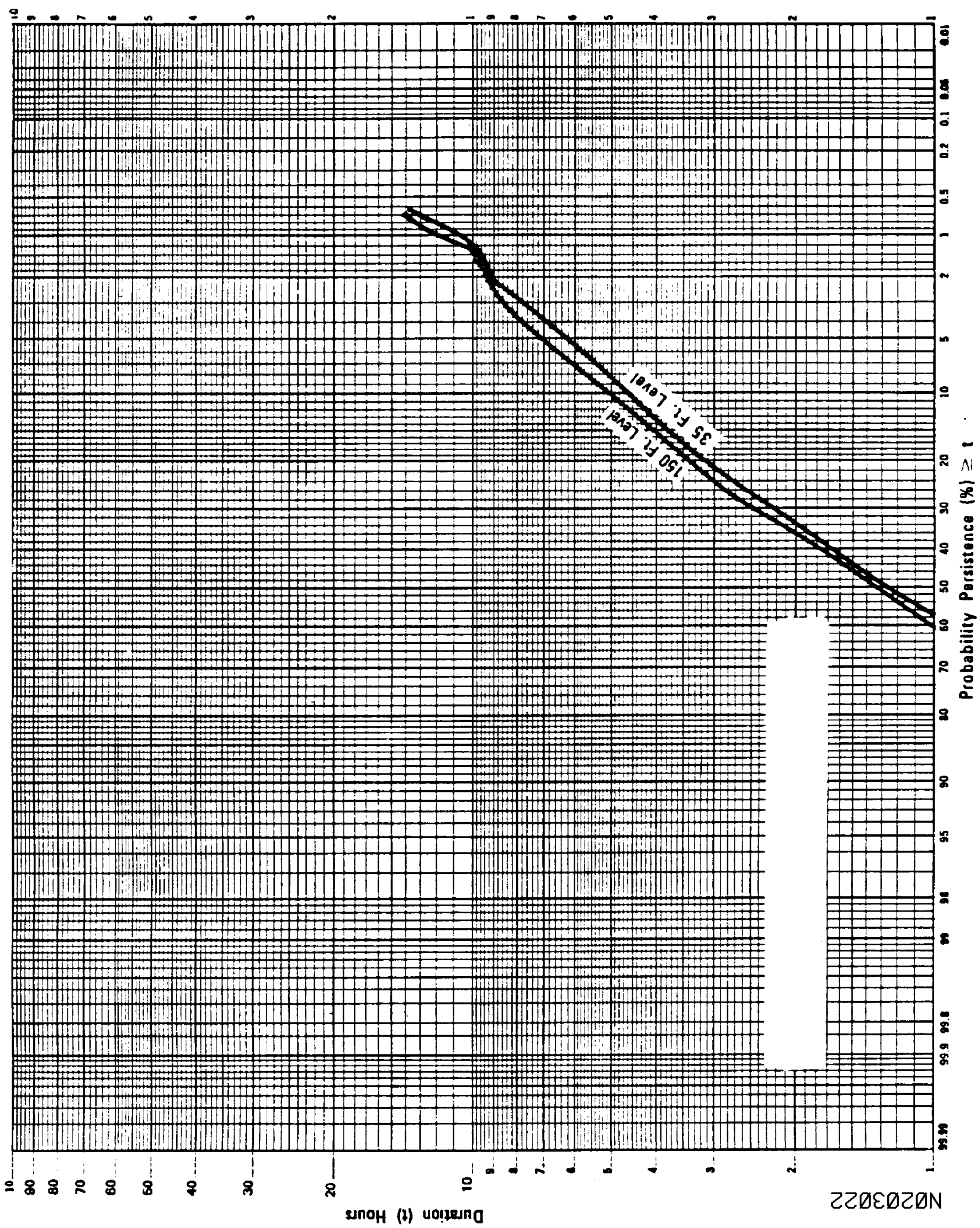


Figure 2.3-23
NORTH ANNA WIND PERSISTENCE ROSES (9/16/71-9/15/72) MAXIMUM NUMBER OF HOURS OF 22 1/2° WIND DIRECTION PERSISTENCE

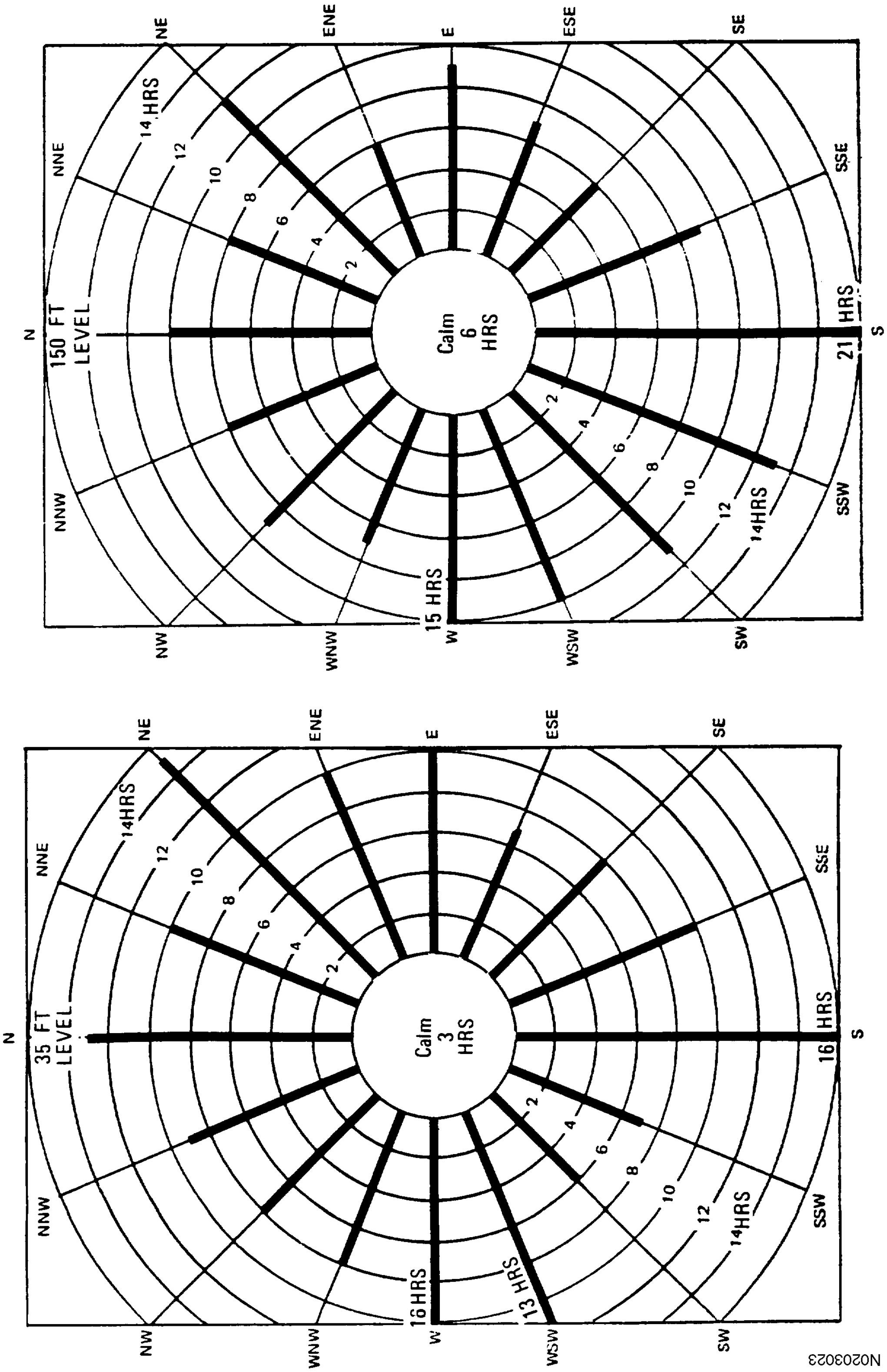
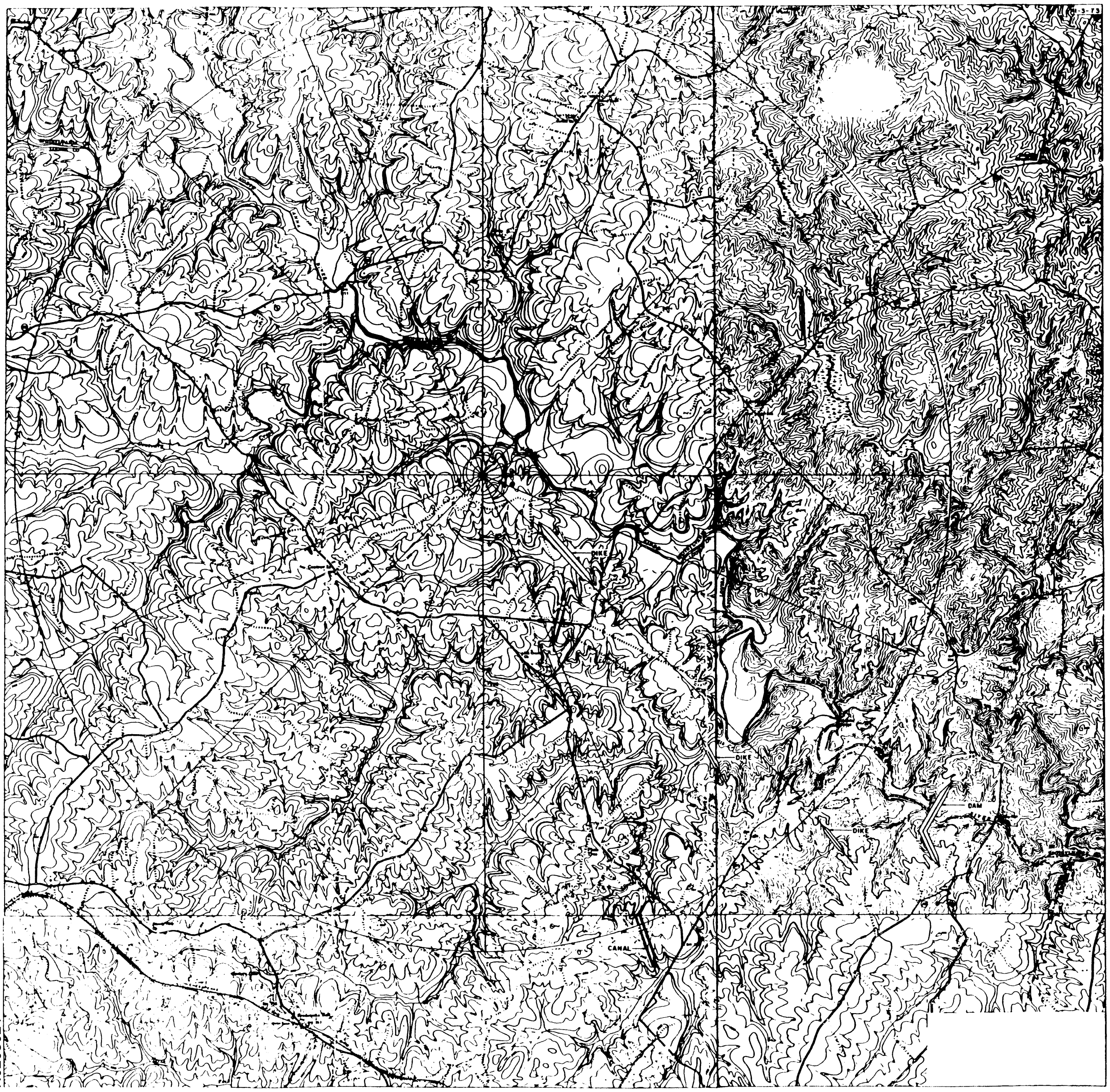
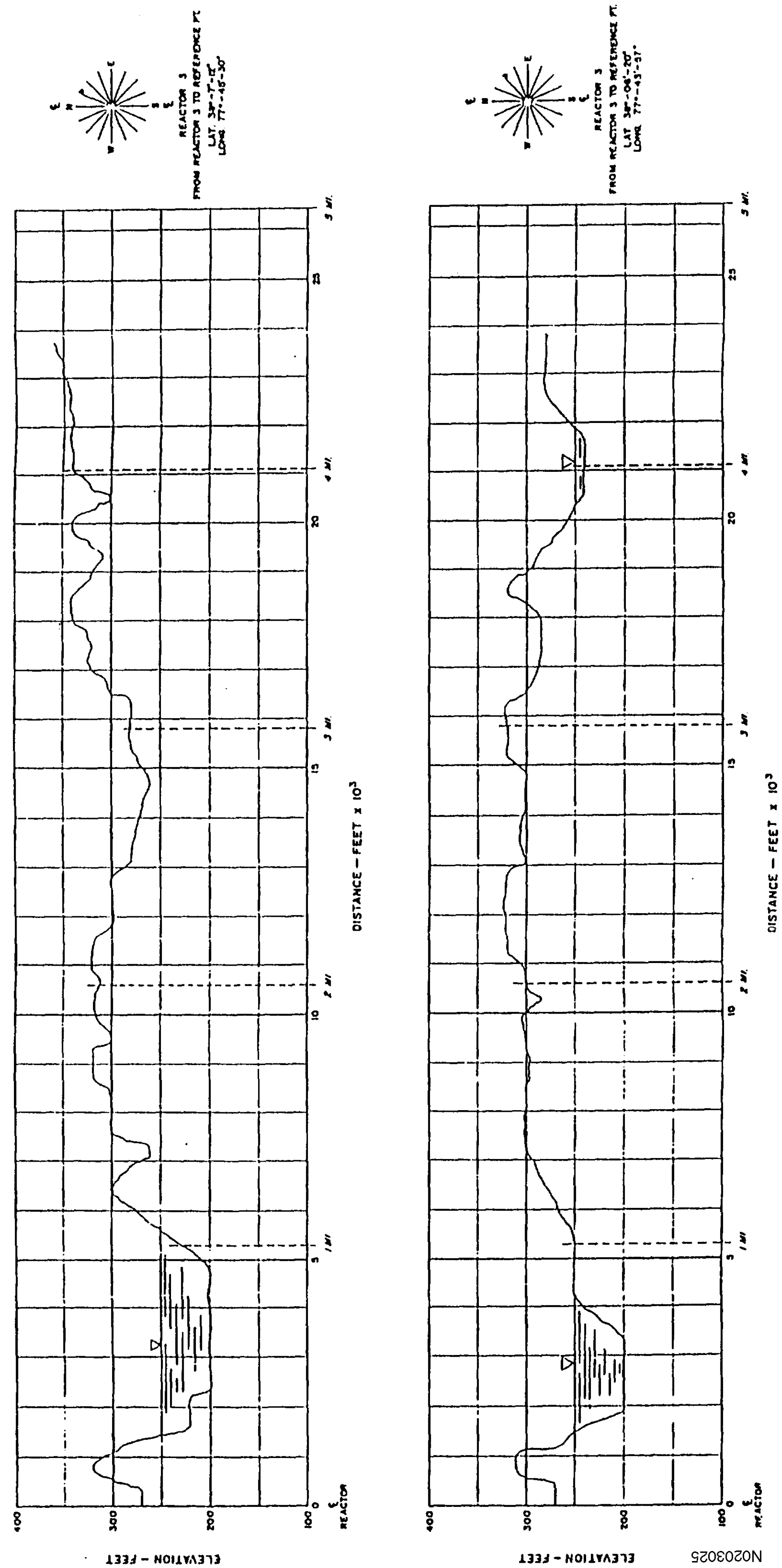


Figure 2.3-24
TOPOGRAPHICAL MAP



N0203024

Figure 2.3-25 (SHEET 1 OF 8)
VERTICAL PROFILES



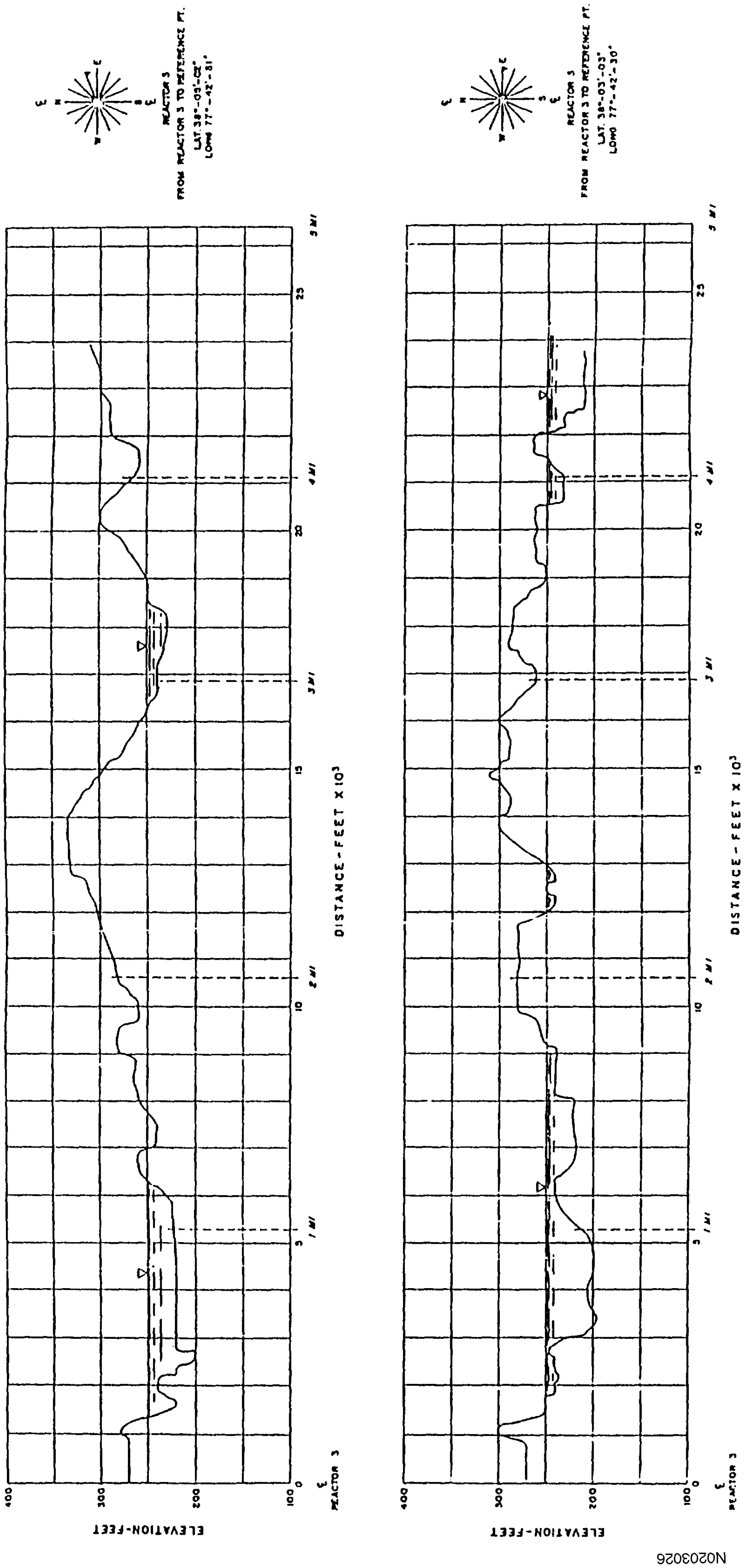
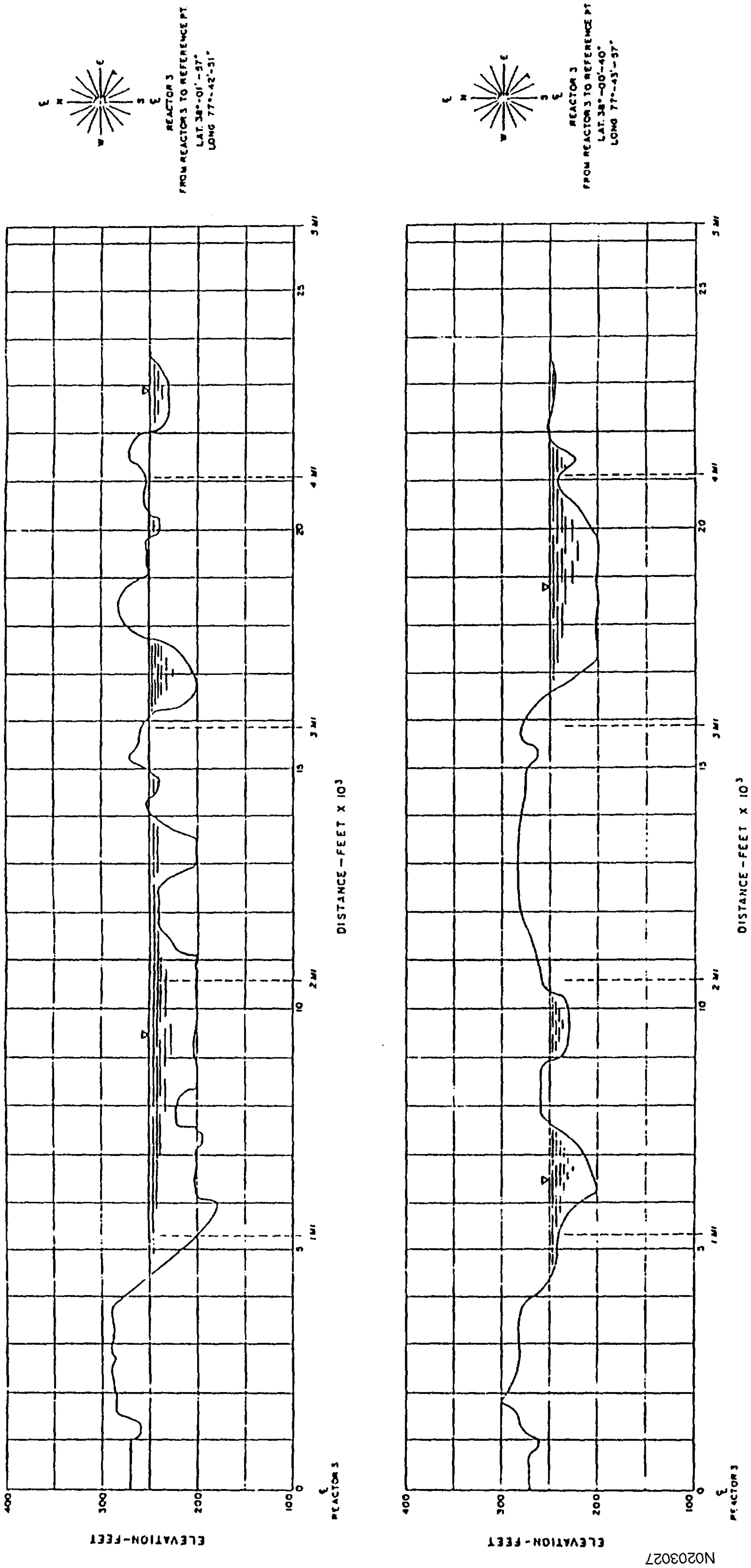


Figure 2.3-25 (SHEET 2 OF 8)
VERTICAL PROFILES

Figure 2.3-25 (SHEET 3 OF 8)
VERTICAL PROFILES



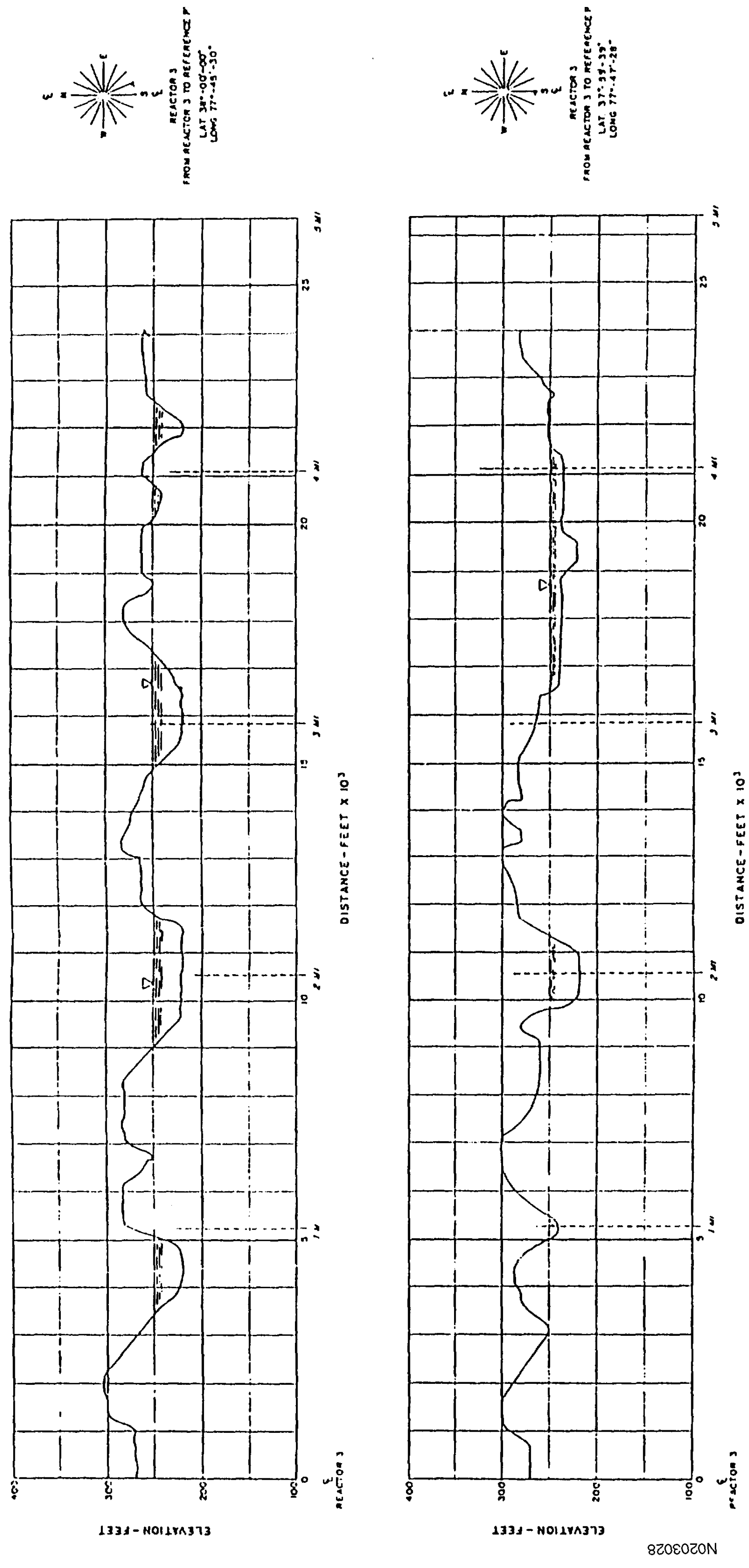


Figure 2.3-25 (SHEET 4 OF 8)
VERTICAL PROFILES

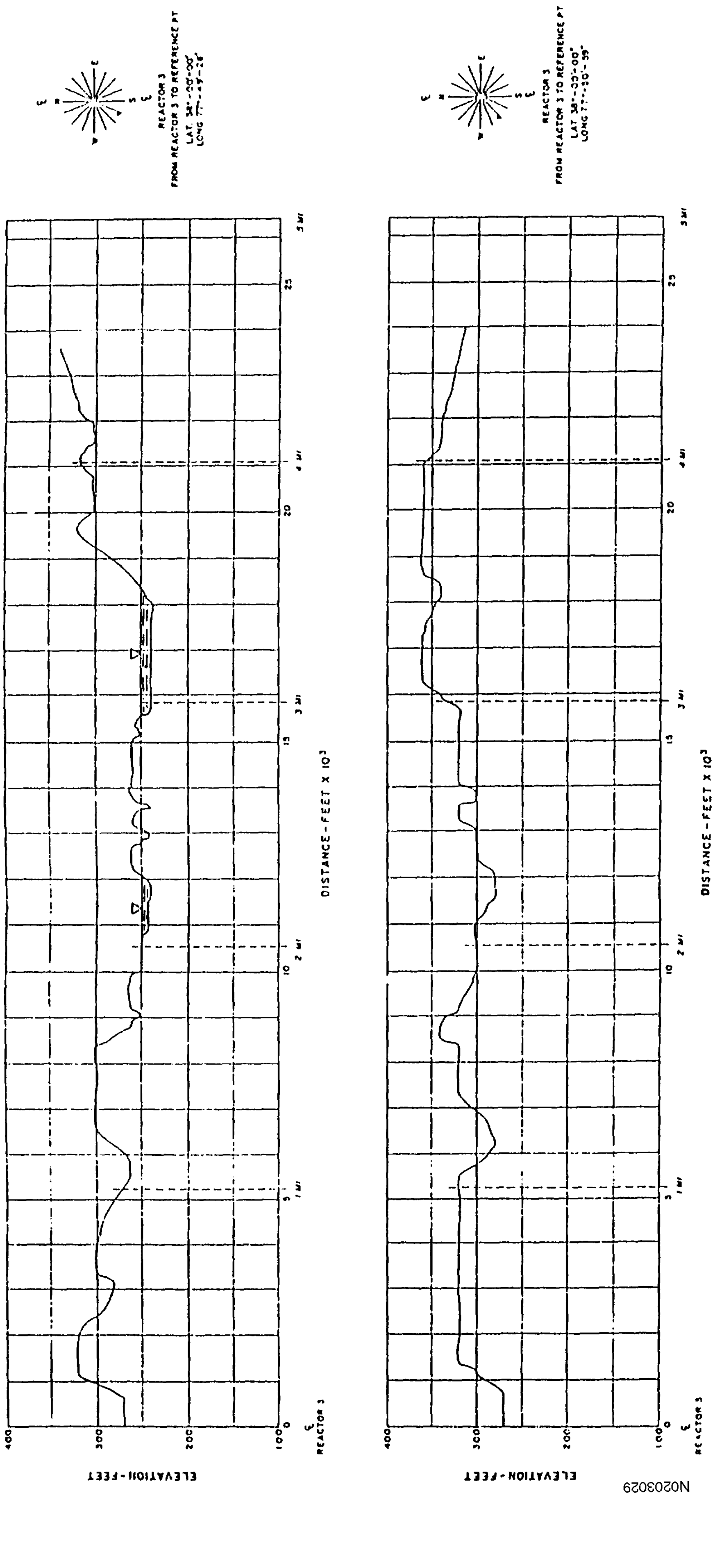


Figure 2.3-25 (SHEET 5 OF 8)
VERTICAL PROFILES

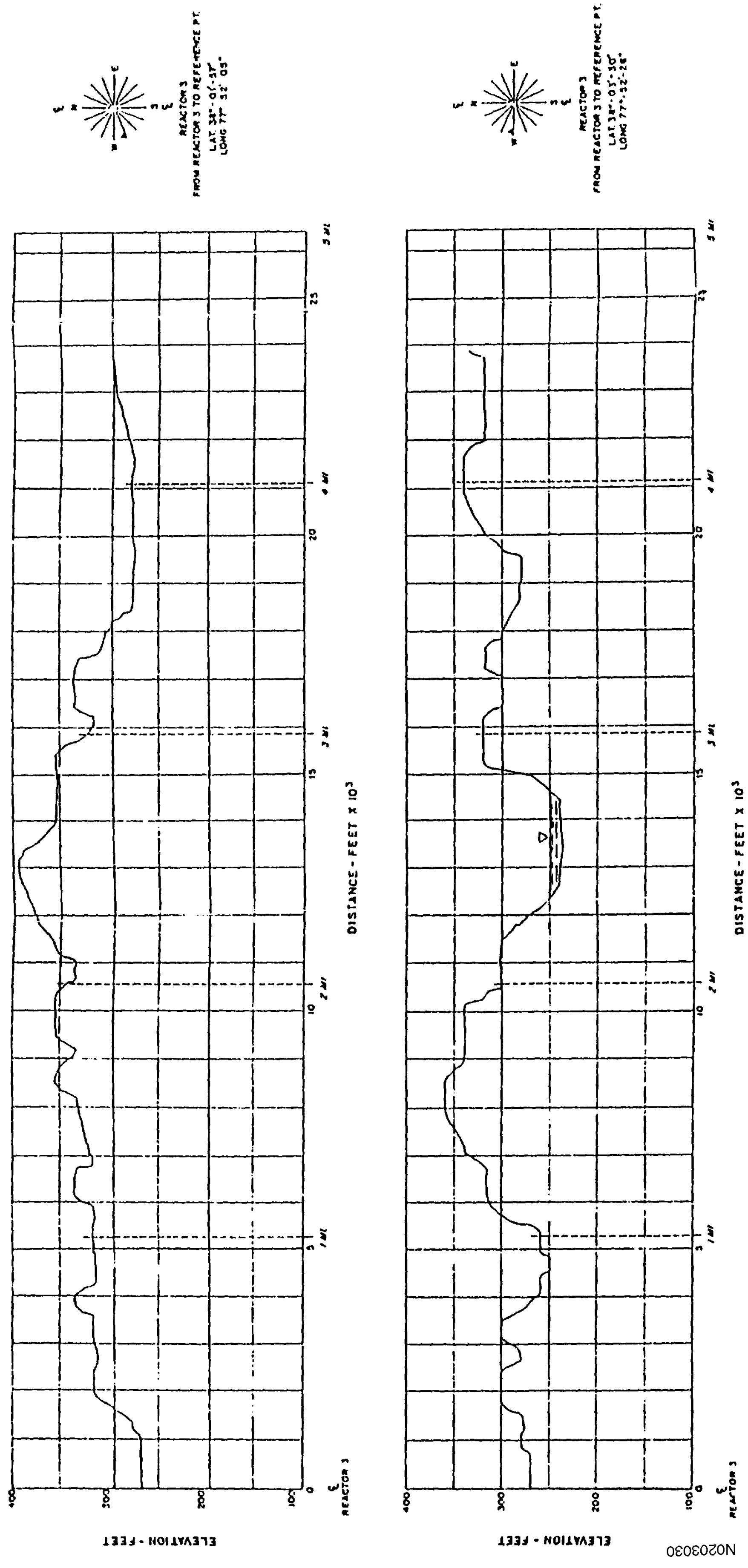


Figure 2.3-25 (SHEET 6 OF 8)
VERTICAL PROFILES

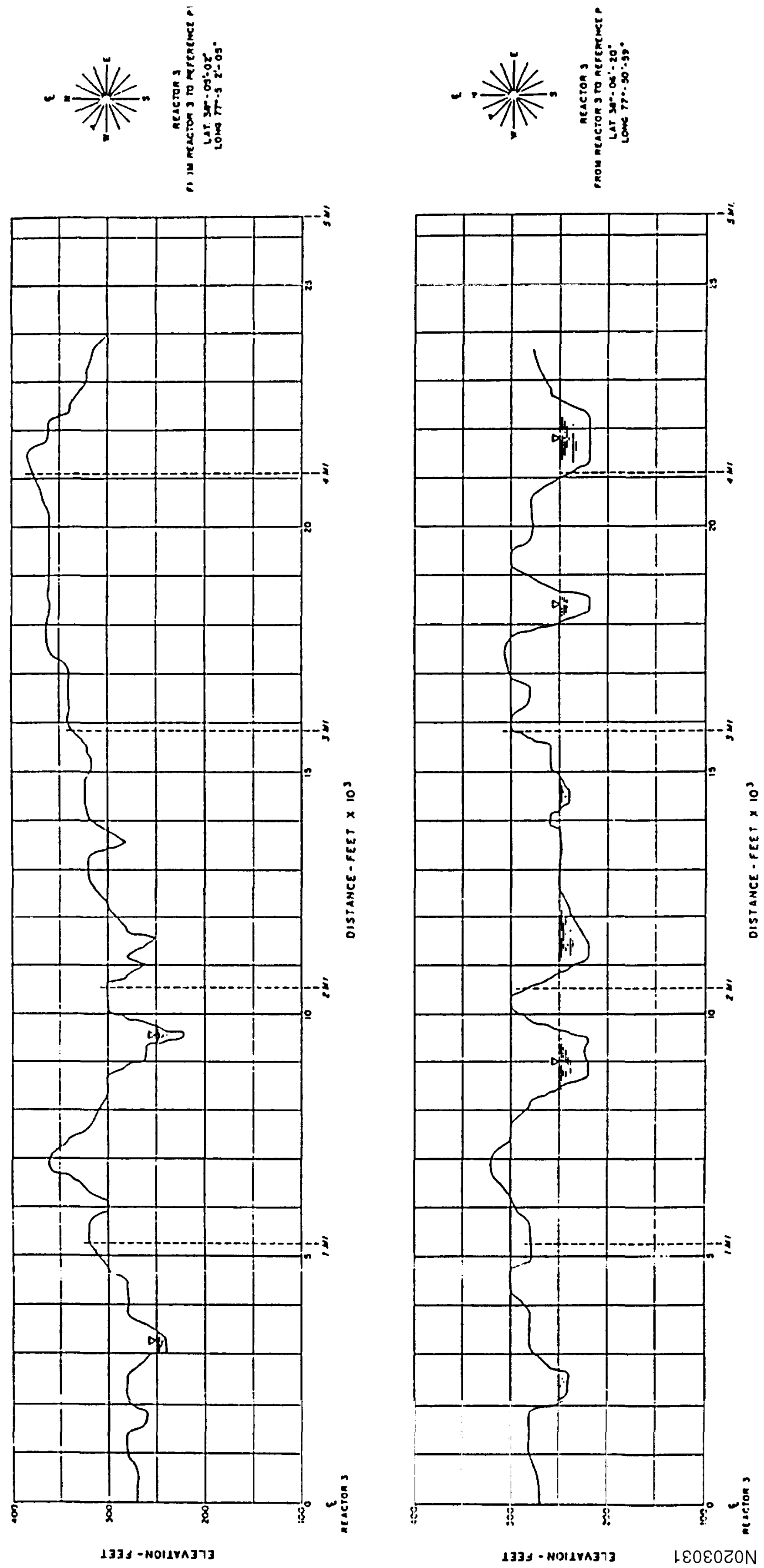


Figure 2.3-25 (SHEET 7 OF 8)
VERTICAL PROFILES

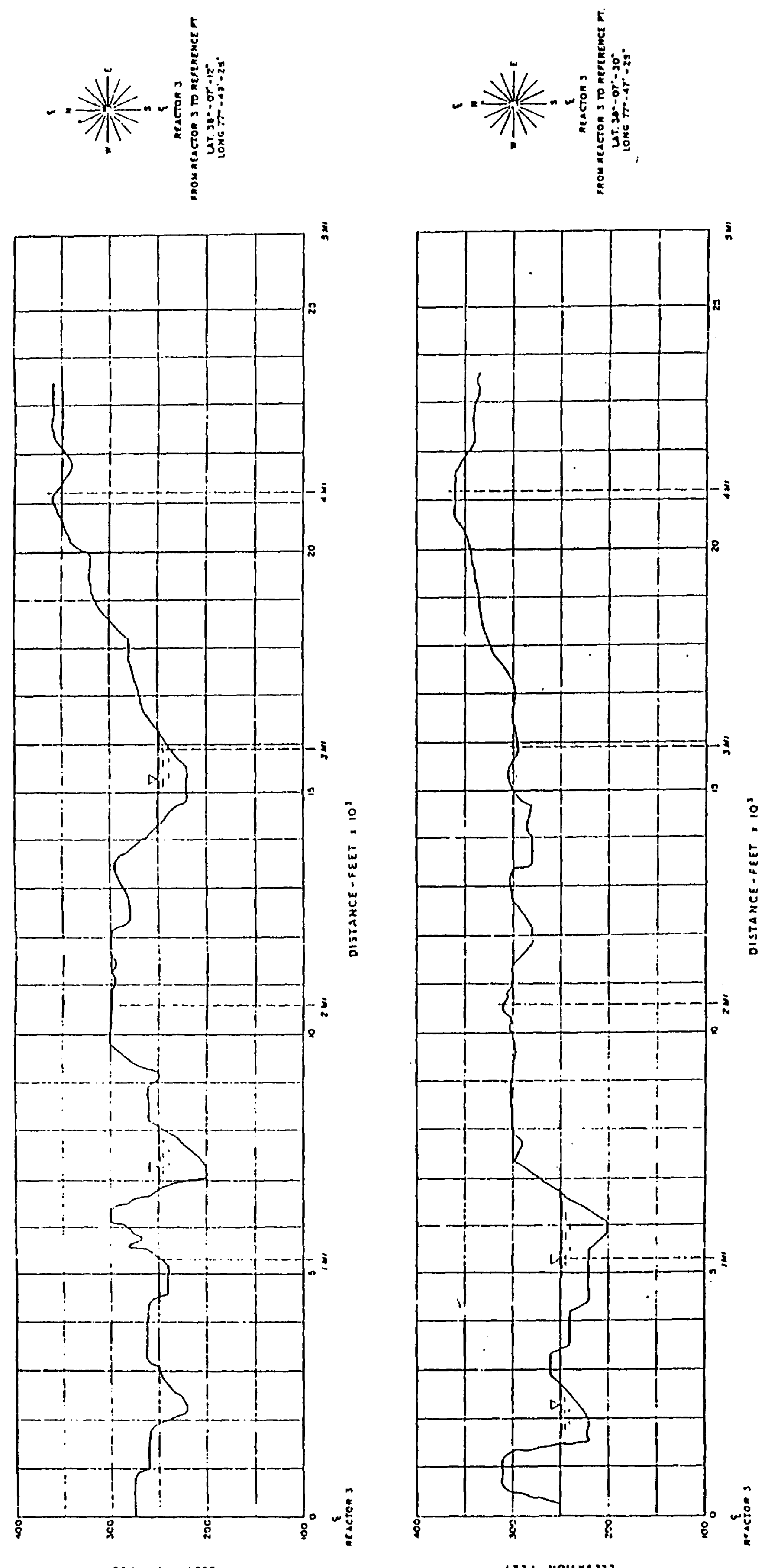


Figure 2.3-25 (SHEET 8 OF 8)
VERTICAL PROFILES

Figure 2.3-26
LOCATION OF METEOROLOGICAL TOWER

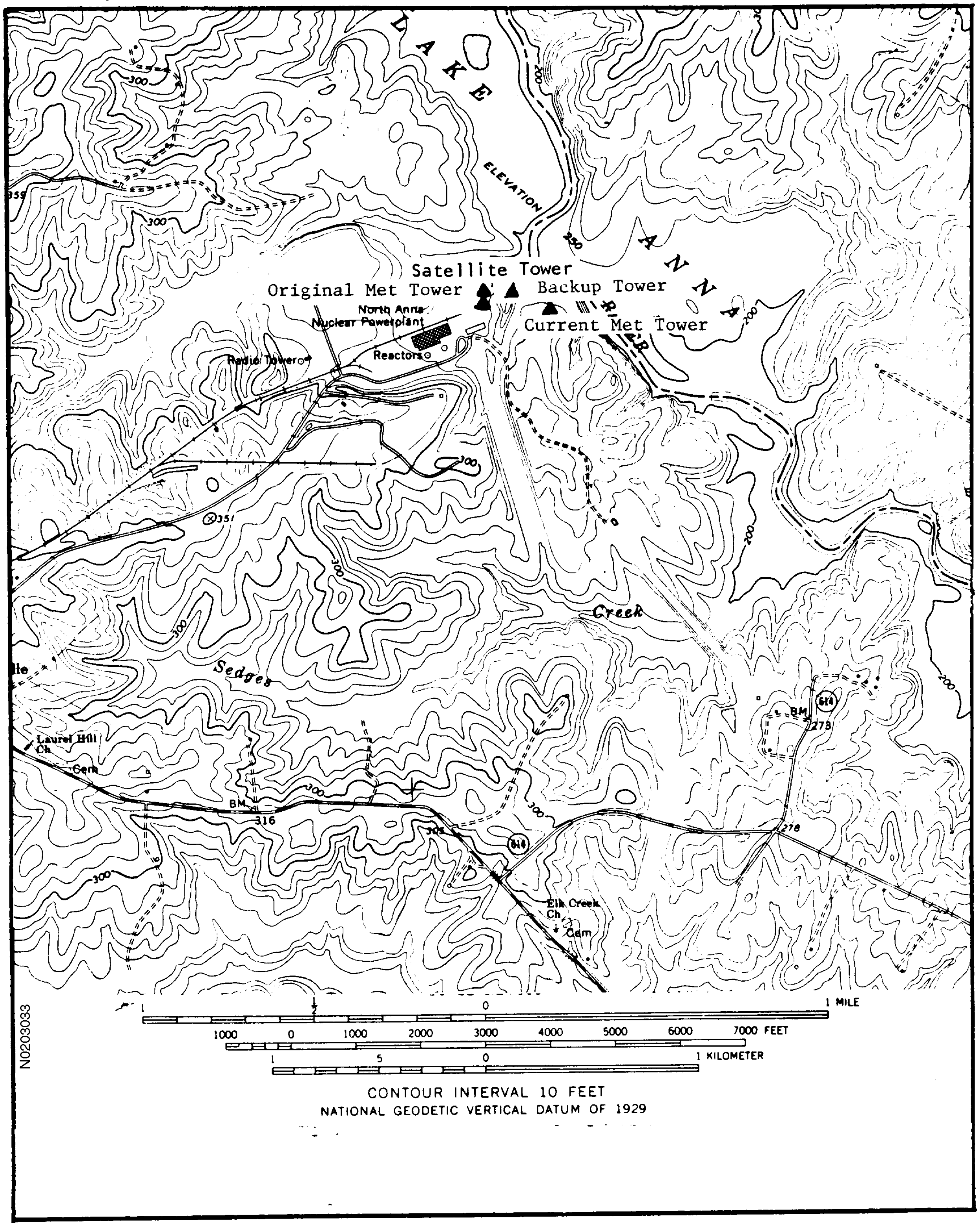
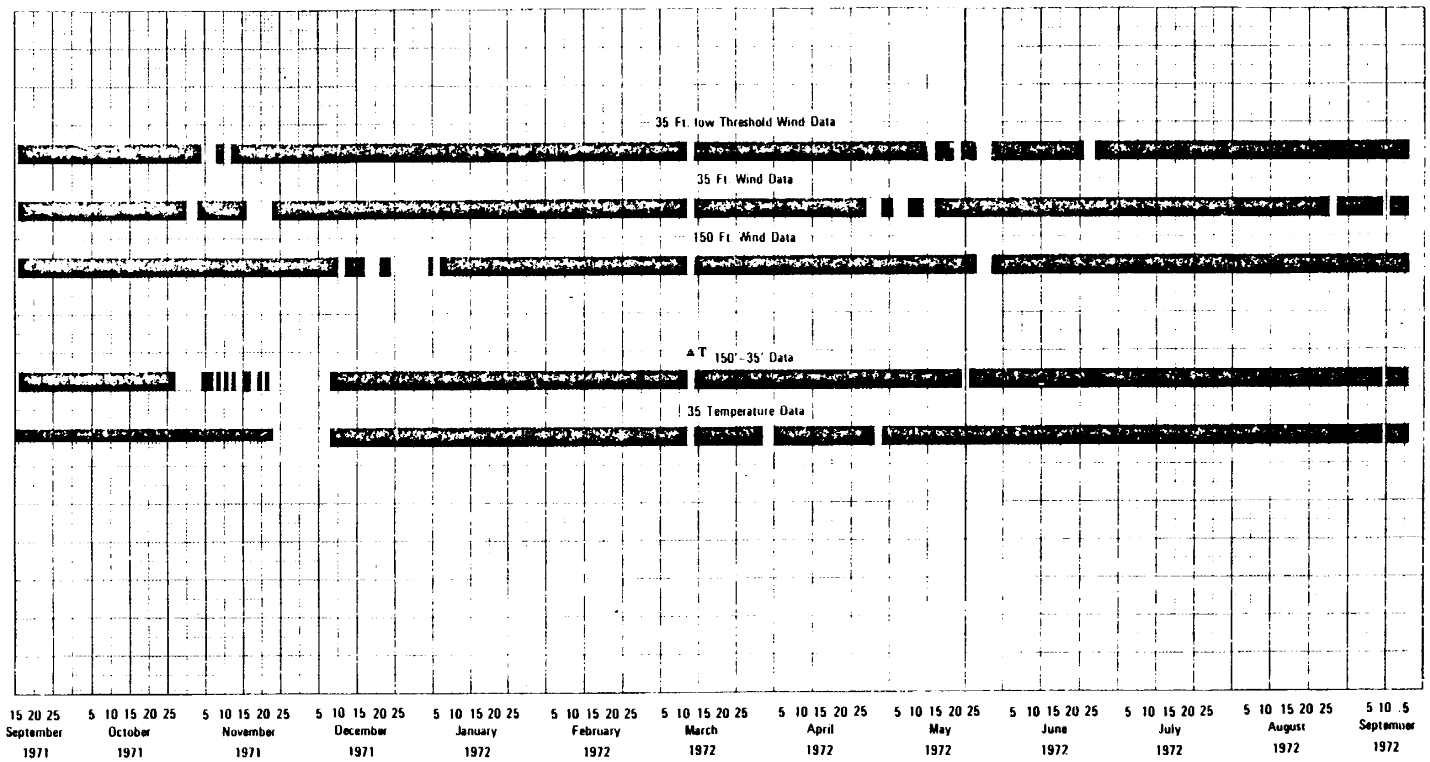


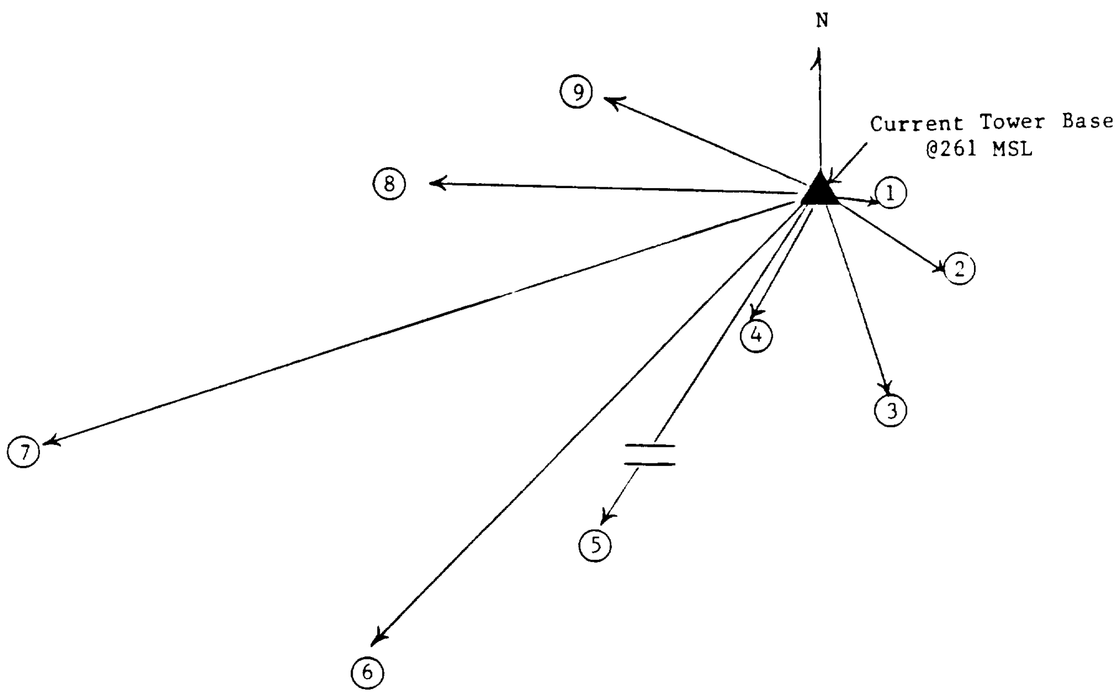
Figure 2.3-27
NORTH ANNA DATA RECOVERY[a] SUMMARY[b]
(SEPTEMBER 16, 1971–SEPTEMBER 15, 1972)



)203034

a. Recoverable wind data is defined as valid wind speed, wind direction, and wind variance data.
b. Graph indicates periods of missing data for duration greater than one day.

Figure 2.3-28
LOCATION OF NEW METEOROLOGICAL TOWER
RELATIVE TO LOCAL GROUND FEATURES



(1)	Basketball Backboard	095°	100'
(2)	30 X 50 Pavilion	122°	222'
(3)	20 X 30 Pavilion	160°	294'
(4)	Softball Backstop	200°	203'
(5)	Nearest Contiguous Tree Line		>500'
(6)	Training Center	205°	740'
(7)	Unit 1 Containment	250°	1750'
(8)	Original Tower	272°	1020'
(9)	Back-up Tower	-	-

N0203035

Figure 2.3-29
0–60 MINUTE χ/Q PROBABILITY AT THE EXCLUSION DISTANCE (1350 m)
(9/16/71-9/15/72)

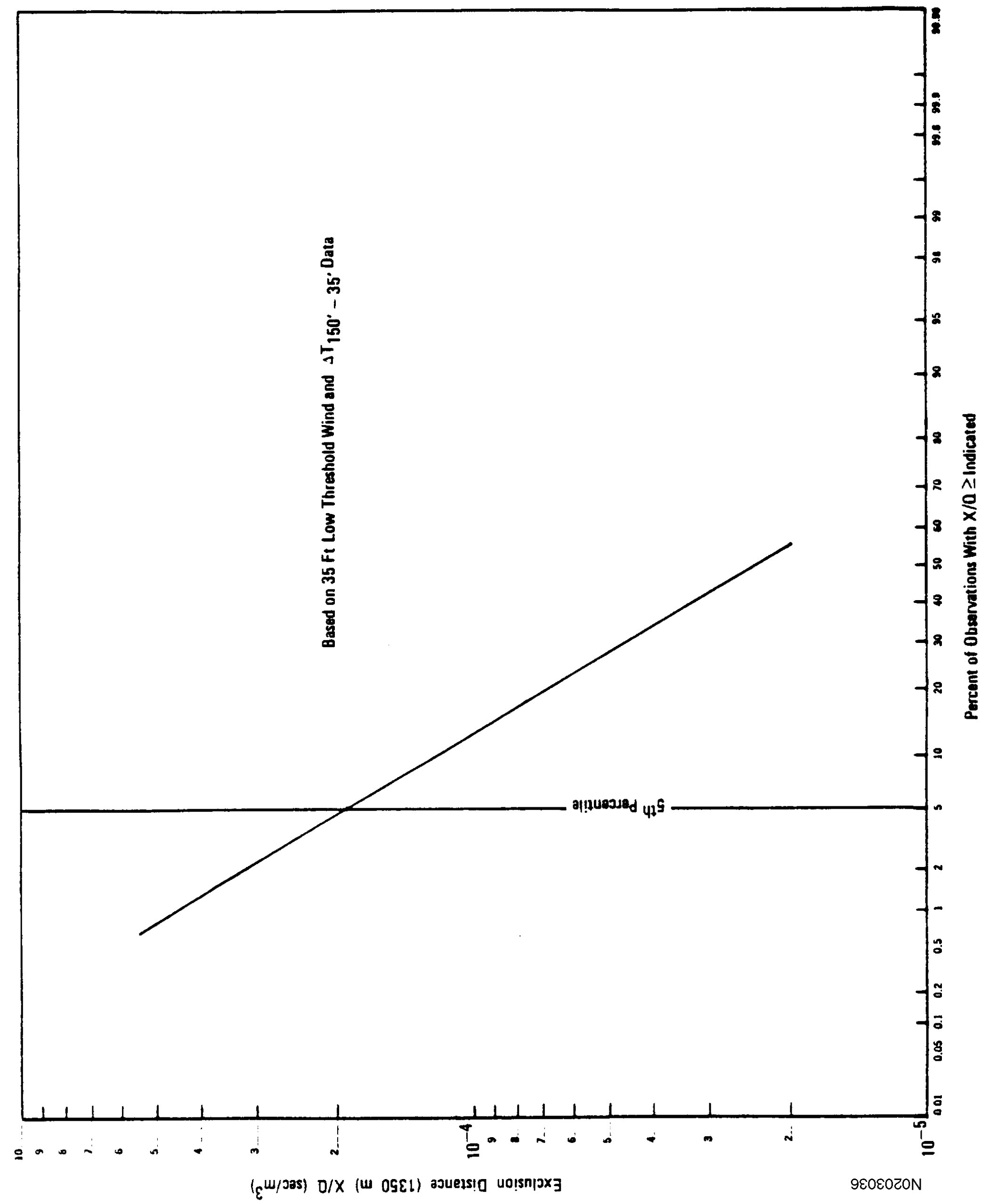


Figure 2.3-30
NORTH ANNA SITE HYPOTHETICAL
ACCIDENT DILUTION FACTORS (9/16/71–9/15/72)

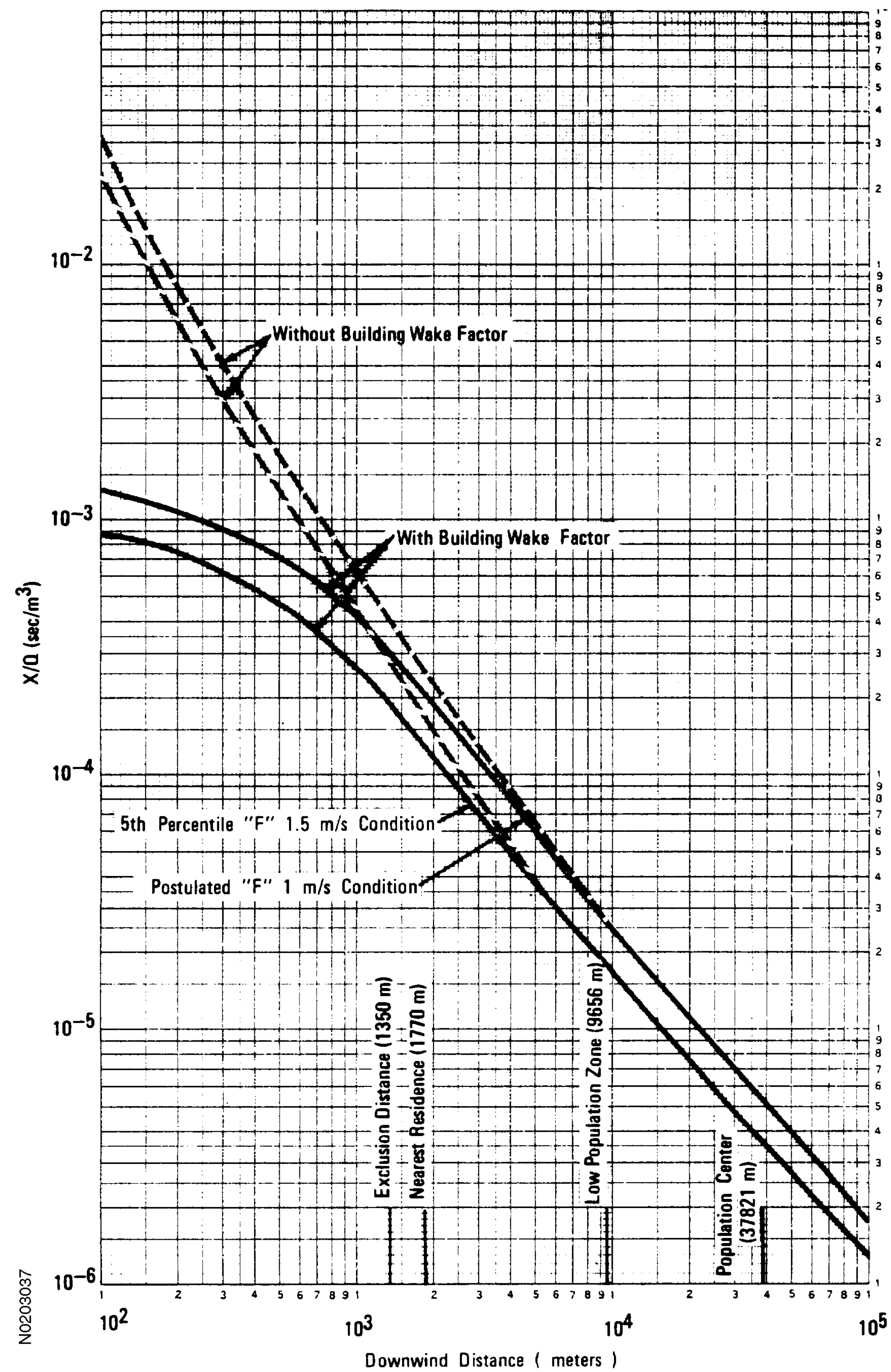
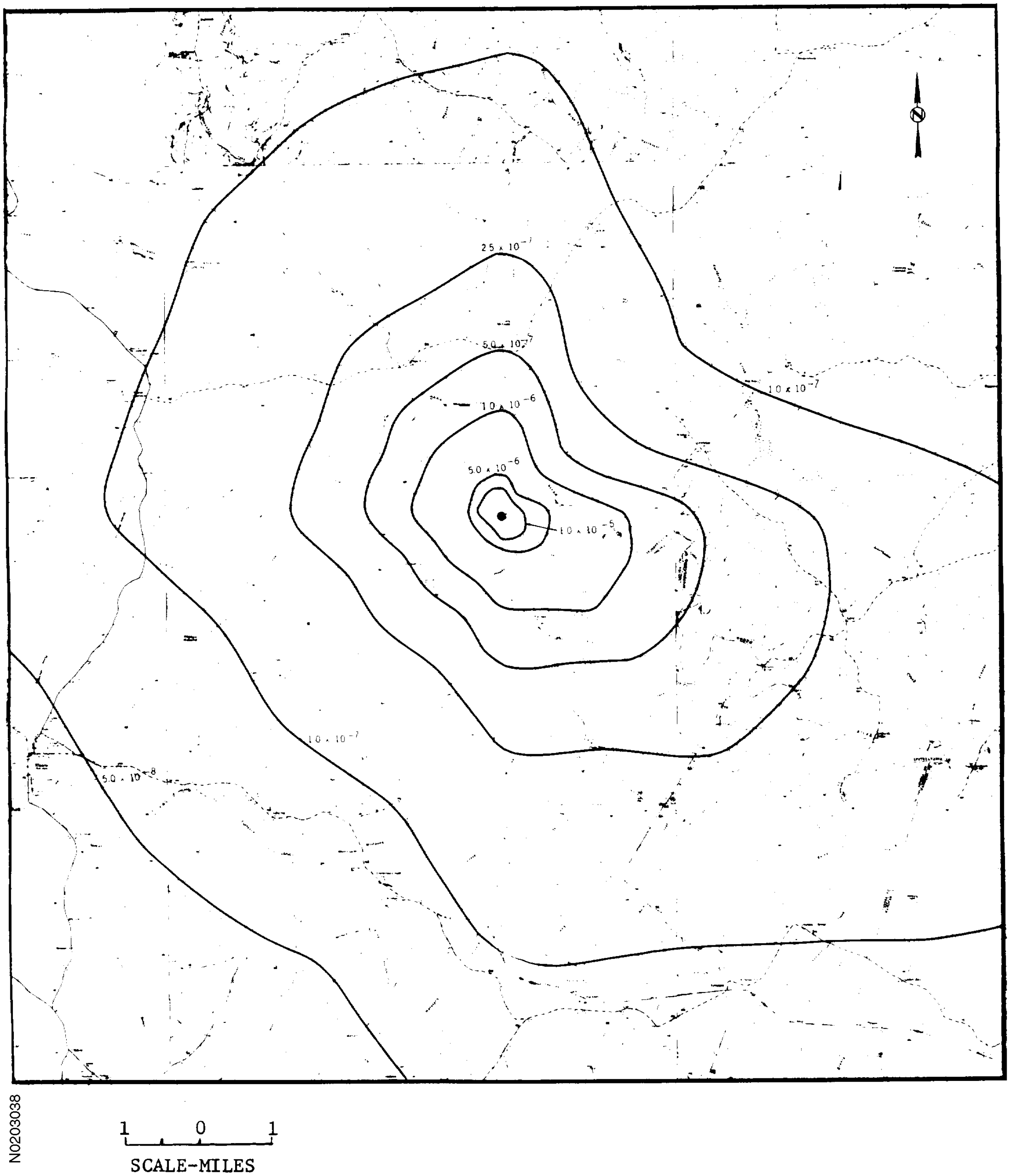


Figure 2.3-31
NORTH ANNA χ/Q DISTRIBUTION



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2.4 HYDROLOGY

2.4.1 Hydrologic Description

2.4.1.1 Site and Facilities

The principal water source for the power station is an impoundment of the North Anna River. Lake Anna is formed by a dam constructed across the North Anna River as part of the overall project development.

The power station is situated approximately 5 miles upstream from the main dam at a minimum elevation of 271 feet msl. All safety-related equipment and systems at the site are located so as to be protected from flooding.

The topographic description of the site is in Section 2.3.2.4.

The principal hydrologic considerations, insofar as the station is concerned, are:

1. The adequacy of the water supply.
2. The prevention of power station site flooding.
3. Environmental effects of radioactive discharge.
4. Thermal effects.

2.4.1.2 Hydrosphere

The North Anna River rises in the eastern slopes of the Southwestern Mountains in the Appalachian Range near Gordonsville, Virginia, and flows along a southeasterly course to its confluence with the South Anna River 5 miles northeast of Ashland, Virginia, where the Pamunkey River is formed. The Pamunkey continues on a general southeasterly course to West Point, Virginia, where it is joined by the Mattaponi River to form the York River. The York River flows into the Chesapeake Bay about 15 miles north of Hampton, Virginia.

The North Anna River drains a watershed area of 343 square miles above the dam, which is located about 4 miles north of Bumpass, Virginia, and about 0.5 mile upstream of Virginia Route 601. The nearest permanent USGS stream-gauging station on the North Anna River is 15 miles downstream from the dam at Doswell, Virginia, and this station gauges the runoff from 439 square miles. Records have been maintained at this gauging station since March 1929. Table 2.4-1 summarizes the records at this gauging station and tabulates basic stream flow data for the dam site, which have been estimated using the gauge records as a guide.

Hydrologic studies indicate that the mean monthly inflow to Lake Anna will be distributed as shown in Table 2.4-2.

As shown on Figure 2.4-1, Lake Anna is about 17 miles long and inundates several small tributaries, thereby resulting in an irregular shape having a shoreline length of approximately 272 miles. To provide optimum thermal performance, Lake Anna is separated into two segments

by a series of dikes and canals. The larger segment of about 9600 acres is considered the North Anna Reservoir and functions as a storage impoundment to ensure adequate water supplies for condenser cooling. The smaller segment, called the Waste Heat Treatment Facility, has an area of about 3400 acres and functions primarily as a heat exchanger to transfer most of the station heat rejection to the atmosphere.

While Lake Anna is constructed for power station purposes, it also provides the additional multipurpose benefits of low stream flow augmentation, flood control, and recreation. The normal pool level at Elevation 250 will be maintained most of the time; however, during extreme droughts, it is expected that the pool will be drawn down to about Elevation 246, assuming a downstream release of 40 cfs throughout the year. This modest drawdown will not seriously interfere with recreational activities or facilities on Lake Anna. A flood surcharge of 15 feet above the normal pool level is provided for flood peak reduction. The total Lake Anna volume of 550,000 acre-ft. is allocated as follows:

Purpose	Volume (acre-ft)
Minimum recreational pool and inactive storage below Elevation 246	255,000
Conservation and active storage, Elevation 246 to Elevation 250	50,000
Flood control storage, Elevation 250 to Elevation 265	245,000
Total storage	550,000

Withheld under 10 CFR 2.390 (d) (1)

[redacted]

[redacted]

Withheld under 10 CFR 2.390 (d) (1)

[redacted]

The general arrangement of the spillway gates at North Anna is shown in Reference Drawing 1, and details are shown in Reference Drawings 2 through 4. The discharge capacity of each of the three main tainter gates is shown in Figure 2.4-3. Two 8.5-ft by 8.5-ft skimmer-type gates, each having a capacity of 500 cfs when the lake is at Elevation 250, are provided, in addition to the tainter gates.

An auxiliary generator is provided at the dam site to operate the spillway gate hoists in the event that normal power supplies are interrupted.

No river control structures exist on the North Anna River other than the North Anna Reservoir and Dam.

There are no known industrial users of either the North Anna River or the Pamunkey River into which it flows, until it reaches the York River some 60 miles downstream at West Point, where a large pulp and paper manufacturing plant is located. There are no known potable water withdrawals along the entire stretch of the river downstream to West Point, at which point it becomes an estuary. Potable water supplies are obtained from municipally owned ground-water sources and springs for the towns of Louisa and Mineral in Louisa County. Individual wells serve the rural homeowners throughout the region. Ground-water users are listed in Table 2.4-3.

2.4.2 Floods

2.4.2.1 **Flood History**

The high-discharge periods listed in Table 2.4-4 have occurred during the period of record on the North Anna River. Peak measurements are taken at the USGS gauging station near Doswell, Virginia, approximately 15 miles downstream from the North Anna Dam site.

The flood of June 1972 had a peak flow very close to the August 1969 flood of record. The flood of April 1937 was the third largest flood for which records are available at the stream gauging station at Doswell. The floods of June and July 1949 and April 1953 were minor floods. The storm of August 1955 caused an intermediate flood at Doswell.

2.4.2.2 Flood Design Considerations

Design flood protection elevation for safety-related facilities, systems, and equipment was based on the maximum North Anna Reservoir level and wave runup associated with the probable maximum flood on the North Anna River.

The unit hydrograph at the dam site was developed by analysis of the rainfall and runoff relationships of the floods listed in Section 2A.2.4.2.

The probable maximum flood for spillway design was developed by applying the probable maximum precipitation as given in the U.S. Weather Bureau Hydrometeorological Report Number 33, to the unit hydrograph of the North Anna River at the dam site.

The site drainage system has been designed to carry the runoff from a 10-year storm of 5-minute duration with a rainfall intensity of 7 in/hr. The design was in accordance with the Drainage Manual of the Virginia Department of Highways. The rainfall intensity/duration curve for Richmond, Virginia, is shown in Figure 2.4-4. The probable maximum precipitation for a 10-square-mile drainage area is estimated to be 29 inches in a 6-hour period or 34 inches in a 24-hour period.

The site is relatively flat, and no concentration of runoff is expected on the flat areas. The drainage area that will contribute to runoff on the site is not much larger than the site. The area west of the site will receive runoff from approximately 35 acres; however, the drainage facilities in this area have been designed for a 50-year storm. Table 2.4-5 shows the effect on the site of localized rainfall-produced flooding. This table assumes no infiltration. The site is graded to cause surface runoff to flow away from the turbine buildings, reactor containments, and any safety-related facilities.

Site drainage maps are shown in the following figures for the areas in the vicinity of the turbine buildings and reactor containments:

- Reference Drawing 5 - Units 1 and 2.
- Reference Drawing 6 - Units 1 and 2.
- Reference Drawings 5, 6, and 10 to 12 - Units 3 and 4.

Drainage for the area west of Unit 4 is shown in Figure 2.4-5.

The areas of potential temporary flooding west of the site from rainfall in excess of the 50-year design storm will have no effect on the site or the integrity of the safety-related facilities. Rainfall in excess of the 100-year storm will temporarily be impounded in ditches and gullies away from the station; when it exceeds the capacity of the site drainage system, it will run off the site and into the North Anna Reservoir (Lake Anna) to the north and east.

This degree of flooding will not interfere with the capability to safely shut down the station nor will it affect any safety-related facility.

A storm water sump system was installed between the Unit 2 Turbine Building and the Flood Protection Dike. (See Section 3.8.6 for further discussion of the Flood Protection Dike.) The storm water sump system consists of a basin with three sump pumps powered from the “M” bus in the Station Blackout Building. The sump does not perform a flood protection design function, but provides a mechanical means to drain the area.

The freeboard allowance on the Service Water Reservoir and the potential flooding of other safety-related facilities from the overflow of the Service Water Reservoir is discussed in Section 3.8.4.

Accumulated rainfall can be removed from the Service Water Reservoir using the following valve lineups: (1) direct discharge from the service water return header through either of two sets of motor-operated valves, to the circulating water discharge tunnel for Unit 2, or (2) direct discharge from the service water supply header to the liquid waste system through a manual isolation valve. These valve lineups (see Figure 9.2-1) would be performed under administrative control.

The auxiliary building roof drainage system will handle locally intense precipitation up to and including the localized probable maximum precipitation. During the period of probable maximum precipitation, ponding will occur only briefly (less than 1-hour duration). The additional weight imposed on the roof, by ponding during the probable maximum precipitation, is within its structural load-carrying capacity.

The other safety-related facilities will not be affected by ponding by virtue of structural design (2-foot-thick concrete) and the pitched roofs with or without gutters that would carry off any excessive rainfall.

2.4.3 Probable Maximum Flood on Streams and Rivers

The probable maximum flood on the North Anna River at the dam site is described in Section 2.4.3.4 and Appendix 2A. This analysis is summarized below.

For the analysis it was necessary to consider four inflow components:

1. Overland flow to the North Anna Reservoir (runoff).
2. Rainfall directly on the North Anna Reservoir.
3. Overland flow to the Waste Heat Treatment Facility (runoff).
4. Rainfall directly on the Waste Heat Treatment Facility.

In view of the fact that flow between the North Anna Reservoir and the Waste Heat Treatment Facility is restricted by four dividing dikes, one of which allows limited exchange, it was conservatively assumed that all rainfall and runoff was routed through the North Anna

Reservoir until the stage reached Elevation 260 (top of dividing dikes). It was also conservatively assumed that only the storage available above Elevation 260 in the Waste Heat Treatment Facility was available. This was equivalent to assuming that the Waste Heat Treatment Facility was full to Elevation 260 at the start of the probable maximum flood, which added approximately 45,000 acre-ft to the volume of the flood. Since the analysis assumes a level reservoir, additional conservatism in the form of an allowance for backwater effects from the spillway was included. The appropriate wind and wave analysis required by Regulatory Guide 1.59 was also performed.

Results of this very conservative analysis showed that all station facilities are capable of withstanding the standard project flood, that the flood stage associated with the probable maximum flood was well below plant grade (Elevation 271), and that all structures and components necessary to maintain the plant in a safe condition are unaffected by the probable maximum flood. If there were a failure of the circulating water system pressure boundary within the turbine building during station operation coincident with the failure of one or more circulating water system valves or the failure to properly operate these valves, the turbine building could be flooded to the lake surface elevation. All important areas surrounding the turbine building are flood-protected to Elevation 257. The Technical Requirements Manual (TRM) requires the station to be taken out of service, the circulating water pumps be secured, and the condenser isolation valves be closed when the lake level exceeds Elevation 256.

The crest of the Lake Anna Dam, which is at Elevation 265, will not be overtopped by the still-water level of the probable maximum flood. There are no safety implications at the station site from a high water level and wave effects at the dam.

In conclusion, the very conservative revised analysis of the probable maximum flood for the North Anna Power Station shows that there is no safety impact associated with the increased flood level and its coincident wind and wave action. Although no corrective action is required, the TRM limitation mentioned above has been established.

2.4.3.1 **Probable Maximum Precipitation**

The probable maximum precipitation was developed based on Hydrometeorological Report No. 33, which was prepared by the Hydrometeorological Section of the U.S. Weather Bureau in collaboration with the U.S. Army Corps of Engineers. The probable maximum precipitation is shown in Section 2A.2.3.2.

2.4.3.2 **Precipitation Losses**

Precipitation losses were derived using rainfall-runoff relationships for the storms investigated and described in Section 2A.2.4.2. Precipitation losses were determined using historical storms and the HEC-1 (Appendix 2A, Reference 4) loss rate parameter optimization.

The design storm over the 343-square-mile drainage area above the dam was based on Reference 1, as discussed in Sections 2.4.3.1 and 2A.2.3.2.

2.4.3.3 **Runoff Model**

The general procedure followed was to derive unit hydrographs from historical staged discharge data for the dam and historical rainfall records from numerous nearby precipitation stations. The unit hydrograph determination follows the method detailed in Appendix 2A. Unit hydrographs for the North Anna Reservoir were derived for the storms of June 1972, April 1973, September 1974, and March 1975. The procedure followed is as outlined below:

1. An isohyetal map of total storm rainfall for each storm was plotted and a Thiessian's polygon was drawn on the isohyetal map to determine the distribution of basin rainfall.
2. Mass curves of rainfall were drawn to define the time distribution of rainfall.
3. The base flow was subtracted from the measured streamflow hydrograph to obtain the runoff hydrograph for each storm.
4. The basin infiltration was adjusted to balance rainfall excess with flood runoff.
5. Using the runoff hydrograph and the time distribution of rainfall excess for guidance, the unit hydrograph for each flood was determined.

The derivations of the unit hydrographs for each of the four storms studied are summarized in Figure 2A-17.

The unit hydrograph for the April 1973 storm was adopted as the unit hydrograph for the North Anna Reservoir. A unit hydrograph was also developed for the Waste Heat Treatment Facility. The probable maximum precipitation was applied to each of the hydrographs and the resulting flood hydrographs were combined resulting in the total inflow relationship. The HEC-1 computer model was used to compute the total inflow hydrograph and route the probable maximum flood (PMF) through the North Anna Reservoir. Routing of the PMF is also discussed in Sections 2A.2.5.1, 2A.2.5.2, and 2A.2.5.3.

2.4.3.4 **Probable Maximum Flood Flow**

When the probable maximum precipitation is combined with the unit hydrograph, the design storm results in the probable maximum inflow of 296,000 cfs. The peak discharge of this flood is about 142,000 cfs, or about 414 cfs/sm.

To pass the probable maximum flood over the spillway without interference by the tainter gates, described in Section 2.4.1, requires that the gates be lifted to about Elevation 254 to clear the upper nappe of the overflow as shown in Figure 2.4-6. Since the spillway hoists can raise the bottom of the gate, about one foot clear of the upper nappe no interference is deemed credible.

Also, as discussed in Section 3.8.4, floods have no effect on the service water reservoir.

Conservatism in the station arrangement beyond the probable maximum flood has been observed, since the Seismic Class I structures and systems of the station are designed to withstand a flood condition equal to or greater than the 296,000-cfs runoff and water surface elevation of

267.3 feet associated with the probable maximum flood noted above. Provision is made for countering the wave action that may occur with this hypothetical flood condition.

2.4.3.5 **Water Level Determinations**

The probable maximum flow hydrograph was routed through the reservoir using the adopted spillway rule curve, and an outflow hydrograph was developed. This routing results in a maximum outflow from the reservoir of 142,000 cfs with the reservoir level at 264.2 feet, and this discharge has been adopted as the design capacity of the spillway.

The backwater profile curve was therefore begun at the dam at Elevation 264.2, and 142,000 cfs was used as the design flood. The basic method of analysis is to separate the reservoir into a number of reaches, each of which has similar hydraulic characteristics throughout its length. The calculational approach to determine the change in water surface level within each reach is based on Bernoulli's and Manning's formulas and is illustrated in Reference 4. The 5.7-mile reach between the dam and the power station was divided into four subreaches. The hydraulic parameters of the cross-sectional area and the hydraulic radius at each of the five cross-sections are shown in Figures 2.4-7 and 2.4-8. A value of 0.030 was for "n" in Manning's equation to calculate the slope of the energy gradient within each subreach. This value is based on a cleared reservoir. The step-by-step calculations for the design condition indicate the lake level at the station will be about 0.2 foot higher than at the dam site.

Since cross-sectional areas in the lower reaches of the reservoir are large, flow velocities are low, even during floods. The cross-sectional area at Elevation 265.0 ranges between 99,000 and 215,000 ft^2; thus, velocities for a discharge of approximately 142,000 cfs will vary between 0.65 and 1.49 fps.

For an order-of-magnitude illustration, consider the computation of the mean slope of the reservoir between the dam and the power station, assuming a single reach. The mean hydraulic radius is 31 feet and the mean cross-sectional area is 124,000 feet. Therefore, the mean surface slope for a flood of 142,000 cfs, as determined by the following equation, is:

$$S = \left[\frac{Vn}{1.468R\frac{2}{3}}\right]^2 = \left[\frac{1.15 \times 0.030}{1.486 \times 10.29}\right]^2 = 5.00 \times 10^{-6}$$

Since the length of the reach is 30,100 feet, the change in elevation from one end of the reach to the other will be only 0.15 foot. This value is less than the 0.2 foot calculated by the step-by-step method, but it illustrates the order of magnitude of the flow regime.

2.4.3.6 **Coincident Wind Wave Activity**

The analysis resulted in a highly conservative upper-bound value for the still-water level of 264.2 feet associated with the probable maximum flood. At the plant site there would be an additional 0.2 foot for backwater effects and 2.9 feet for wind and wave effects, bringing the maximum level to 267.3 feet. The upper-bound value for the still-water level associated with the

standard project flood is 255.2 feet. At the station site, the addition of 0.2 foot for backwater effects and 2.9 feet for wind and wave effects brings the maximum level to 258.3 feet. Wave runup effects on the circulating water intake structure are conservatively calculated to be less than 4.2 feet. The stages associated with the standard project flood and probable maximum flood at the circulating water intake structure are 259.6 and 268.6 feet, respectively.

The fetch diagram used to estimate effective fetches at the plant and at the screenwell structure is shown in Figure 2.4-9. The typical profile of the area used to estimate runup is shown in Figure 2.4-10. This shows the typical slope to be about 1V on 16H.

Further information concerning the calculation of wave runup at the station site is given in Section 2A.2.7.

2.4.4 Potential Dam Failures (Seismically Induced)

A report entitled *Report on Design and Stability of North Anna Dam for Virginia Electric and Power Company*, dated May 7, 1971, was submitted as Amendment 15 to the North Anna 1 and 2 PSAR. This report demonstrates that the design of the North Anna Dam complies with requirements associated with Seismic Class I structures. Thus, a seismically induced failure of this dam is not credible. The dam is discussed in Section 3.8.3.

The Service Water Reservoir is the normal source of water for the service water system. Therefore, adequate service water would be immediately available to maintain Units 1 and 2 in a safe condition even if Lake Anna were to be drained. (See Section 9.2 for a further discussion of the ultimate heat sink.)

There are no other dams in existence on the North Anna River either upstream or downstream. The only impoundments in the area would be small farm ponds whose failure would not produce any measurable effect on the North Anna Reservoir, the North Anna Dam, or any safety-related systems.

2.4.5 Probable Maximum Surge Flooding

Since the site is not located on an estuary or open coast, surge flooding would not produce the maximum still-water level at the site. An analysis for maximum still-water level using the probable maximum flood is described in Section 2.4.3. Appendix 2A includes the surge effect in its calculation of the maximum water level at the station site due to the probable maximum flood.

2.4.6 Probable Maximum Tsunami Flooding

Tsunami flooding is not a design consideration for the North Anna site because of its inland location.

2.4.7 Ice Flooding

Reservoir operation studies indicate that monthly average natural temperatures of the reservoir would have reached the freezing point only once during the entire period of record. The natural temperature is that which would occur with no station heat load imposed on the reservoir.

With the full generating capacity of the station providing heat to the reservoir, it is estimated that the minimum temperature in the reservoir would be approximately 40°F. Thus, ice-formation-caused flooding is not deemed to be a potential problem at the site.

2.4.8 Cooling Water Canals and Reservoirs

As indicated in Section 2.4.1.2, a series of dikes and canals divide Lake Anna into two segments, the smaller segment forming the Waste Heat Treatment Facility. Circulating water is withdrawn from the North Anna Reservoir at the screenwell near the power station and, from there, is pumped through the condenser and discharged through circulating water discharge tunnels into the circulating water discharge canal, which terminates at the head end of the Waste Heat Treatment Facility. The circulating water then flows through sections of the Waste Heat Treatment Facility and through interconnecting canals to the easternmost dike. This dike contains the circulating water outlet works, which are essentially low-level outlets designed to cause the effluent from the Waste Heat Treatment Facility to thoroughly mix with the residual water in the North Anna Reservoir. While flowing through the Waste Heat Treatment Facility, the circulating water loses a large portion of its heat to the atmosphere. Further temperature reduction is achieved as the circulating water is entrained with the North Anna Reservoir.

The Waste Heat Treatment Facility and North Anna Reservoir are sized to transfer the heat loading imposed by a four-unit power station having a full-load heat rejection rate of 28×10^9 Btu/hr. Further information on the service water reservoir and ultimate heat sink is contained in Section 3.8.4, Section 9.2.1.2.2, and the North Anna PSAR supplement for Chapter 10.

Four dikes and three canals are required to form and interconnect the three cooling lagoons of the Waste Heat Treatment Facility. Hydraulic losses of circulating water as it flows through the canals and the circulating water outlet cause the waste heat treatment facility elevation to be about 1.5 feet higher at the station discharge than the normal North Anna Reservoir pool level.

The dikes consist of compacted earth materials except for a 700-foot length of the easternmost dike, which is constructed of dumped rock fill. The circulating water outlet works are constructed within this rock fill section, and the rock fill area will serve as an emergency overflow for the Waste Heat Treatment Facility. The crest of the rock fill is at Elevation 253.5, while the crest of the earth fills for the remainder of the dikes is at Elevation 260. Thus, when waste heat treatment facility levels exceed 253.5 feet, the rock fill will be overtopped, thereby allowing excess flood waters to enter the North Anna Reservoir without causing the differential level

between the reservoir and the Waste Heat Treatment Facility to exceed 2 feet. It is expected the emergency overflow will operate once in approximately 100 years.

The earth dikes have a minimum crest width of 20 feet and a typical side slope ratio of 2.0 to 1, and each side slope has riprap erosion protection. Diversion pipes through the base of each dike, which were necessary for construction purposes, were left intact during the Lake Anna-filling operation.

The waste heat treatment facility outlet is a skimmer wall structure designed to cause the waste heat treatment facility effluent to enter the North Anna Reservoir as a submerged jet having an initial velocity of about 8 fps. The top of the outlet is submerged at least 10 feet below the minimum lake level. Stop logs are provided to modify outlet discharge flow characteristics as additional units are added to the station.

The three waste heat treatment facility canals are each designed to convey approximately 8000 cfs with a low-water level in the Waste Heat Treatment Facility of about 247 feet. This flow corresponds to the circulating water flow requirement of a 4000-MW station. The canals are also capable of conveying the flood runoff from the drainage area of the Waste Heat Treatment Facility plus the circulating water flow required for the ultimately developed station. In this latter case, however, water levels in the Waste Heat Treatment Facility will be above 251.5 feet, which is the normal waste heat treatment facility level. The maximum expected water level in the Waste Heat Treatment Facility has been estimated to be about 264.2 feet, and this would occur under probable maximum flood conditions when the main reservoir is at Elevation 264.2. The canals are constructed through soil and bedrock and are unpaved. Erosion protection is provided by vegetation along all banks except in the vicinity of the circulating water outfall where riprap is provided.

2.4.9 Channel Diversions

The possibility of upstream diversion of the North Anna River is considered extremely remote. Historical information indicates that the river has not had a major change of course in recent history.

Ice jams would not create a low-flow period of sufficient duration to affect station integrity.

2.4.10 Flood Protection Requirements

The design of Lake Anna, discussed in Sections 2.4.2 through 2.4.7, precludes any possibility of the flooding of the station because its maximum high-water level, including wave runup, is below ground grade at the station site and the crest of the flood-protection dike to the west. Static and dynamic consequences of various types of flooding were considered but had no bearing or effect on the design of safety-related station structures except to the extent that ground-water elevations may be influenced by variations in Lake Anna’s level. Design provisions against the effects of ground water are discussed in Section 3.4 (see also Section 2.4.2.2).

The service water reservoir impounding structures, discussed in Section 3.8.1, are designed to resist seismic events as well as the probable maximum precipitation and associated wind-driven waves. Static and dynamic consequences of flooding were considered in the design of safety-related station structures.

Culverts and drainage ditches have been designed to carry runoff from the most severe storm that is predicted to occur once in 50 years. Precipitation in excess of this storm will result in some localized flooding, but safety-related station structures will be unaffected.

Flood protection from the maximum expected lake elevation and from the effects of local intense precipitation was provided for completed units during the ongoing construction of subsequent units.

Flood protection from high lake water is inherent because of the plant grade, which is above the maximum expected lake surface elevation, including coincident wind and wave activity.

Flood protection from the effects of local intense precipitation is provided by the yard storm and sanitary sewer system, as shown on Reference Drawings 5 and 6, and by local site grading to direct runoff away from all safety-related structures. Both the yard storm and sanitary sewer system and the local site grading were completed before the loading of fuel for the first unit and were not disrupted or otherwise affected by the construction of subsequent units.

2.4.11 Low Water Considerations

2.4.11.1 Low Flow in Rivers and Streams

The mean low flow of the North Anna River is 5 to 6 cfs. The lowest instantaneous flow recorded is 1 cfs; however, the lowest recorded flow for a 24-hour period is 2 cfs.

The normal pool of Lake Anna, created by the dam on the North Anna River, will be maintained at Elevation 250 most of the time; however, during extreme droughts, it is expected that the pool will be drawn down to about Elevation 246. This modest drawdown will not seriously interfere with recreational activities or any safety-related facilities on Lake Anna.

2.4.11.2 Low Water Resulting from Surges

The low water at the station due to the probable maximum meteorological conditions would occur with wind from the south.

The methods described in Reference 6 were used to determine the characteristics of the probable maximum hurricane. The fetch based on winds from the south is approximately 8200 feet. Maximum-force winds from the south were calculated based on the probable maximum hurricane having the following over-water characteristics:

1. Radius of maximum winds: 35 nautical miles.
2. Forward speed of translation: 22 kn.

3. Central pressure index: 26.8 in. Hg.
4. Maximum winds 30 ft above water surface: 135 mph.

In order to reach the station, the pressure center of the hurricane would be over land for approximately 12 hours, and the maximum wind speed from the south would be reduced to approximately 87 mph.

Using the method of analysis in Section 1 of Reference 5, the low-water surge is estimated to be approximately 0.3 foot below the still-water surface.

If it is postulated that the probable maximum hurricane occurs during the drought of record, extreme low water would be governed by meteorological conditions of the drought of record and the low-water surge. The low-water surge of 0.3 foot is subtracted from the calculated minimum water level during the drought of record of 246 feet msl. Extreme low water at the station is estimated to be approximately 245.7 feet msl.

Since all safety-related facilities and other facilities necessary to support operation of the plant are designed for a low-water level of 242 feet msl, these systems will remain capable of fulfilling their design functions.

2.4.11.3 **Historical Low Water**

Prior to filling the reservoir, there was no low-water history available. Low flows in the North Anna River are given in Section 2.4.11.1. The period of record routing used to establish the minimum water elevation in the North Anna Reservoir used a mathematical model. This mathematical model is presented in Appendices G and J of the *Applicant's Environmental Report Supplement, North Anna Power Station, Units 1, 2, 3, and 4*.

2.4.11.4 **Future Control**

During the filling of Lake Anna, a minimum downstream release of 40 cfs was maintained from January through May and 150 cfs was maintained from June through December 1972. Subsequent to the filling of the lake, a minimum downstream release of 40 cfs will be maintained except during drought conditions in accordance with the Lake Level Contingency Plan. This rate is independent of the inflow to the lake, since storage has been provided to augment natural river flows less than 40 cfs.

2.4.11.5 **Plant Requirements**

Circulating water flow for each unit is 952,800 gpm. The circulating water system is described in Section 10.4.2. Approximately 12,000 gpm goes to the bearing cooling water system (Section 10.4.7), and the remainder, 940,000 gpm, goes to the main condenser.

The minimum design operating levels and pump submergence elevations for pumps located in the main intake structure are shown in Table 2.4-6.

The information provided in Table 2.4-6 is for pumps located in the main intake structure only. Information on the service water pump located in the service water pump house is in Section 9.2.1 and on Reference Drawings 8 and 9. The required submergence of the service water pumps is 4 feet. The actual submergence at the minimum service water reservoir level is 6.8 feet.

The minimum design North Anna Reservoir level for all safety-related facilities and other facilities necessary to support operation of the plant is 242 feet msl. This provides a significant margin to accommodate level decreasing to or below the calculated extreme low water elevation of 245.7 feet msl. Even if the lake were drained, service water would still be available through the Service Water Reservoir.

The circulating water discharge structure invert is at 227 feet msl and the top of the opening is located at 245 feet msl. The extreme-low-water level in the North Anna Reservoir is 245.7 feet msl, and the discharge canal level is approximately 1.5 feet above the reservoir level, or approximately 247.2 feet msl. As a result, the centerline of the submerged effluent is 11.2 feet below the surface of the discharge canal.

2.4.11.6 **Dependability Requirements**

The North Anna Reservoir level is displayed at the dam and is available in the main control room from the plant computer. The normal operating reservoir level is 250 feet msl, which provides a 4.3-foot margin to the calculated extreme low water elevation of 245.7 feet msl. Since a 9.33-foot margin exists between the normal operating reservoir level and the minimum operating level (240.67 feet msl) required for the auxiliary service water pumps, a low-water safety factor of 2.17 is provided for the pumps.

The service water reservoir is described in Sections 9.2.1 and 3.8.4. Normal service water operation for Units 1 and 2 uses the service water reservoir. The service water reservoir elevation is not affected by low-flow conditions in the North Anna River or low levels in Lake Anna. The reservoir volume will be controlled to provide a minimum water supply of 30 days.

Fire protection water is drawn from the service water system, and 600,000 gallons has been added to the required 30-day supply for this purpose. The Chapter 10 supplement to the North Anna Units 3 and 4 PSAR (Docket Nos. 50-404 and 50-405) also deals with the performance and dependability of the service water reservoir.

The normal operating heat loads rejected to the service water reservoir from either Unit 1 or 2 maintain the reservoir above freezing. The flow in the spray headers in use during normal operation prevents the freezing of the headers themselves. Additionally, the arrays are self-draining to aid in preventing them from freezing when shut down. When not in use, spray drift or frozen precipitation could result in the icing of the nonoperating nozzles. To prevent this, a minimum flow of water is maintained through these nozzles when specific adverse weather conditions exist.

2.4.12 Environmental Acceptance of Effluents

Estimated releases of radioactive effluents are discussed in Section 11.2.5 of this report. The locations of users of surface water and ground water are presented in Sections 2.4.1.2 and 2.4.13.2, respectively.

2.4.13 Ground Water

2.4.13.1 Description and Onsite Use

The station site is situated in the central portion of the Piedmont physiographic province, with the Blue Ridge province about 40 miles to the west and the Coastal Plain province about 15 miles to the east. Surficial soil in the province, mainly saprolite, has been produced by the weathering of underlying igneous and metamorphic rocks and ranges in thickness from 0 to 125 feet.

Ground water in the saprolite occurs under water table conditions, recharge occurs by precipitation, and discharge commonly occurs as springs in low-lying areas. The altitude and depth of the water table are governed by topography, and therefore the direction of movement is toward lower elevations.

Most wells in the saprolite have been either bored or hand dug and have capacities less than 5 gpm. Many of the shallow wells become dry during periods of deficient rainfall.

Water is also stored in the underlying crystalline rock and transmitted through cracks, fissures, and planes of foliation. Ninety percent of the wells founded in rock and for which records are available yield less than 25 gpm. The most productive well in the site area is 13 miles away, near Louisa; it is 163 feet deep and yields about 180 gpm. The average yield of the rock wells in the area is less than 5 gpm, indicating low permeability of the bedrock.

Two in situ surface percolation tests were conducted to evaluate the infiltration characteristics of the micaceous hornblende saprolite and the more prevalent granitic gneiss saprolite that are found at the site proper. The observed absorption rates varied from 0.3 to 0.6 gal/day-ft^2, indicating that the soil is essentially impermeable. Laboratory data indicate a permeability range of 0.02 to 0.84 gal/day/ft^2.

Pumping tests of two wells in zones of highly fractured rock were conducted at the site. Each of the wells was pumped dry in about 1 hour at a pumping rate of about 5 gpm. Measurements taken at nearby observation wells indicated that ground-water levels were unaffected by the pumping tests.

The configuration of the piezometric surface generally follows surface topography and, in the site area, the surface slopes at an average rate of 8 feet per 100 feet toward the North Anna River and its tributaries. The final station yard grade is at Elevation 271 and the North Anna Reservoir is maintained at Elevation 250, and all surface and subsurface drainage from the site is toward the reservoir. About 95% of all surface water runs off directly to the reservoir and about

5% percolates vertically through the saprolite to the ground-water table, whereupon it flows toward the reservoir. Fluids discharged below the ground surface behave similarly. Filling the reservoir raised the local base level of ground-water discharge about 50 feet and thereby reduced the hydraulic gradient across the site to about 6 feet per 100 feet. The expected rate of ground-water movement under these conditions is about 0.015 ft/day.

Wells provide water for the plant's domestic water system. These wells are described in Section 9.2.3.1.

Structures for Units 1 and 2 were designed and analyzed using a uniform ground-water level of 256-foot. The interpretation of available data on subsurface conditions at the site before construction led to this prediction. Since the time the 256-foot prediction was made, data casting doubt upon the accuracy of that prediction have become available. Additional investigations revealed that it is possible for ground-water elevations to be as high as 265 to 270 feet within the station area.

The variability of subsurface conditions and limited data availability do not permit exact predictions of postconstruction ground-water conditions. In view of these difficulties, a conservative, revised, general prediction of higher ground-water elevations is based on a water surface profile sloping uniformly from the toe of the excavated slope south of the plant area (Elevation 271) to Lake Anna (Elevation 250). The contours for the post-construction ground-water elevations above mean sea level are shown in Reference Drawing 7. Not included in this prediction are the effects of any subsurface drainage or structures on the ground-water level. Where conditions appear capable of producing locally higher ground-water levels, appropriate modifications are made to the general prediction to ensure the adequacy of safety-related structures and facilities.

A reanalysis of affected Unit 1 and 2 structures was performed to evaluate structural integrity at increased ground-water levels. From this reanalysis, it was determined that the below-grade portions of all structures have sufficient structural capacity to withstand both static and dynamic loads (design-basis earthquake) associated with the higher water levels.

In addition to the structural reanalysis, it was necessary to reanalyze certain safety-related structures for stability in association with the design-basis earthquake at higher ground-water levels. Class I structures founded below the ground-water levels shown in Reference Drawing 7 were reanalyzed for the higher ground-water levels shown on this figure. Table 2.4-7 lists the structures, the original and revised ground-water levels for which they were analyzed, and the corresponding factors of safety against overturning and sliding, where applicable, for these ground-water elevations. Table 2.4-8 provides the factors of safety for the operating-basis earthquake (with ground-water elevations as shown in Reference Drawing 7) in those cases where the factor of safety for the design-basis earthquake was less than 1.5.

2.4.13.2 **Offsite Ground-Water Use**

There are no known users of large quantities of ground water within 25 miles of the site. Several small towns use ground-water supplies; however, the larger towns use surface supplies. There are 45 public water supplies within 25 miles of the site. These are illustrated in Table 2.4-3. Thirty-four of these obtain water from wells, and the rest obtain water from surface sources. The nearest public water supply is for the town of Mineral and is about 9 miles away.

The site area is sparsely populated and at present there is only one dwelling within a mile of the site. Water for this residence is obtained from a spring. There are 15 dwellings and 2 churches between 1 and 2 miles from the site. Water for these residences is obtained from springs and dug wells, which are located across drainage divides or at elevations above the new ground-water level at the site.

A map showing the location of ground-water users in the vicinity of the site is on Plate IIB-3 of a report entitled *Report, Site Environmental Studies, Proposed North Anna Power Station, Louisa County, Virginia, Virginia Electric and Power Company*, which was submitted as Appendix A to the North Anna Units 1 and 2 PSAR. This plate is reproduced here as Figure 2.4-11. Ground-water users in the vicinity of the site are tabulated in Table 2.4-3.

2.4.13.3 **Accident Effects**

As stated in the previous section, all wells are either located at a higher elevation than the ground water at the site or across drainage divides. Ground water flows in the direction of Lake Anna and there are no wells between the site and the lake. Thus, an adverse effect on existing water wells or the ground-water resources in the site vicinity from the construction and operation of the station is extremely improbable.

2.4.13.4 **Monitoring or Safeguard Requirements**

The potential for the contamination of existing ground-water resources is remote; however, a radiological environmental monitoring program is conducted. The preoperational program is described in the North Anna Environmental Report, Appendix F-5. The monitoring program during operation was originally given in the Environmental Technical Specifications. The Environmental Technical Specifications have been replaced by the Offsite Dose Calculation Manual (ODCM) which now contains the radiological environmental monitoring program.

2.4.14 Station and Emergency Operation Requirements

Adverse hydrometeorologically related events are expected to have no impact on safety-related facilities.

The North Anna Dam and Power Station, including all safety-related facilities, were designed to operate safely through the occurrence of the probable maximum flood.

Ample margin has been provided in the location and design of these systems to accommodate a flood of much greater magnitude than the probable maximum flood without endangering the safety of the station.

The overtopping of the dam by the still-water level of the probable maximum flood is not deemed to be a credible event. However, if this did occur, the station would have already been shut down in accordance with the Technical Requirements Manual, which will require the station to be shut down in the event the lake level exceeds 256 feet msl. This operational restriction is required by the revised probable maximum flood analysis presented in Appendix 2A. In any event, the station is designed to withstand flooding in the turbine building up to an elevation of 257 feet msl. The Technical Requirements Manual will also require the shutdown of the station with a lake elevation below 242 feet msl. As stated in Section 2.4.11.2, this is the minimum design level for all safety-related facilities. Table 2.4-6 indicates that the actual minimum operating level for the safety-related screen wash pumps is 241 feet msl and 240.67 feet msl for the auxiliary service water pumps.

2.4 REFERENCES

1. *Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1000 Square Miles and Durations of 6, 12, 24, and 48 Hours*, Hydrometeorological Report 33, U.S. Weather Bureau, 1956.
2. *Civil Works Investigations - Project 152, 1963 - Unit Hydrographs: Part I, Principles and Determinations*, U.S. Army Corps of Engineers, U.S. Army Engineer District, Baltimore, Maryland.
3. *Handbook of Applied Hydraulics*, C. V. Davis, editor-in-chief, McGraw-Hill, New York, 1952.
4. *Report, Site Environmental Studies, Proposed North Anna Power Station, Louisa County, Virginia*, Part 2, Section B, Virginia Electric and Power Company, January 13, 1969.
5. *Shore Protection Planning and Design*, Technical Report No. 4, 3rd Edition, Department of Army Corps of Engineers, 1966.
6. *HUR-7-97, Interim Report - Meteorological Characteristics of the Probable Maximum Hurricane, Atlantic and Gulf Coasts of the United States*, U.S. Weather Bureau, Hydrometeorological Branch, May 1968.
7. R. L. Daugherty and A. C. Ingersoll, *Fluid Mechanics with Engineering Applications*, McGraw-Hill, New York, 1954.

2.4 REFERENCE DRAWINGS

The list of Station Drawings below is provided for information only. The referenced drawings are not part of the UFSAR. This is not intended to be a complete listing of all Station Drawings referenced from this section of the UFSAR. The contents of Station Drawings are controlled by station procedure.

	Drawing Number	Description
1.	11715-FH-201A	Tainter Gates, General Arrangement
2.	11715-FH-201B	Tainter Gates, Details
3.	11715-FH-201C	Tainter Gates, Trunnion Bearings and Support Girders
4.	11715-FH-201D	Tainter Gates, Guide Detail
5.	11715-FB-1A	Arrangement: Yard, Storm and Sanitary Sewer, Sheet 1
	12180-FB-1A	Yard Storm Sewers, Sheet 1
6.	11715-FB-1B	Arrangement: Yard, Storm and Sanitary Sewer, Sheet 2
7.	11715-GSK-188	Maximum Anticipated Site Ground Water Elevations
8.	11715-FM-8A	Arrangement: Service Water Pump House, Sheet 1
9.	11715-FM-8B	Arrangement: Service Water Pump House, Sheet 2
10.	12180-FB-1C	Yard Storm Sewers, Sheet 3
11.	12180-FB-1D	Yard Storm Sewers, Sheet 4
12.	12180-FB-1E	Yard Storm Sewers, Sheet 5

Table 2.4-1
SUMMARY OF USGS GAUGING STATION RECORDS AND ESTIMATED STREAM FLOW DATA FOR THE NORTH ANNA DAM

River Location	Drainage Area ($mile^2$)	Period of Record[a]	Discharge (cfs)		
			Average	Minimum	Maximum
USGS gauge at Doswell	439	1929-1971	382[b]	1[c]	24,800[d]
North Anna Dam	343[e]	1929-1971	300[e]	1[e]	19,500[e]

a. Dam was closed January 1972.
b. Average discharge for 41-year period.
c. Date of discharge: September 30 to October 2, 1932.
d. Date of discharge: August 21, 1969.
e. Estimated.

Table 2.4-2
FLOW-DURATION DATA

Lake Anna Inflow, (cfs)	Percentage of Months Inflow Is Exceeded
6	100
142	75
285	50
505	25
835	10

Table 2.4-3
PUBLIC WATER SUPPLIES IN THE VICINITY OF THE SITE, MARCH 1977

Owner	Source	Remarks
Walton Lumber Co.	1 well	The well is 240 feet deep. The system serves 13 users.
Fredericksburg	Rappahannock River	The municipal water supply system has 5900 equivalent residential connections.
Louisa	3 wells and 1 spring	There are 344 connections.
Blue Ridge Shores	3 wells	The wells, which are 163, 300, and 239 feet deep, provide water to 400 users.
Department of Welfare and Institutions	3 wells	The wells are 200, 245, and 300 feet and institutions deep and yield 20, 100, and 10 gpm, respectively.
Mineral	1 well and 2 springs	The well, 200 feet deep, supplies most of the water; however, two springs are sometimes used. There are 310 connections.
Bowling Green	2 wells	The wells are 301 and 344 feet deep.
Ashland	South Anna River	The municipal water supply system has about 900 users.
Gordonsville	Springs	Pikes Mountain Springs, located 5 miles northwest of town, and Cameron Springs, located 2 miles southwest of town, are the water sources.
Lake of the Woods	Wells	Several wells are rated for production of from 5 to 45 gpm
Goochland	4 wells	The wells furnish water to about 500 users.
Doswell	North Anna River	The system produced 100 million gallons of treated water in 1976; withdrawals began in 1975.
Correctional Field, Unit 12	1 well	The well is 87 feet deep and produces 20 gpm.
Edgcomb Steel Company	1 well	The well is 510 feet deep and produces 10 gpm.
Twin Oaks Community	2 wells	One well is 250 feet deep and produces 5 gpm. The depth of the other well is unknown; it produces 5 gpm. The wells supply water to 54 persons.

Table 2.4-3 (continued)
PUBLIC WATER SUPPLIES IN THE VICINITY OF THE SITE, MARCH 1977

Owner	Source	Remarks
Walnut Grove Trailer Park	1 well	The trailer park is located at the intersection of Routes 618 and 650.
Six-O-Five Trailer Court	1 well	Trailer court is located on Route 605, 0.25 mile north of Route 33.
Taylor West Trailer Court	1 well	Trailer court is located south of Route 33, 3 miles west of Louisa.
Lake Anna Estates Trailer Park	1 well	Trailer park is located on Route 652, 1.5 miles west of Route 600 in Louisa County.
Weyerhauser	1 well	The well serves the company’s 150 employees. The company is located off Route 1, at the North Anna River.
Hanover Industrial Air Park	1 well	The well produces 25,400 gal/day.
Natkin and Company	1 well	The well serves the company’s 160 employees. The company is located on Route 1, 1.2 miles north of Henrico-Hanover County line.
Stoney Run Estates		Not yet developed.
Holly Farms	James River	Contract with Henrico County and City of Richmond. The system supplies 600,000 gal/day.
Oak Hill Estates	1 well	The well serves the 400 persons in the development, which is located 2 miles west of Route 1, off Route 33.
State Farm Filtration Plant	Beaverdam Creek, Courthouse Creek	The system serves state correctional units in the area. It supplies 1.5 million gal/day.
Hickory Haven Subdivision	2 wells	The wells serve the 184 persons in the subdivision which is located off Route 1006, south of Route 6.
Samary Forest Subdivision	1 well	The well serves 11 homes, a motel, and a restaurant.
Greenfield Village	2 wells	There are 109 connections; wells are 140 and 164 feet deep.
Doubleday Publishing Company, Inc.	1 well	The well is 400 feet deep and produces 150 gpm.
Lake Wilderness	5 wells	There are 166 connections.

Table 2.4-3 (continued)
PUBLIC WATER SUPPLIES IN THE VICINITY OF THE SITE, MARCH 1977

Owner	Source	Remarks
Ni River Water Treatment Plant (Route 627)	1 well	The well produces 1.0 million gal/day. Spotsylvania County Department of Public Works.
Winewood Subdivision	1 well	The well is 390 feet deep and produces 50 gpm. There are 50 connections.
Sylvania Heights	1 well	The well is 224 feet deep and produces 47 gpm. There are 165 connections. Spotsylvania County Department of Public Works.
Ni River Water Treatment Plant (Route 208)	Ni River	The system supplies 0.144 million gal/day. Spotsylvania County Department of Public Works.
Indian Acres of Thornburg	4 wells	The wells supply 4900 campsites.
General Products, Inc.	1 well	The well, which serves the company’s 160 employees, is 300 feet deep and produces 107 gpm.
Country Club Estates	1 well	The well is 250 feet deep and produces 165 gpm. There are 33 connections.
Town of Orange	Rapidan River	The system supplies 2 million gal/day.
Germanna Community College	1 well	The well is 310 feet deep and produces 25 gpm.
Lake Caroline	Stevens Mill Run	The system supplies 0.576 million gal/day.
Lake Land’Or	2 wells	The wells are 292 and 475 feet deep. There are 121 connections.
I-95 rest area	1 well	The well is 445 feet deep and produces 78 gpm.
Twin Cedars	1 well	The well is 317 feet deep and produces 50 gpm. There are 35 connections.
Campbell’s Creek Subdivision	1 well	The well is 450 feet deep and produces 25 gpm. There are 49 connections.
Wilderness Camping Resorts	2 wells	The wells supply 1522 campsites.

Table 2.4-4
FLOODS ON THE NORTH ANNA RIVER

Flood Period	Peak Flow at Doswell (cfs)	Volume of Direct Runoff at Doswell (acre-ft)
April 24-29, 1937	18,300	81,400
June 28-July 1, 1949	3720	11,400
April 12-16, 1953	3720	14,200
August 12-25, 1955	12,400	54,700
August 20-23, 1969	24,800	141,000
June 20-22, 1972	24,000	107,200[a]

a. Includes 52,100-acre-ft change in storage in Lake Anna.

Table 2.4-5
ONSITE FLOODING PRODUCED BY LOCALIZED RAINFALL

Storm Return Period (year)	Storm Duration (hr)	Rainfall Intensity (in/hr)	Total Rainfall (in.)	System Capability (in.)	Excess Water Onsite at End of Storm (in.)
10	1	2.7	2.7	7	0
	3	1.2	3.6	21	0
	6	0.7	4.2	42	0
	12	0.4	4.8	84	0
50	1	3.7	3.7	7	0
	3	1.8	5.4	21	0
	6	1.0	6.0	42	0
	12	0.5	6.0	84	0
100	1	4.2	4.2	7	0
	3	2.0	6.0	21	0
	6	1.1	6.6	42	0
	12	0.6	7.2	84	0
PMP	1	14.5	14.5	7	7.5
	3	7.8	23.4	21	2.4
	6	4.8	28.8	42	0
	12	2.6	31.3	84	0

Key: PMP = probable maximum precipitation.

Table 2.4-6
PUMP SUBMERGENCE AND MINIMUM OPERATING LEVEL
AT THE MAIN INTAKE STRUCTURE [a, b]

Description	Minimum Operating Level (ft above msl) [c]	Required Submergence Below Minimum Operating Level (ft-in.) [d]	Actual Submergence Below Extreme Low Water Level (ft-in.) [e]
Circulating water pumps	235	11-6	22-2
Auxiliary service water pumps	240.67	4-0	9-0
Circulating water screen wash pumps - safety-related (1-CW-P-2B & 2-CW-P-2A)	241	2-0	6-9
Circulating water screen wash pumps - non-safety-related (1-CW-P-2A & 2-CW-P-2B)	239.5	2-0	8-3
Motor driven fire protection pump	233.8	1-7	13-5
Bearing lubricating water pumps	240.6	2-6	7-7
Auxiliary flash evaporator pumps	241.5	3-0	7-3
Reverse osmosis water pump	241	1-6	6-3

a. The sump invert elevation is at +221 ft msl.
b. This table provides nominal values and does not include other operational considerations such as differential water levels that may develop across the trash racks and traveling screens.
c. This value represents the bottom of the pump bell elevation + manufacturer's minimum required submergence.
d. This value represents the manufacturer's minimum required submergence above the bottom of the pump bell elevation.
e. This value represents the difference between the elevation of the extreme low water level (245.7 feet, accounting for hurricane conditions) and the elevation of the bottom of the pump bell.

Table 2.4-7
MINIMUM FACTORS OF SAFETY AGAINST OVERTURNING AND SLIDING AT DESIGN GROUND-WATER ELEVATIONS FOR DESIGN-BASIS EARTHQUAKE

Structure	Factors of Safety at Ground-Water Elevations of 256 ft msl				Ground-Water Elevations as Shown in Reference Drawing 7 (ft above msl)	Factors of Safety at Ground-Water Elevations Shown in Reference Drawing 7			
	Sliding		Overturning			Sliding		Overturning	
	N-S	E-W	N-S	E-W		N-S	E-W	N-S	E-W
Fuel building	2.1	(a)	3.7	(a)	267	1.8	(a)	3.1	(a)
Auxiliary building	1.8	(a)	10.8	(a)	265	1.5	(a)	9.2	(a)
Reactor containment, Unit 1	(b)	(b)	(b)	(b)	264	(b)	(b)	(b)	(b)
Reactor containment, Unit 2	1.6	(a)	1.8	(a)	266.5	1.3	(a)	1.5	(a)
Service building	1.4	(a)	2.2	(a)	262	1.2	(a)	1.8	(a)
Auxiliary feedwater pipe tunnel	These structures are entirely below grade; therefore, sliding and/or overturning are not credible by inspection.				267				
Buried fuel-oil tanks					270.5				
Waste gas decay tank enclosure					267				
Main steam valve and quench spray pump house, Unit 1	2.35	(c)	1.42	(c)	263	1.87	(c)	1.19	(c)

a. Factor of safety either equals or exceeds the value for the direction given.
b. Factor of safety either equals or exceeds the value given for reactor containment, Unit 2.
c. Direction of motion for factor of safety is toward containment.

Table 2.4-7 (continued)
MINIMUM FACTORS OF SAFETY AGAINST OVERTURNING AND SLIDING AT DESIGN GROUND-WATER ELEVATIONS FOR DESIGN-BASIS EARTHQUAKE

	Factors of Safety at Ground-Water Elevations of 256 ft msl				Ground-Water Elevations as Shown in Reference Drawing 7 (ft above msl)	Factors of Safety at Ground-Water Elevations Shown in Reference Drawing 7			
	Sliding		Overturning			Sliding		Overturning	
Structure	N-S	E-W	N-S	E-W		N-S	E-W	N-S	E-W
Main steam valve and quench spray pump house, Unit 2	2.34	(c)	2.25	(c)	266	1.58	(c)	1.39	(c)
Safeguards area, Unit 1	2.14	(c)	2.25	(c)	263	1.46	(c)	1.52	(c)
Safeguards area, Unit 2	1.91	(c)	2.56	(c)	267	1.28	(c)	1.83	(c)

a. Factor of safety either equals or exceeds the value for the direction given.
b. Factor of safety either equals or exceeds the value given for reactor containment, Unit 2.
c. Direction of motion for factor of safety is toward containment.

Table 2.4-8
MINIMUM FACTORS OF SAFETY AGAINST SLIDING AND OVERTURNING AT GROUND-WATER ELEVATIONS SHOWN ON REFERENCE DRAWING 7 FOR OPERATING-BASIS EARTHQUAKE[a]

Structure	Ground-Water Elevations (ft above msl)	Sliding		Overturning	
		N-S	E-W	N-S	E-W
Reactor containment, Unit 2	266.5	2.1	(b)	--	--
Safeguards area, Unit 1	263	1.70	(c)	--	--
Safeguards area, Unit 2	267	1.58	(c)	--	--
Main steam valve and quench spray pump house, Unit 1	263	--	--	1.73	(c)
Main steam valve and quench spray pump house, Unit 2	266	--	--	2.83	(c)
Service building	262	2.1	(a)	--	--

a. Factors of safety are provided for only those cases where the calculated factor of safety for the design-basis earthquake was less than 1.5 (see Table 2.4-6).
b. Factor of safety either equals or exceeds the value for the given direction.
c. Direction of motion for factor of safety is towards containment.

Figure 2.4-1
NORTH ANNA RESERVOIR

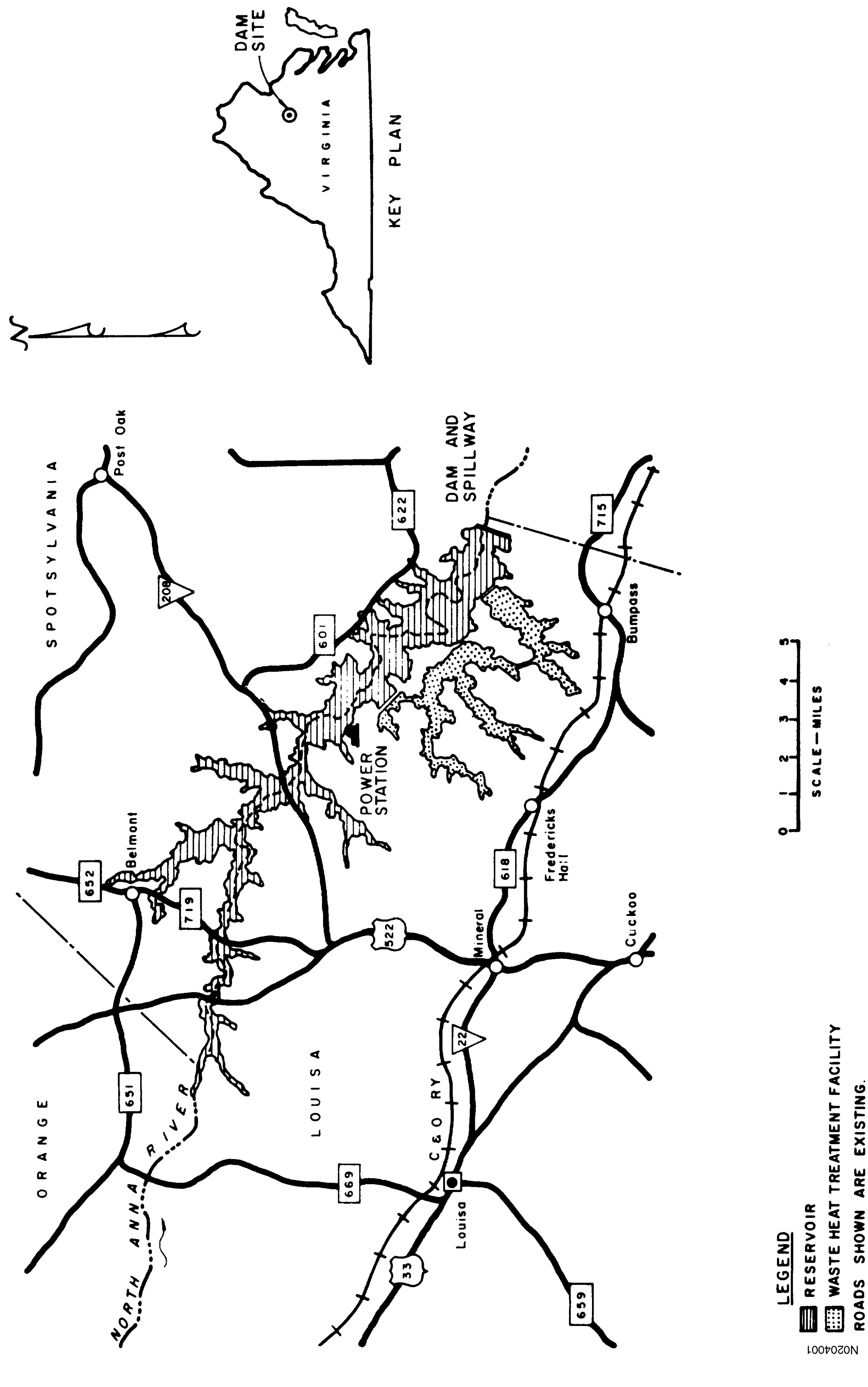

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Figure 2.4-3
SPILLWAY DISCHARGE CAPACITY (ONE GATE OF THREE) NORTH ANNA DAM

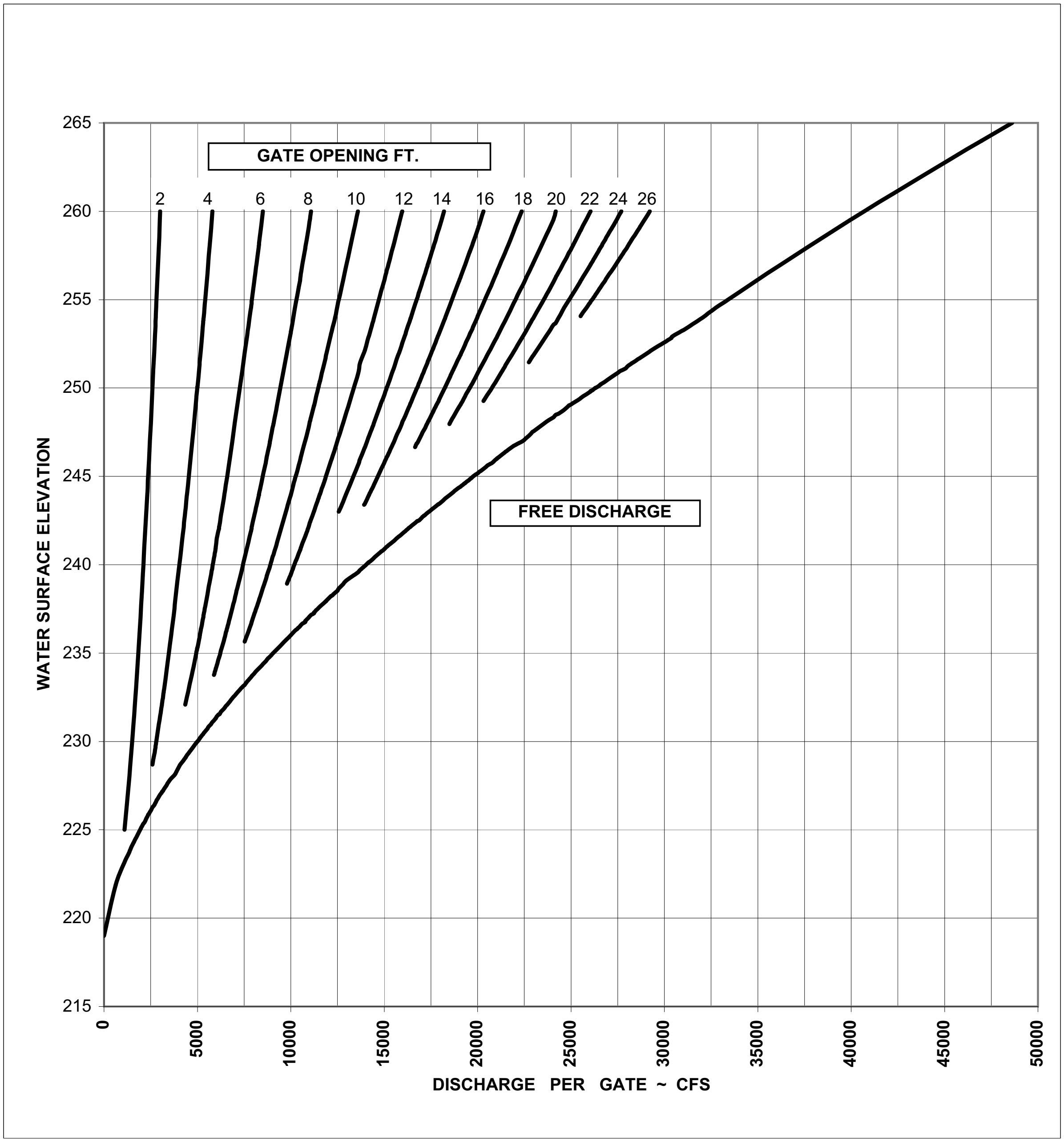
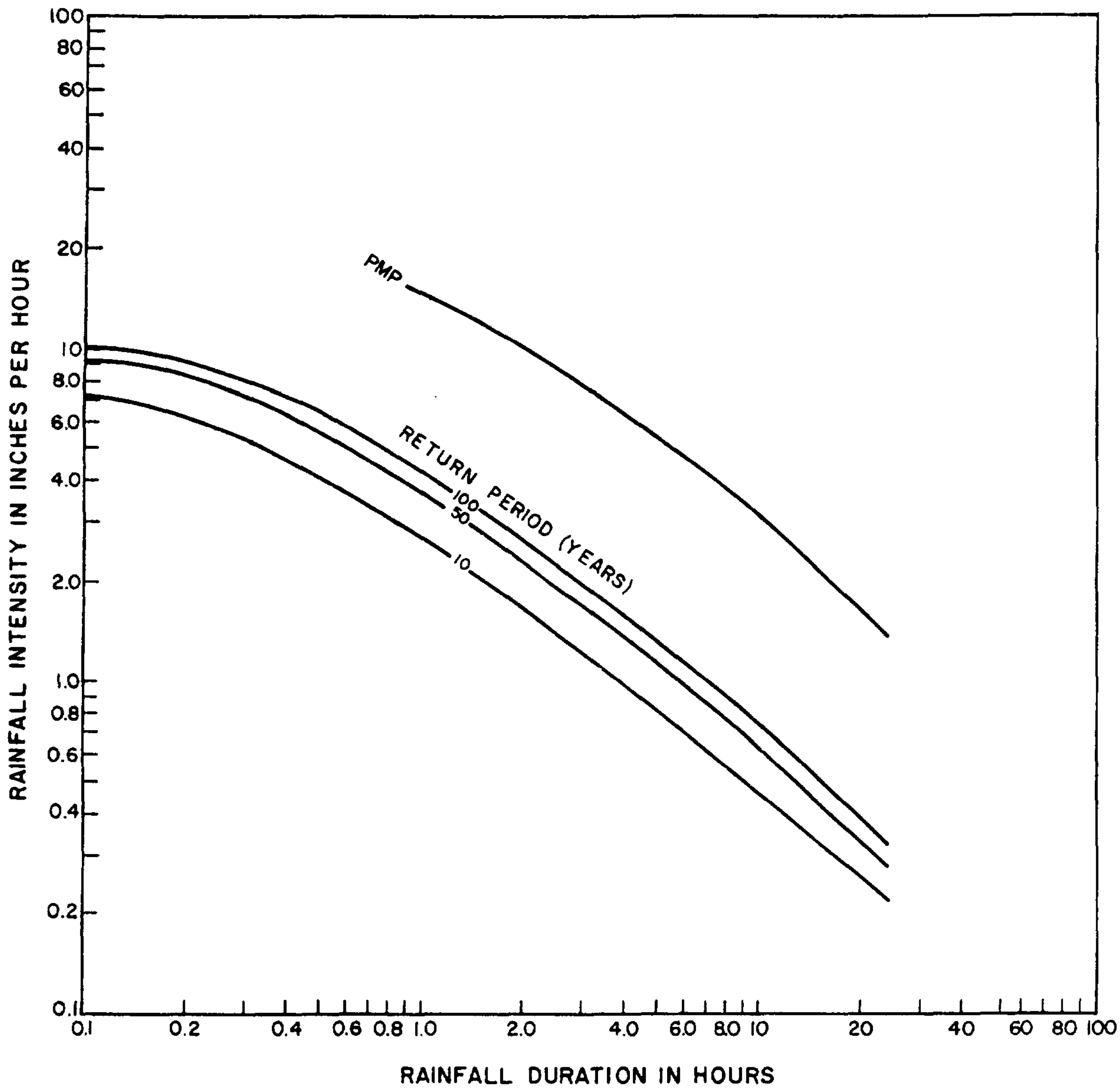


Figure 2.4-4
RAINFALL INTENSITY DURATION, RICHMOND VIRGINIA



N0204005

REPRODUCED FROM VIRGINIA
DEPARTMENT OF HIGHWAYS
DRAINAGE MANUAL

Figure 2.4-5
DRAINAGE AREA WEST OF SITE

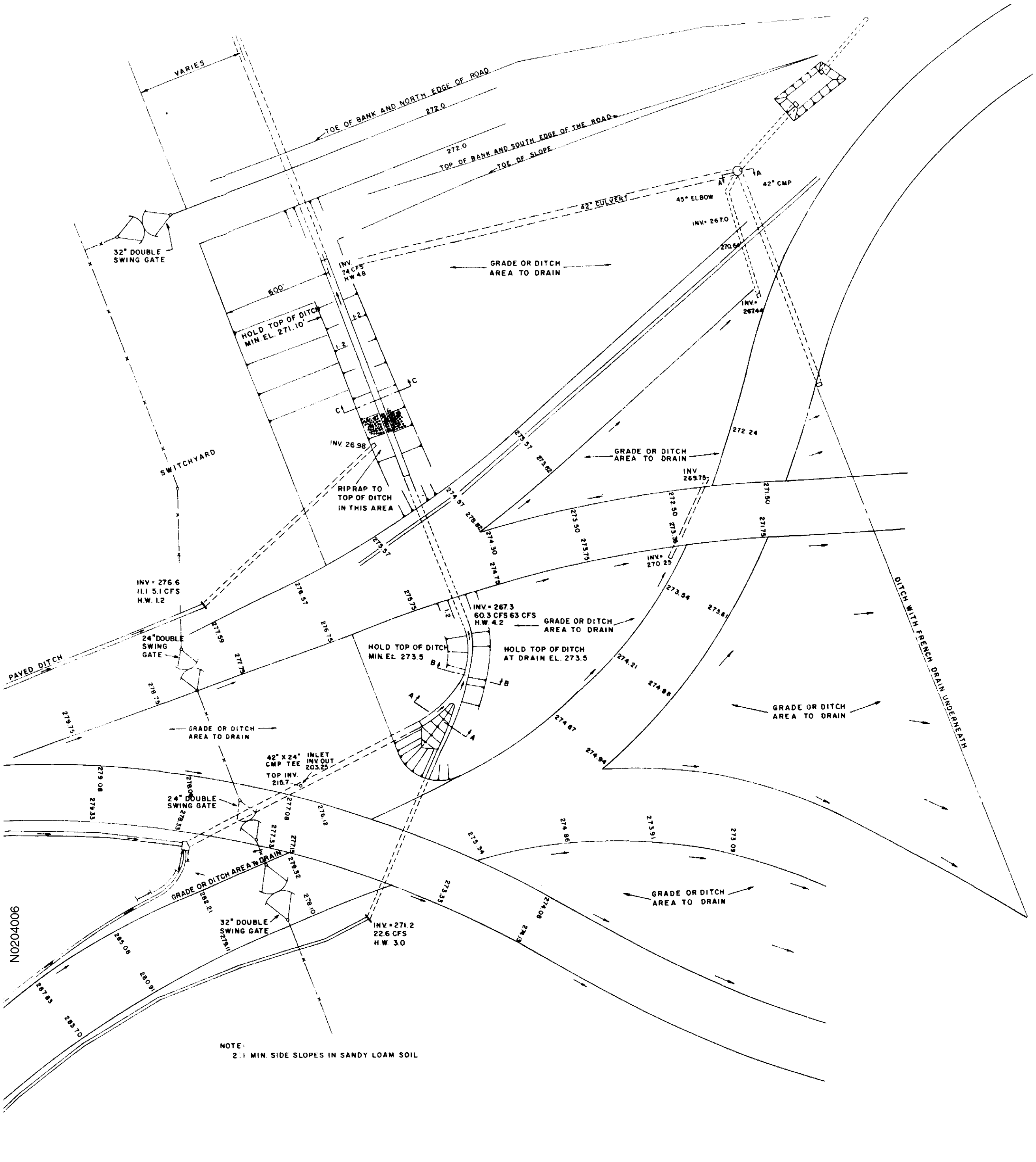
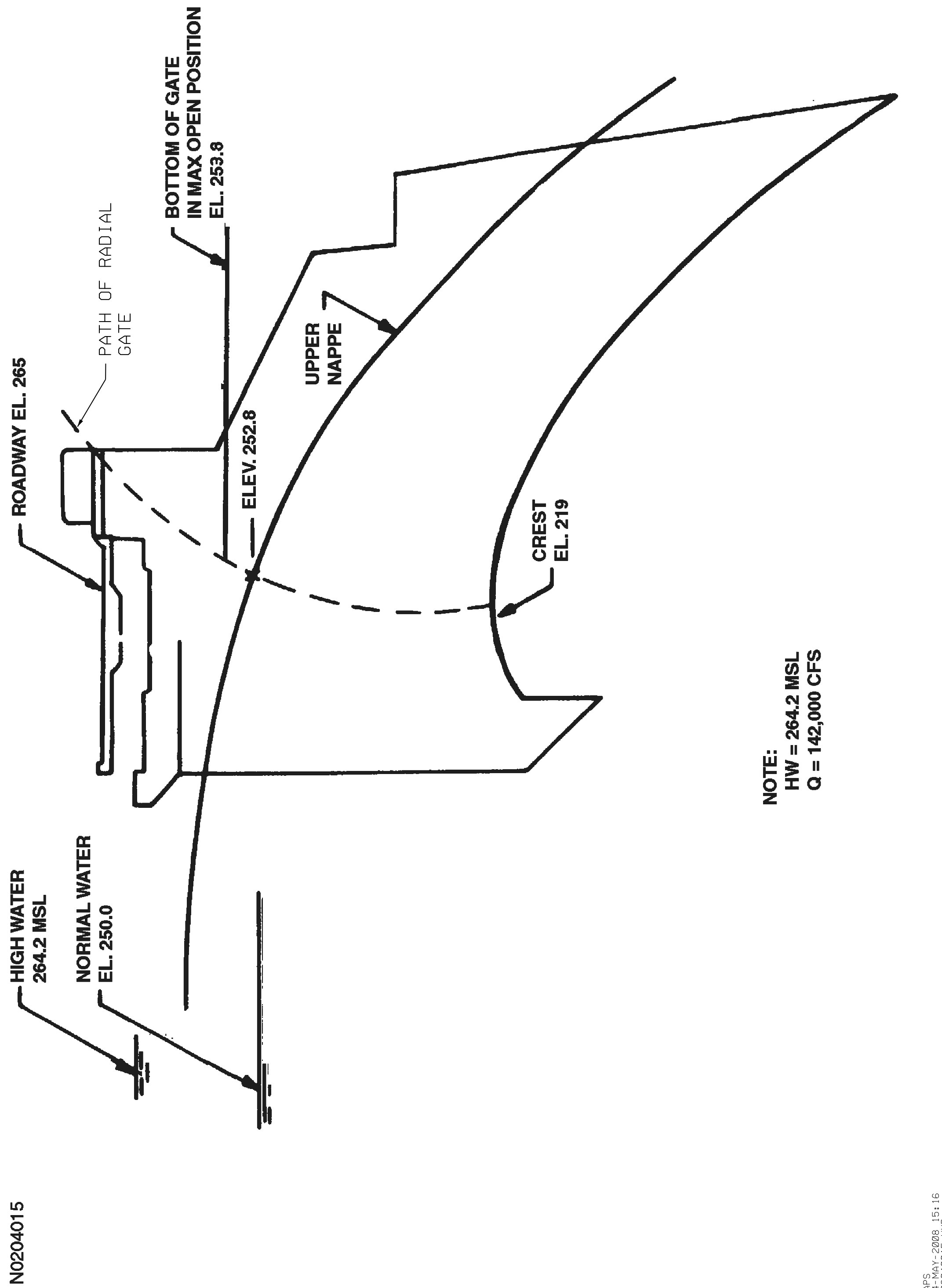


Figure 2.4-6
DRAWDOWN AT SPILLWAY



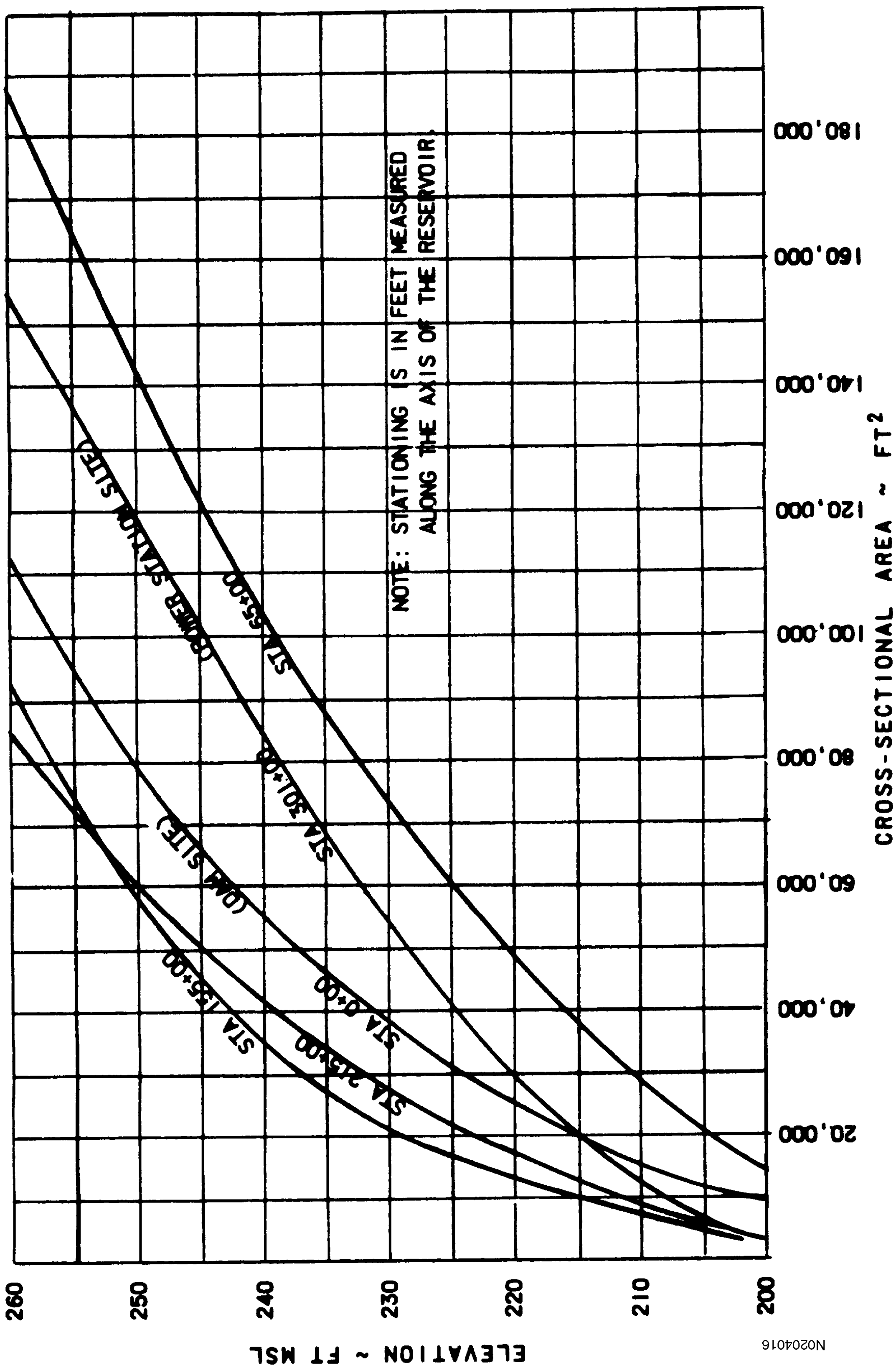


Figure 2.4-7
AREA - ELEVATION - NORTH ANNA RIVER

Figure 2.4-8
HYDRAULIC RADIUS VS. ELEVATION - NORTH ANNA RIVER

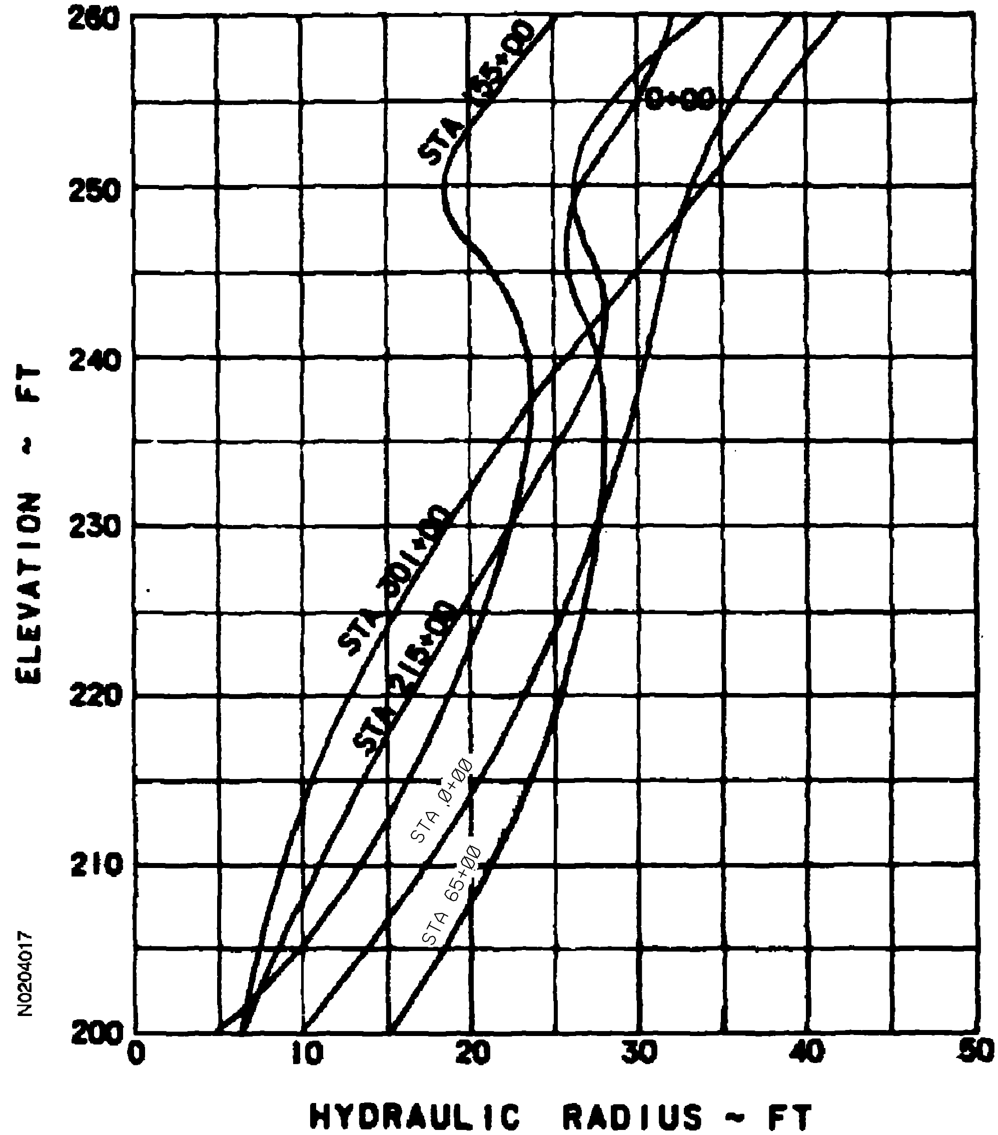


Figure 2.4-9
FETCH DIAGRAM FOR SURGE AND WAVE RUNUP

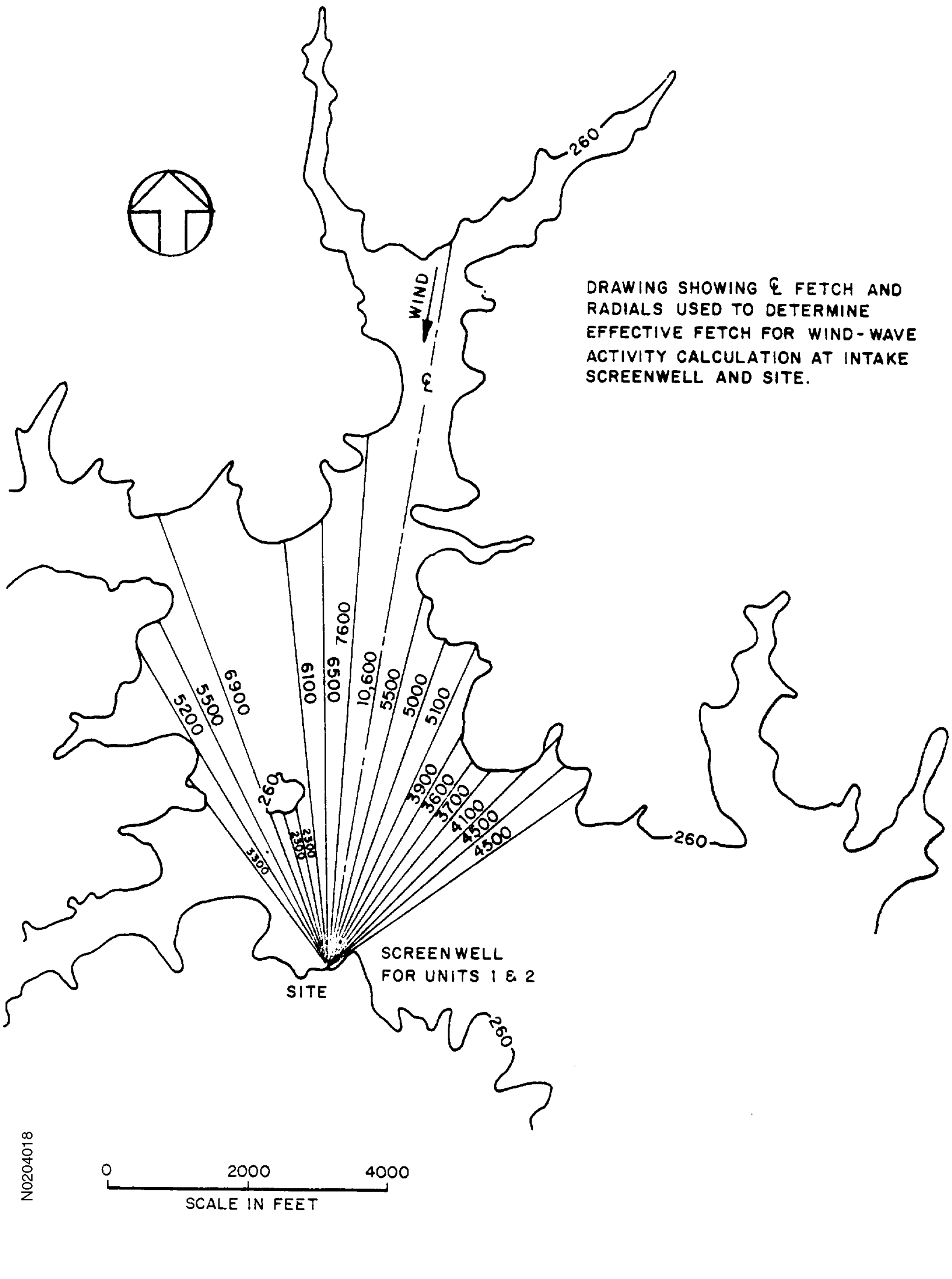


Figure 2.4-10
TYPICAL GROUND PROFILE - VICINITY OF STATION INTAKES

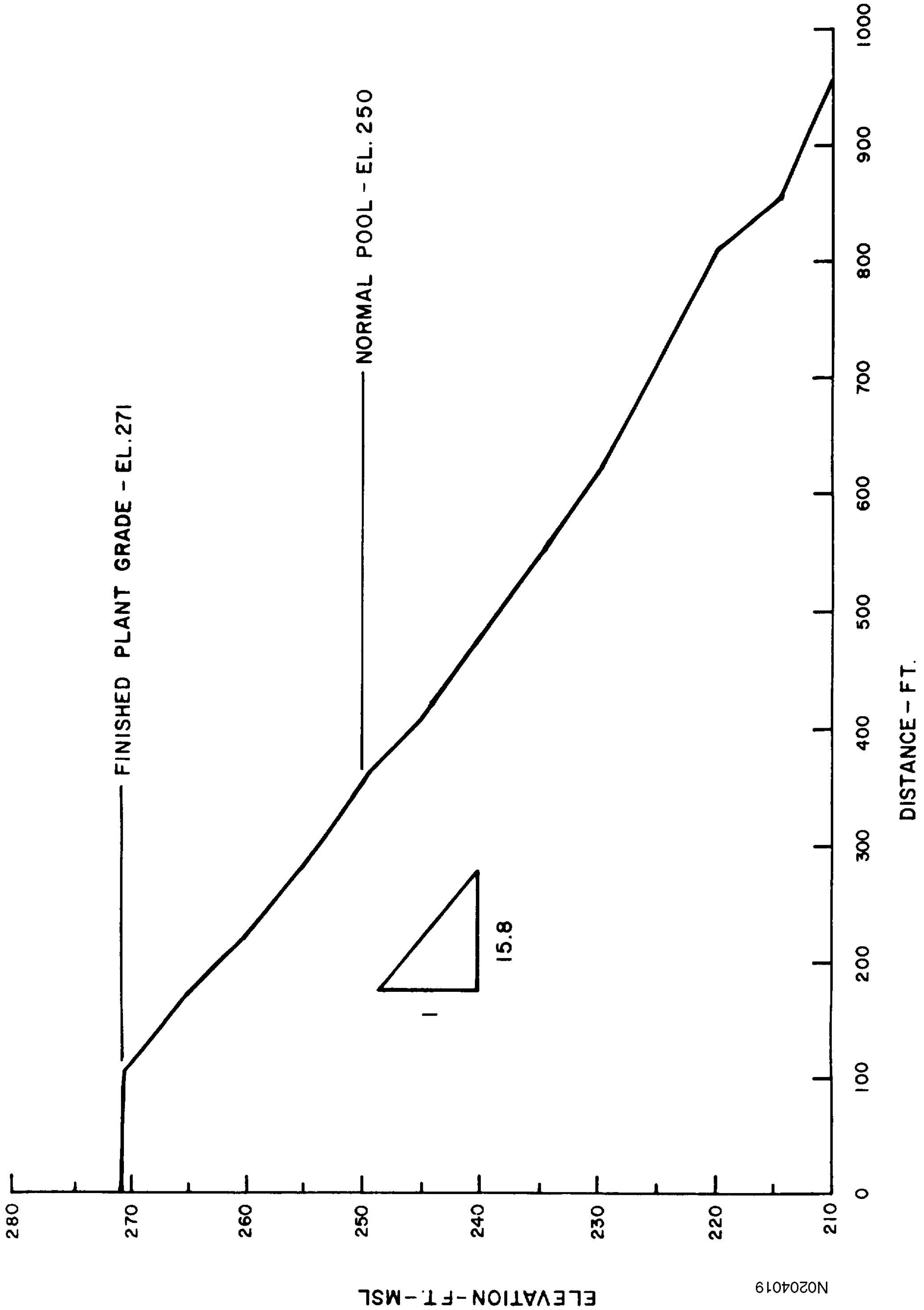
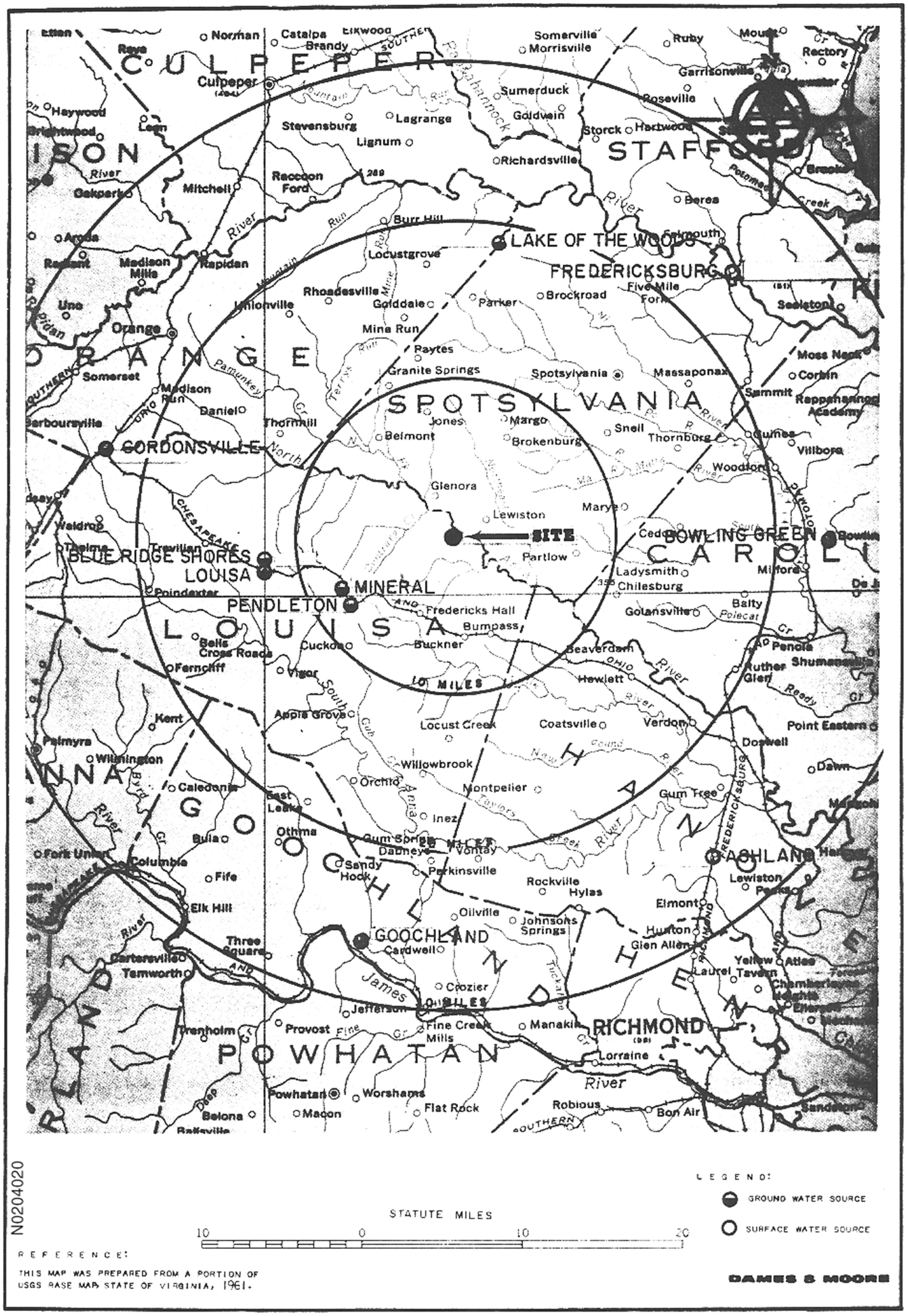


Figure 2.4-11
PUBLIC WATER SUPPLIES IN VICINITY OF SITE



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2.5 GEOLOGY AND SEISMOLOGY

2.5.1 Basic Geologic and Seismic Data

This section of the report summarizes the principal results of the geologic, seismologic, and foundation studies on Units 1 and 2 of the North Anna Power Station in order to describe how the design basis for foundations, vibratory ground motion, and the design-basis earthquake was determined. The studies included a geologic and seismic investigation of the site and surrounding area, a review of geologic literature, interviews with officials of government agencies and private organizations, a review of information acquired during the excavations of Units 1 and 2, and a foundation test boring and laboratory testing program. An update of the geologic and seismologic studies was performed in 1994 for the Safety Analysis Report and Environmental Report for the Independent Spent Fuel Storage Facility (ISFSI) site which is located on a contiguous site south of the plant. This update provides additional information obtained over almost 20 years since the original studies were performed. However, this new information does not alter the original seismic design basis for the station. Details of these studies are described in References 1 through 9.

Regional maps of the physiography, geology, tectonics, and areal geology are shown and discussed in Reference 1. The topics are summarized in UFSAR Sections 2.5.2.2, 2.5.2.3, and 2.5.2.4. An update of this information is provided in References 8 and 9.

Site maps showing the surficial geology and top-of-bedrock contours are shown in Figures 2.5-1 and 2.5-2. Figure 2.5-3 illustrates the plan of site geotechnical profile locations. These profiles, showing the relationship of the major foundation units to subsurface geologic materials, ground water, and backfill, are shown in Figures 2.5-4 through 2.5-10. The topics are discussed in detail in References 1 and 5. They are also summarized in UFSAR Section 2.5.4 of and updated in References 8 and 9.

A plan showing the location of all test borings (except those described in References 7, 8 & 9), wells, and trenches is presented as Reference Drawing 1. The logs of borings as well as the results of laboratory tests are included and discussed in References 1 and 6. The conditions encountered and the results of laboratory tests at the plant site are summarized in UFSAR Section 2.5.4.

2.5.2 Vibratory Ground Motion

2.5.2.1 General

A brief summary of physiography, lithology, statigraphy, and geologic structure is presented in the following paragraphs. A complete, detailed study and geologic history of the region and of

the site is available in References 1, 8, and 9. References to specific sections of this report and additional information are presented as follows:

1. Geologic history is described in the section entitled *History of the Piedmont* beginning on page IIA-8 and ending with the second paragraph of page IIA-10 of Reference 1, and Section 2.5.1.2 of References 8, and 9.
2. Stratigraphy is described in the section entitled *Stratigraphy* beginning on page IIA-2 and ending with the second paragraph of page IIA-4 of Reference 1.
3. Lithology is described in the section entitled *Areal Geology* beginning with the fourth paragraph of page IIA-11 and ending with the third paragraph of page IIA-12 and in the section entitled *Site Geology* comprising the fourth and fifth paragraphs of page IIA-15 of Reference 1.

2.5.2.2 **Physiography**

The station site is situated in the central portion of the Piedmont physiographic province, with the Blue Ridge province about 40 miles to the west and the Coastal Plain province about 15 miles to the east. The Piedmont terrain is characterized by gently sloping upland areas and broad, relatively shallow valleys. Bedrock within the piedmont is metasedimentary and metavolcanic and consist of granites, gneisses, and schists. The bedrock typically is deeply weathered into a saprolite mantle of up to approximately 100 feet thick.

2.5.2.3 **Geology**

The bedrock of the Piedmont is composed of crystalline metamorphic rocks, igneous intrusives, and Triassic sedimentary rocks.

General regional trends are established by the northeast-southwest alignment of geologic structures in the Appalachians. The structural pattern of the Piedmont consists of northeast-southwest anticline-syncline trends, igneous intrusions, and depositional basins. The synclinal trends are dominant. Several synclinal structures, which may be part of the Virginia and/or James River synclinorium, can be projected into the site area. Among these are the Arvonia syncline and the Columbia syncline southwest of the site, and the Quantico syncline to the northeast. Projected along its mapped strike, the Columbia synclinal axis would pass about 5 miles west of the site. About 20 miles west of the site, the syncline dominance ends at the base of the Blue Ridge Anticlinorium, which consists of Precambrian rocks folded anticlinally and asymmetrically toward the northwest. East of the site, the Coastal Plain sediments conceal the downwarped basement.

The folding of a local scale, consistent with the northeast-southwest regional trend, is apparent in the site area. The dominant structure in the area is a small anticline trending approximately N 15 deg E and bending slightly northward before plunging at around 15 degrees to the north. The station site is located on the northwest flank of the anticline near its northern extremity. As a result of the folding, the rocks at the site generally strike N 60 deg-80 deg E and

dip NW 40 deg-50 deg. An examination of the available outcrops indicates that the anticlinal structure closes near the site with no apparent offsets.

The predominant rock types in the site area are a gray, fine-grained, granitic gneiss and schist and a dark greenish-gray, slightly calcareous, fine-grained hornblende gneiss. The hornblende gneiss occurs in zones within the granite gneiss and schist zone. A third rock type, a dark gray, garnetiferous mica schist was identified in the northeastern portion of the site area. These rocks are believed to be of Early to Middle Paleozoic Age, or about 450 million years old. They were recrystallized by regional metamorphosis in the Late Palezoic Age about 300 million years ago.

2.5.2.4 **Tectonics**

Since Precambrian time, the Piedmont has undergone extensive tectonic activity, which has resulted in a very complex regional pattern of folding and faulting. It experienced three periods of major mountain building during the Paleozoic Era and a fourth period of less intense tectonic activity during the Triassic Period. The most recent period of tectonic activity during the Triassic Period, about 200 million years ago, arched the Inner Piedmont and resulted in the formation of downfaulted grabens (i.e., Triassic basins) along either side of the Inner Piedmont axis. These basins are characterized by local normal faulting on either or both borders.

Surface mapping, boring data, and an inspection at the excavation for Units 1 and 2 all indicated a continuity of strata beneath these units and no significant shear zones are known to exist in the site area. However, during excavation for Units 3 and 4 at the North Anna Power Station, a minor zone with an offset of the type commonly found in the Piedmont was exposed. As discussed in the report *Supplemental Geologic Data, North Anna Power Station, Louisa County, Virginia* (Reference 10), intensive geologic investigations have shown that this shear zone has not been active since at least Triassic time. The shear zone exposed in Units 3 and 4 extends through Units 1 and 2 without any indication or evidence of offset. Additional information on this shear zone is contained in Section 2.5.3.2. An update of the tectonics section is presented in Section 2.5.1.3.2 of Reference 8.

The closest major shear zone is located at the edge of the Blue Ridge Anticlinorium about 20 miles west of the site. Faulting associated with the northwestern flank of the Blue Ridge Anticlinorium has thrust Precambrian basement rocks over sediments of the Valley and Ridge province. A parallel shear zone of almost similar extent is found on the southeastern flank of the anticlinorium. Incorporated within this zone are several Triassic basins, including the Culpeper and Scottsville, where numerous thrust and normal faults are found. The faults within this zone, the closest to the site, are the border faults of the Culpeper basin located about 20 miles west-northwest of the site area. Other downfaulted graben structures in the Piedmont of significance in the site study are the Farmville and Richmond basins. These basins do not lie in any known regional shear zone.

The closest known significant fault is located near Mineral, Virginia. The known length of the fault is limited to 1000 feet. The fault has no surface expression that can be confirmed by the

examination of aerial stereoscopic photographs. There are no abrupt magnetic changes in or across the known fault area. The only evidence of the fault is exposures in underground mine workings near Mineral, Virginia. Over the known distance, the fault strikes north 20 degrees east and dips southeast 60 to 70 degrees. The maximum length of the fault is probably no more than a few miles; if projected along its known strike and dip, it would lie about 4.5 miles northwest of the site.

Additional detailed information, including maps and an assessment of activity status, is given in References 1, 8, and 9. Relevant sections are listed below:

1. Regional tectonic structures are described in the section entitled *Structure* beginning with page IIA-14 and ending with the fourth paragraph of page IIA-8 of Reference 1 and Section 2.5.13 of References 8 and 9.
2. Areal tectonic structural features are described in detail beginning with the fourth paragraph of page IIA-12 and ending with the first paragraph of page IIA-14 of Reference 1.
3. Site structural features are described beginning with the second paragraph of page IIA-16 and ending with the last paragraph of page IIA-18 of Reference 1.
4. Regional tectonic structures are identified and shown on the *Regional Tectonic Map*, Plate IIA-2. Areal tectonic structural patterns are shown on Plate IIA-4. Site structural features are shown on geologic cross sections shown on Plate IIA-7 of Reference 1.
5. Information on the assessment of tectonic activity is found beginning with the fourth paragraph of page IIA-6 and ending with the first paragraph of page IIIA-8 and in the first and second paragraphs of page IIA-10 of Reference 1.

2.5.2.5 Seismic History

A seismic history and summary of all significant earthquakes possibly affecting the site area from 1774 through 1966, as well as a regional epicenter map, are presented in Reference 1. An update of the seismic history and tabulation of significant earthquakes within a 200 mile radius of the station through January 1994 is presented in Reference 8.

The site is located in an area that has experienced a minor amount of earthquake activity. Most of the reported earthquakes of the region are related to known faulting more than 30 miles from the site. The zone of major earthquake activity nearest the site is in the vicinity of Charleston, South Carolina, approximately 400 miles to the south. Sixty-seven earthquakes of intensity V to VII have been reported within 200 miles of the site from 1758 through January 1994. Most of these are associated with well-documented geologic structures. None of these shocks have been greater than VII.

The most significant earthquakes in the region of the station affecting its design occurred near the Richmond Basin in 1774 (Intensity VI-VII), and near the Arvonia Syncline in 1875 (Intensity VII). These shocks and related zones of earthquake activity are both located within 50 miles of the site and are believed to be associated with faulting in their respective basin-like

structures. Additional earthquakes of epicentral intensity V occurred on December 11, 1969, near Richmond, Virginia (37.8° N 77.4° W) and on March 15, 1991 west of Richmond in Goochland County, some 37 Km south-southeast of the site.

The 1875 shock was probably felt in the vicinity of the site with an intensity approaching V. The 1774 shock cannot be accurately projected to the site area because of the lack of information, but it is believed that ground motion at the site did not exceed a few percent of gravity. The 1969 shock was perceptible over a 3500-square-mile area. A study of the recent land forms in the site area does not reveal any adverse features such as faulting, slides, or areas of instability or brecciation that could have been caused by these shocks or from earlier earthquake shocks.

Additional detailed information on earthquake history is discussed in Reference 1, beginning with the second paragraph of page IIC-4 and ending with the first paragraph of page IIC-10 and in Section 2.5.2.2 of Reference 8. A discussion of the specific correlation of epicenters with geologic structures is also presented in Reference 1, beginning with the first paragraph of page IIC-8 and ending with the first paragraph of page IIC-10. Further discussion is presented in the second paragraph of page IIC-11 and the first paragraph of page IIC-12.

2.5.2.5.1 Seismic Event of August 23, 2011

The United States Geological Survey (USGS) reported that a Magnitude 5.8 earthquake occurred August 23, 2011 at 13:51 hrs. The epicenter of this seismic event was reported to be at 37.936 degrees north latitude, 77.933 degrees west longitude, which places the event approximately 5 miles from Mineral, VA and 7 miles from Louisa, VA. Per reports, the epicenter was approximately 11 miles from the North Anna Power Station. The depth of the earthquake was reported to be 3.7 miles.

The Kinemetrics instrument records at the containment basemat of Unit 1 provided the most reliable indication of time-histories from the August 23, 2011 event at North Anna. Amplified response spectra (ARS) from these time histories were developed at 5% spectral damping value in each of the three directions. Comparisons of the ARS from the recorded motions to the design-basis earthquake (DBE) ARS are shown in Figures 2.5-15 and 2.5-16. The peak ground acceleration (PGA) values at the containment basemat from the August 23, 2011 event as compared to the operational-basis earthquake (OBE) and DBE PGA values (rock) are shown below.

	North Anna OBE PGA-Rock	North Anna DBE PGA-Rock	August 23, 2011 Event Containment Basemat
Horizontal-N-S	0.06g	0.12g	0.264g
Horizontal-E-W	0.06g	0.12g	0.109g
Vertical	0.04g	0.08g	0.118g

It is noted that the above PGA values of the recorded motions are consistent with the USGS data discussed in Reference 17. Section 3.7 of the UFSAR contains information related to the

implementation of a seismic margin management plan (SMMP) as a result of the August 23, 2011 event.

2.5.2.6 Design-Basis Earthquake

The earthquake producing the maximum vibratory accelerations at the site is designated the design-basis earthquake. The earthquake producing one-half the maximum vibratory accelerations at the site is designated the operating-basis earthquake.

The PSAR and design for this station were done before the issuance of Appendix A, 10 CFR 100. Accordingly, the term design-basis earthquake as used here has the meaning it had before the issuance of Appendix A. The term operating-basis earthquake as used here does not and is not intended to conform to the meaning of operating-basis earthquake as defined in Appendix A, 10 CFR 100.

Damaging earthquake ground motion is not expected at the site during the economic life of the facility. On a conservative basis, Seismic Class I structures and systems were designed to respond elastically, with no loss of function, to horizontal ground accelerations as high as 0.06g of gravity for structures founded on rock and as high as 0.09 g for structures founded on soil.

For the purpose of establishing a design-basis earthquake, it was assumed that an earthquake equal to the largest shock associated with the Arconia Syncline might occur close to the site area. With the epicenter of a shock similar to the 1875 intensity-VII Arconia earthquake shifted to the vicinity of the site, it was estimated that the maximum horizontal ground acceleration at the rock surface would be less than 0.12 g. Accordingly, the design-basis earthquake for structures founded on rock was taken at 0.12 g for horizontal ground motion and two-thirds that value for vertical ground motion. For structures founded on soil, the design-basis earthquake was taken at 0.18 g for horizontal motion and 0.12 g for vertical motion.

For Seismic Class I structures founded on rock, analyses for earthquake motion were made using response spectra developed by enveloping the response spectra, for various degrees of damping, of the east-west and north-south components of the Helena (1935) earthquake and the south-east component of the Golden Gate record of the San Francisco (1957) earthquake, all normalized to 0.06 g for the operating-basis earthquake and 0.12g for the design-basis earthquake. For Seismic Class I structures founded on saprolite more than 15 feet thick, these analyses for earthquake motion were normalized to 0.09g for the operating basis earthquake and 0.18 g for the design-basis earthquake to provide for calculated amplification through the overburden. The spectra are shown on Figures 2.5-11 through 2.5-14.

The amplification of earthquake motion through the overburden was computed using a lumped-mass spring system with modal superposition (Reference 11).

Based on the two-to-three pulses of strong ground motion for the San Francisco, California (1957), and Helena, Montana (1935), earthquakes, a conservative estimate of strong ground motion pulses to be experienced at the North Anna site is four to five pulses of strong ground

motion for the operating-basis earthquake and eight to ten pulses of strong ground motion for the design-basis earthquake.

The results of the regional study of the seismicity and tectonics indicate the conservatism of the ground accelerations. Therefore, the North Anna Power Station seismic design meets all safety requirements.

The results of the regional seismicity and structural geology update provided in Reference 8, did not provide any basis for modifying the original seismic design basis for the site. Additionally, continued seismic monitoring in the region surrounding the site over the last 20 years has not provided any basis to associate the minor seismicity of the region with either Lake Anna or the fault at the North Anna Power Station. The seismic design for the North Anna Power Station provides adequate conservatism for seismic Class I Structures at the North Anna Power Station (Reference 8).

2.5.3 Surface Faulting

North Anna Units 1 and 2 were not and need not be designed for surface faulting. There is no evidence of active surface faulting at or near the site.

2.5.3.1 Geologic Condition at the Site

See Sections 2.5.2.3 and 2.5.2.4 and, for additional detailed information, see Part II, Section A of Reference 1.

2.5.3.2 Evidence of Fault Offsets

Regionally, there is no known evidence of active faulting of rock strata. Within the vicinity of the site the following studies were done, and no evidence indicative of active faulting was revealed:

1. The interpretation of airphotos and topographic maps of the site area revealed no evidence of surface rupture, surface warping, or the offset of geomorphic features possibly indicative of active faulting.
2. Seismic surveys of the site area showed that no macroseismic activity has been centered in the site area; the closest epicentral location is about 30 miles away.
3. A detailed geologic mapping of the site area and vicinity by Dames & Moore geologists and an inspection of the excavation during construction by Stone & Webster geologists revealed no evidence of geologically recent or active faulting.
4. Borings drilled at the site indicated continuity of strata and an inspection of soil and rock showed no adverse effects indicative of geologically recent or active faulting.

The closest known significant fault is located 4.5 miles northwest of the site, if projected along its known strike and dip, and as evidenced by mine exposures near Mineral, Virginia. The absolute age and history of the fault are unknown and indeterminate.

The known length of this fault is 1000 feet, with its estimated maximum length only a few miles. Vertical displacement is unknown but is estimated to be about 1500 feet. Over the known distance, the fault strikes north 20 degrees east and dips southeast 60-70 degrees. There are no abrupt magnetic changes on or across the known fault area. No surface expression can be confirmed by examination of topophotos. There is no evidence of geologically recent movements along the fault; thus, it is believed that the fault has been inactive for millions of years. There is no evidence that any known earthquake hypocenters are related to or can be attributed to this fault.

During the excavation of Units 1 and 2, three chlorite seams were discovered. At that time, geologic studies indicated that these seams were of depositional origin and had acted as aquicludes. The weathering of the rock was more severe above than below the seams and extended along the seams, decreasing in intensity with depth. An X-ray analysis of the infilling material showed a normal weathering sequence. It was then concluded that no motion had occurred along those three seams, inasmuch as several north-trending joints crossed the seams without showing any offset.

The same seams were found during the excavation of Units 3 and 4. This time, however, geological relations suggested possible faulting along Seam A. An extensive investigative program was then initiated involving both Dames & Moore and Stone & Webster geologists. The following conclusions have been reached: (1) the seams are minor faults of limited extent, (2) K-Ar dating indicates that the last motion occurred at least 200 million years ago, (3) the seams are not capable faults within the meaning of Appendix A, 10 CFR 100, (4) these seams do not affect the stability and/or safety of the North Anna Power Station in any respect, and (5) the faults had not been reactivated by the filling of Lake Anna. Details concerning this investigation program and the resulting conclusions have been presented in Appendix E to the North Anna Units 3 and 4 PSAR, Docket Nos. 50-404 and 50-405.

Confirmatory microearthquake monitoring was initially conducted over the period from January 21, 1974, to August 1, 1976, and was subsequently extended an additional year to August 1, 1977. The purpose of the monitoring program was to determine whether seismic activity was associated with the faults at the site and whether Lake Anna was affecting that activity. No microearthquake detected in the three and one-half years of monitoring was associated either with the fault onsite or was related to the impoundment of Lake Anna. Four stations of the original 17-station monitoring network were incorporated into Virginia Tech's Central Virginia Monitoring Network for the specific purpose of monitoring any changes in seismicity in the region of the North Anna Power Station. To date, no changes have been observed that would contradict the conclusions reached in 1977 regarding the lack of association of microearthquakes with Lake Anna or with the fault at the North Anna Power Station (Reference 8). The microearthquakes observed at the site appear to be part of, or are occurring at, a level no greater than the spatially varying background activity found in central Virginia. Since the North Anna units have already been designed to withstand the largest earthquake that has occurred within the past 200 years in central Virginia, the existing plant design is adequate.

The nearest known post-Mesozoic faulting belongs to the northeast-southwest trending Stafford Fault Zone. The nearest approach of this zone is near Fredericksburg, about 22 miles northeast of the site. As originally reported (References 11 through 13), and later substantiated by detailed subsurface explorations (Reference 14), the youngest discernible fault movement of significance within the zone was pre-mid-Miocene, more than 10 million years ago. According to the criteria of Appendix A of 10 CFR 100, the zone is not capable. A subsequent report, *Lateral Continuity of a Pre- or Early Cretaceous Erosion Surface Across Neuschel's Lineament, Northern Virginia* (Reference 12), demonstrates that the faulting near Fredericksburg does not extend southwestward toward the site. This report also substantiates earlier studies, which indicate that the local geophysical anomaly known as Neuschel's Lineament is tectonically stable. The fracture trends northeast-southwest and passes about 3.5 miles southeast of the site. The results of the latter study also demonstrate that if the Lineament is a fault, it has not been discernibly offset for more than 100 million years.

A northern projection of the Brandywine Fault Zone, near Brandywine, Maryland, was investigated in 1976 and 1978 because geologic anomalies were suggestive of recent fault movement. Both investigations demonstrated that differential settlement, not faulting, was responsible for the anomalies; indeed, lines of borings indicate that movement of the fault ceased in the Miocene epoch. Therefore, the Brandywine Fault Zone cannot be considered capable.

2.5.3.3 **Earthquake Associated with Active Faults**

There are no reported historical earthquake epicenters that can be associated with active faults within 5 miles of the plant site.

2.5.3.4 **Correlation of Epicenters with Active Faults**

There is no evidence of active faults or historically reported earthquake epicenters within 5 miles of the site, and, therefore, there is no correlation.

2.5.3.5 **Description of Active Faults**

There is no evidence of active faults greater than 1000 feet long within 5 miles of the site.

2.5.3.6 **Zone Requiring Detailed Faulting Investigation**

There is no zone requiring detailed investigation of the faulting of rock strata. A zone of shear movement with a chlorite-rich foliation plane between rock strata was investigated for the adjoining Units 3 and 4.

2.5.3.7 **Results of Faulting Investigation**

There is no evidence of active faulting of rock strata in the site area. Investigation of shear movement along a chlorite-rich foliation plane referred to in Section 2.5.3.7 shows the zone to be noncapable (not active) as defined in 10 CFR 100, Appendix A.

2.5.3.8 Design Basis for Surface Faulting

North Anna Units 1 and 2 were not and need not be designed for surface faulting. There is no evidence for active surface faulting at or near the site.

2.5.4 Stability of Subsurface Condition

References containing raw data and detailed evaluation of the stability of subsurface conditions at the site can be found in References 1, 3, 4, 6, and 8.

2.5.4.1 Station Area Conditions

The area surrounding the site is generally mantled by residual soils derived from the weathering of the underlying metamorphic rocks. At the site, weathering has destroyed all parent geologic structure in the saprolite soils to an average depth of 4 to 5 feet. Surficial soils are underlain, in turn, by generally yellowish-brown to gray, silty, fine sands. These soils are saprolitic in nature and retain many of the structural and mineralogical features of the parent rock. These saprolite soils extend to the surface of the relatively intact rock from which they were derived. Weathering has produced an erratic bedrock surface and resulted in a subsurface profile characterized by three significant zones of weathering, as follows:

1. Residual saprolite soil that is derived from the weathering of gneiss and schist. This soil is composed of clay, silt, and sand-sized particles with many rock fragments. It is predominantly silty, fine sand with core stone less than 10% of the volume of the mass. This soil is represented as Zone I and Zone IIA in the boring logs presented in Reference 1.

   Severely weathered rock that retains its rock structure but is generally soft and is heavily iron stained. Quartz-rich areas are fractured and in part friable. The core stone is from 10% to 50% of the volume of the mass. This rock is presented as Zone IIB in the PSAR boring logs (Reference 1).

2. Moderately weathered rock that is generally iron-stained on most joints and fractures, with some staining and weathering of the rock matrix. The core stone is more than 50% of the volume of the mass. The rock generally gives a dull sound when struck with a geologist's pick. This rock is represented as Zone III in the PSAR boring logs (Reference 1).

3. Slightly weathered to fresh rock with occasional iron staining on joints or fractures. The rock is generally hard, giving a sharp sound when struck with a geologist's pick. This rock is represented as Zone IV in the PSAR boring logs (Reference 1).

While the weathering profile can be divided into these three generalized zones for descriptive purposes, the contact between them has been found to be gradational and generally not well defined. The seismic refraction survey, test borings, and test pits showed possible erratic conditions. Excavations for structures proved this to be the case. The excavations showed ribs of moderately to slightly weathered rock protruding into severely weathered rock and deep, narrow zones of highly weathered rock penetrating relatively fresh rock. A top-of-bedrock map based on generalized conditions is shown in Figure 2.5-2. This map is based on conditions revealed in

excavations and borings made during construction. The rock revealed during construction excavations indicated slightly higher rock elevations for moderately weathered rock in the reactor building, auxiliary building, and fuel building areas, and slightly lower elevations in the turbine room area than those predicted in the initial PSAR studies.

Additional borings were taken during construction in the turbine room area to better define the subsurface profile and bedrock conditions. Based on soil sample data, the design of the turbine foundation was changed from a pedestal type to a mat foundation as shown in Figures 2.5-5, 2.5-6, and 2.5-7. The higher rock conditions encountered in the reactor building area were favorable and had no influence on initial PSAR design concepts.

The bedrock and soil at the foundation locations provide suitable support for site facilities. The bedrock is competent, hard, and crystalline metamorphic rock, which is insoluble and free of any solution or collapse features. There are no known economic mineral resources present, nor have any been extracted from the immediate site area in the past. Since Triassic time, about 200 million years ago, the region has been tectonically stable and without marked tectonic activity. No significant residual stress conditions are apparent in the bedrock. The site area is free of any known capable faults. There are no predominant deformational features present other than the normal jointing associated with metamorphic rocks of this geologic age, together with the previously identified minor, noncapable faults.

Ground water in the saprolite soils occurs under hydrostatic conditions and is directly connected with the ground water stored and transmitted through cracks, fissures, and other planes of foliation in the underlying crystalline rock. The configuration of the ground-water surface generally follows surface topography. Before construction, this surface sloped at an average rate of 8 feet per 100 feet toward the North Anna River. During construction, dewatering operations encountered relatively low amounts of water, which were easily handled by a sump-type dewatering system. The lowest drawdown imposed was in the reactor containment area, where the water level was lowered approximately 70 feet to Elevation 203. Filling Lake Anna to Elevation 250 raised the base level of ground-water discharge about 50 feet and thereby reduced the hydraulic gradient across the site to about 2.5 feet per 100 feet. The expected rate of postconstruction ground-water movement under this gradient was about 0.01 ft/day. The water level as determined by observation wells located in the Unit 1 alleyway indicates the ground-water level to be within several feet of Lake Anna's level (Elevation 250 ft).

2.5.4.2 **Station Foundations**

Foundation conditions under the major structural components of the power station are summarized in the following paragraphs. The locations and logs of the borings, as well as the results of laboratory tests, are provided in Reference 1. Geologic cross sections, showing subsurface conditions in the immediate area of the plant, are presented in Figures 2.5-4 through 2.5-10. The location of these cross sections in reference to the power station layout is shown in Figure 2.5-3.

The reactor containment structures are founded on hard crystalline rock. Other Seismic Class I structures are founded on fresh to severely weathered crystalline rock, on dense residual soil derived from the weathering of the rock, or on compacted granular fill. Foundations have been designed and installed using conservative bearing values so that no excessive postconstruction deflections will occur.

The contact areas, founding elevations, and maximum contact pressures for the major structural components of Units 1 and 2 of the North Anna Power Station are listed in Table 2.5-1.

The allowable bearing capacities for foundation materials at the site are given in Table 2.5-2. Ultimate bearing values, from which these allowable values were derived, were computed based on classical theory using measured properties for residual soils and rock found at the site and conservatively selected empirical values for compacted granular fills. The recommended bearing values are for all combinations of load, including dead load plus live load plus either design-basis and/or operating-basis earthquake loading or wind (tornado) loading, whichever is greater. In all cases, the ratio of ultimate to allowable values is in excess of three.

Both Units 1 and 2 reactor containment structures and the fuel building are supported on reinforced-concrete mats founded on sound rock at Elevations 203 and 243, respectively. The rock cuts for the reactor containment structures are approximately 40 feet deep below the general excavation grade at Elevation 242. The foliation of the rock strikes approximately parallel to the axis of the two containment structures and dips to the northwest about 45 degrees. Most of the rock in the walls was fresh and hard. However, there was an area approximating a quadrant of the circumference along the north side of Unit 2, calling the axis of the units east-west, which had weathered to dense saprolite. This extended to a maximum depth of about 15 to 18 feet below the general excavation (Elevation 242). The wall of the excavation in this area was supported by horizontal sheeting and soldier piles anchored by tie backs into sound rock. In the remainder of the excavation for Units 1 and 2 rock was encountered at and below the general excavation grade. The rock wall support consists of 20-foot rock bolts (1 inch in diameter) set 5 feet center-to-center both ways in a staggered pattern covered with wire mesh and gunite. Within the rock walls, some areas of moderate to severe weathering were encountered. In these areas, all rock bolts were grouted and surfaces were sprayed with plastic spray when excavated to prevent further weathering.

Along the south wall of Units 1 and 2, severe weathering had developed along a thin biotite-chlorite schist member parallel to foliation. During excavation, a rock fall developed along this seam in Unit 1. Subsequently rock above this weak plane was removed for practically the full width of the containment excavation for both units. This plane intersected the south wall of the excavations at about Elevation 225.

For the permanent support of the walls of the containment excavation, rock bolts were installed as described earlier and the space between the line of excavation and the shell of the structure was backfilled with lean concrete, which acts as a ring girder. This concrete fill extends from above the 10-foot foundation mat to the general level of rock excavation. A layer of

compressible material is provided between the containment shell and the lean concrete for insulation.

The auxiliary building is supported on a reinforced-concrete mat. The foundation mat is founded at Elevation 240 on moderately to severely weathered rock having a maximum thickness of about 15 feet above slightly weathered to fresh rock (Zone III).

The service building, including the control area, is supported on a reinforced-concrete mat and strip footings foundation resting on severely weathered rock (saprolite).

The main steam and feedwater isolation valve housing and safeguards area abutting the Units 1 and 2 reactor containments is supported on reinforced-concrete mats founded at about Elevation 252 on concrete backfill or compacted granular fill over severely to moderately weathered rock.

The service water reservoir pump house is supported on a reinforced-concrete mat founded on approximately 80 feet total thickness of residual soil and severely weathered rock. The main reservoir screenwell is founded on dense saprolite about 5 to 8 feet thick over moderately weathered to fresh rock.

The service water valve house is supported on a reinforced concrete mat foundation founded on approximately 60 feet of residual soil and severely weathered rock.

The service water tie-in vault is supported on a reinforced-concrete mat foundation founded on approximately 40 feet of residual soil.

Based on geologic studies and the observation of existing site conditions at foundation depths, there do not appear to be any geologic features that will adversely affect the intended use of the site during vibratory motion associated with the design-basis earthquake.

Foundation design criteria for the service water pump house written in 1970 required that the maximum allowable bearing pressure not exceed 3000 psf, and no increase in this value was permitted for abnormal or extreme environmental loading conditions. An examination of the design calculations indicates an apparent misunderstanding of the criteria, since increases in the allowable bearing pressures were permitted for the one-pump shutoff, tornado wind, and earthquake loadings. As a result, maximum toe pressures directly beneath the edge of the mat higher than 3000 psf were computed and accepted for these loads. Maximum toe pressures are as follows:

Design Loading	Maximum Toe Pressure, ksf	Mat Location
One-pump shutoff	3.92	Southwest corner
Design-basis earthquake	3.86	South edge
Tornado wind	3.44	Southwest corner

A reevaluation of the soil bearing capacity of the service water pump house foundation, on the basis of recent soils investigations, shows that a minimum value of allowable bearing capacity is 4.2 ksf. For a seismic or sudden loading, it is assumed that the foundation soil is subject to undrained shear. Therefore, the ultimate bearing capacity is determined as follows (Reference 16):

$$q_{ult} = N_c S_u + \gamma d \quad (2.5\text{-}1)$$

where:

N_c = bearing capacity factor = $5\left[1 + 0.2\frac{B}{L}\right]$

S_u = undrained shear strength

γ = total unit weight of soil

d = depth of footing base

Based on investigations reported in Section 3.8, a conservative lower bound for undrained shear strength, Su, is 2.0 ksf. For this value, and considering the effect of embedment on the Service Water Reservoir side only, the ultimate bearing capacity of the foundation soil is conservatively calculated to be:

$$q_{ult} = 5\left[1 + \frac{0.2 \text{ x } 61}{64}\right]2 + [(0.121)(3) + (0.624)(5)] = 12.59 \text{ ksf} \quad (2.5\text{-}2)$$

For a factor of safety of 3, the allowable bearing pressure is:

$$q_{allow} = \frac{q_{ult}}{F.S} = 4.20 \text{ ksf} \quad (2.5\text{-}3)$$

Based upon extensive triaxial shear tests reported in Section 4 of *Report on Design and Stability of North Anna Dam for Virginia Electric and Power Company* (Reference 12), the undrained triaxial shear strength for undisturbed foundation soils of Zones I and II can be conservatively represented by the parameters C_c = 720 psf and φ_c = 26°.

2.5.4.3 Engineering Properties of Foundation Materials

The static and dynamic engineering properties of materials underlying the site are presented in this section. These properties were determined from borings extending to a depth of approximately 80 feet below the base of the lowest foundations and represent the characteristics of materials that transmit earthquake-induced motions to the foundations of the plant.

Additional detailed information on the engineering properties of materials underlying the site is given in Appendix 2C.

Pertinent static and dynamic properties of rock and weathered rock reported in the listed appendices include the following:

1. Unconfined compressive strength tests on rock specimens: Reference 1 and Table 2.5-3
2. Birdwell 3D Logs (Borings 20, 204, Well 1): Reference 4.
3. A refraction seismic survey of the site area: Reference 2.
4. A cross-hole seismic survey of the reactor containment: Reference 3.

Pertinent tests of the physical properties of residual soils reported in Reference 1 of include:

1. Dry density tests on selected samples.
2. Moisture contents tests.
3. Triaxial compression tests on undisturbed soils.
4. Grain size analysis.
5. Consolidation tests on undisturbed samples.
6. Cyclic triaxial tests.
7. Shock scope tests.

Pertinent physical properties determined from these tests are as follows:

1. Rock
   a. Density: 165 lb/ft^3.
   b. Unconfined compressive strength (psi)
      (1) Fresh rock (Zone IV): 5800 to 16,200.
      (2) Slightly to moderately weathered rock (Zones III-IV): 2880 to 12,800.
      (3) Weathered rock: 620 to 2400.
   c. Shear modulus

      The shear modulus values for slightly weathered to fresh rock were determined using the following two methods of measurement:

Basis of Measurement	C_s (ft/sec)	G (psi)
Birdwell 3D logs	4000 to 8000	0.6×10^6 to 2.5×10^6
Cross-hole seismic	5000 to 6000	0.9×10^6 to 1.3×10^6

2. Residual soils
   a. Shear modulus

A cross-hole seismic survey in the dam site area gives the following values for near-surface soils:

(1) C_s = 800 to 850 ft/sec

(2) G = 16,500 to 18,600 psi

Tests on saprolite (severely weathered rock to residual soil) yield the following values:

(1) C_s = 950 ft/sec (shear wave)

(2) C_p = 2300 ft/sec (compression wave)

(3) G = 23,000 psi

b. Density: 98 to 134 pcf (dry)

c. Water content: 5.2 to 30.5% (median: 13.1%)

(Note: Many samples were taken from above ground-water level and were not saturated.)

d. Porosity: 0.21 to 0.4 (average: ±0.3)

Based on these test data, it was concluded that the shear modulus for the fresh to slightly weathered rock would be 1.0×10^6 psi. Hardin gives the following expression for the shear modulus of soils:

$$G = 1230 \frac{(2.97 - e)^2}{1 + e} \sqrt{\bar{\sigma}\frac{1 + 2K_o}{3}}$$

where:

G = shear modulus, psi

e = void ratio

$\bar{\sigma}$ = vertical effective stress

K_o = ratio of vertical to horizontal effective stress

Computed values for the residual soils based on this expression were as follows:

1. At 10-foot depth, G = 14,000 psi.
2. At 20-foot depth, G = 19,800 psi.

These values correspond well to measured surface values of the shear modulus from cross-hole seismic surveys as noted above. Accordingly, this expression was used in computing shear moduli for residual soils at various depths for an analysis of the amplification of vibratory motion through overburden; it has been shown that the shear modulus decreases with increasing strain (References 14 & 15), and an adjustment of the shear modulus with strain has been made in accordance with relations proposed by H. B. Seed (Reference 15).

The backfill around structures is compacted fill placed according to procedures. The fill on which foundations of tanks and other structures placed is select granular material compacted to a density of not less than 95% of modified Proctor Compaction, ASTM D-1556. Compressible material was placed between the containment shell and the concrete backfill to provide isolation.

Further information on this subject can be found in Section 3.8 and Appendix 3E.

2.5.5 Slope Stability

Pertinent slopes whose failure could adversely affect the nuclear power plant include the following:

1. Service water reservoir dike and cut slopes.
2. Intake channel cut slopes from the North Anna Reservoir to the screenwell structures.
3. The cut slope located along the south side of the plant site between the containment structures and the service water reservoir.
4. Flood Protection Dike

A summary of steps taken to ensure stability of cut slopes in rock for the containment excavation area is provided in Section 2.5.4.2.

Stability analyses of critical dike sections were made to evaluate the factors of safety for all anticipated operating conditions of the service water reservoir. Details can be found in Section 3.8.4. A plan view of the service water dikes and cut slopes is shown on Figure 3.8-31. Typical cross sections of the compacted dike and excavated cut slope are shown on Figure 3.8-33. Boring logs associated with the service water pump house and the major section of the dike are given in Figure 3.8-34.

Properties of the materials in the constructed service water reservoir dike fill are given in Table 3.8-13 and Figures 3.8-53 and 3.8-54. Histograms of compaction control tests for the compacted earth fill and select earth lining are given on Figures 3.8-55 through 3.8-58. The results of stability analysis are given in Table 3.8-13.

These steps are believed to be conservative and sufficient to prevent any slope or wall failure that could conceivably affect the nuclear power plant or its operation during or following the design-basis earthquake.

There has been no evidence of a potential for earth slides into Lake Anna in the vicinity of the plant site. Natural ground slopes in these residual soils, which vary between about 10 to 20 feet per 100 feet, are stable. The general configuration of the excavation into the natural hillside for the plant site area and the impoundment of water within Lake Anna serves to increase the stability of natural slopes between the plant site and the lake.

The intake channel from the North Anna Reservoir to the screenwell structure has a bottom width of 240 feet, cut slopes of 3 horizontal to 1 vertical that steepen to 2:1 at the screenwell, and a maximum depth of 50 feet below the surrounding terrain. A major portion of this excavated

channel is within very dense saprolite formed from weathering of the present granite gneiss rock, and there is foliation in a favorable orientation relative to the axis of the channel. With foliation planes dipping steeply upstream and striking across the channel roughly perpendicular to the cut slopes, the channel will be stable against large earth slides. The 240-foot channel bottom width in combination with the 50-foot maximum cut prevents small earth slides from causing any significant blockage of this channel, which leads to the service water pumps associated with the main reservoir.

The natural-cut slopes for the intake channel from the North Anna Reservoir to the screenwell structure (Section F-F) are illustrated on Figure 2.5-9. The location of this section has been added to Figure 2.5-3. Detailed logs of borings shown on this profile are presented in Section IB of References 5 and 6.

The natural-cut slope located along the south side of the plant site between the containment area and the service water reservoir (Section G-G) is shown in Figure 2.5-10. The location of this section has been added to Figure 2.5-3. The detailed logs of borings referenced on the profile are presented in Section IB of References 1 and 6. The estimated saturation line within this slope after filling of the service water reservoir is also shown on Section G-G of Figure 2.5-10.

Stability analyses of the flood protection dike located west of the Unit 2 turbine and service buildings were made for applicable loading conditions. A description of this dike can be found in Section 3.8.6. A plan view and typical section of the dike are shown in Figure 3.8-61.

2.5 REFERENCES

1. *Report, Site Environmental Studies, Proposed North Anna Power Station, Louisa County, Virginia, Virginia Electric and Power Company*, Appendix A of North Anna Units 1 and 2, PSAR, Dames & Moore, January 13, 1969.
2. *Seismic Survey of the North Anna Power Station, Virginia Electric and Power Company*, Appendix A to the FSAR and Appendix 2G to the UFSAR, Weston Geophysical Engineers, Inc., February 14, 1969.
3. *Velocity Measurements, North Anna Power Station, Virginia Electric and Power Company*, Weston Geophysical Engineers, Inc., January 14, 1970. (This document was submitted in an addendum to the reply to Question 2.8 in the North Anna Units 1 and 2 PSAR Supplement Volumes.)
4. *Report, Birdwell Geophysical 3.D Well Logs*. (These logs were submitted in reply to Question 2.8(b) in the North Anna Units 1 and 2 PSAR Supplement Volumes.)
5. *Report on Foundation Studies for the Proposed North Anna Power Station in Louisa County, Virginia; Virginia Electric and Power Company*, Appendix 2H to the FSAR, Dames & Moore, May 8, 1969.
6. *Report, Site Environmental Studies, North Anna Nuclear Power Station, Proposed Units 3 and 4, Louisa County*, Dames & Moore, August 18, 1971. (This document was submitted as Appendix B to the North Anna Units 3 and 4 PSAR, Docket Nos. 50-404 and 50-405.)
7. *Report, Subsurface Investigation Program, Screen Well Area (Units 1 and 2), North Anna Nuclear Power Station, Louisa County, Virginia*, Dames & Moore, September 22, 1971. (This was transmitted to the NRC in VEPCO letter of November 6, 1975, Serial No. 767.)
8. Safety Analysis Report, North Anna Power Station, Independent Spent Fuel Storage Installation, submitted to the NRC on May 9, 1995.
9. Environmental Report, North Anna Power Station, Independent Spent Fuel Storage Installation, submitted to the NRC on May 9, 1995.
10. *Supplemental Geologic Data, North Anna Power Station, Louisa County, Virginia*, 1973.
11. R. V. Whitman and J. M. Roesset, *Effect of Local Soil Conditions Upon Earthquake Damage: Report 5, Theoretical Background for Amplification Studies*, Research Report R69-15, Soils Publication No. 231, Massachusetts Institute of Technology, Cambridge, 1969.
12. *Lateral Continuity of a Pre- or Early Cretaceous Erosion Surface Across Neuschel's Lineament, Northern Virginia*, submitted to the NRC by VEPCO letter, Serial No. 197, dated May 16, 1977.

13. *Report on Design and Stability of North Anna Dam for Virginia Electric and Power Company*, submitted as Amendment 15 to the North Anna Units 1 and 2 PSAR.

14. B. D. Hardin and V. P. Drnevich, *Shear Modulus and Damping in Soils I. Measurement and Parameter Effects II. Design Equations and Curves*, Technical Reports UKY17-70-CE, 2 and 3, College of Engineering, University of Kentucky, Lexington, 1970.

15. H. B. Seed, “The Influence of Local Soil Conditions on Earthquake Damage,” *Proceedings Speciality Conference on Soil Dynamics, International Conference on Soil Mechanics and Foundation Engineering*, Mexico, D. F., 1969.

16. Lambe and Whitman, 1969 ed., p. 486.

17. Engineering Transmittal, ETE-CEM-2011-0008, Revision 1, *Characterization of the North Anna Seismic Event of August 23, 2011*.

2.5 REFERENCE DRAWINGS

The list of Station Drawings below is provided for information only. The referenced drawings are not part of the UFSAR. This is not intended to be a complete listing of all Station Drawings referenced from this section of the UFSAR. The contents of Station Drawings are controlled by station procedure.

	Drawing Number	Description
1.	11715-FY-2A	Boring Location Plan, Station Area

Table 2.5-1
FOUNDATION DESIGN DATA FOR MAJOR STRUCTURAL COMPONENTS

Structure	Contact Area (ft x ft)	Founding Elevation (ft)	Maximum Contact Pressure (psf)[a]	Foundation Material
Fuel building	41 x 136 (mat)	243.3	5400	Sound rock
Auxiliary building	113 x 218 (mat)	240	2850	Sound and weathered rock and compacted granular fill
Service building	Varies (mat and strip footings)	Varies	5500	Residual soil and weathered rock
Main steam valve housing (including quench spray pump housing)	37 x 87 (mat)	252	3740	Concrete back fill, Unit 1; compacted granular fill, Unit 2
Safeguards area	21 x 74 (mat)	253.5	1900	Concrete backfill
Service water pump house	64 x 61 (mat)	297	(b)	Residual soil
North Anna Reservoir screenwell	64 x 187 (mat)	218	3330	Residual soil
Service water valve house	50-1/2 x 47 (mat)	295	4700	Residual soil
Service water tie-in vault	31 x 30 (mat)	278	2000	Residual soil

a. Dead load and live load.
b. See explanation in Section 2.5.4.2 with regard to maximum toe pressures.

Table 2.5-2
ALLOWABLE BEARING VALUES FOR FOUNDATION MATERIALS

Material	Allowable Bearing Value (lb/ft^2)
Residual soil (dense saprolite)	8000
Compacted granular fill	8000
Weathered rock	20,000
Sound rock	100,000
Residual soil (service water pump house)	4200

Table 2.5-3
UNCONFINED COMPRESSIVE STRENGTHS OF SELECTED ROCK SAMPLES

Samples			
Boring	Depth (ft)	Zone	Strength (psi)
Fresh to slightly weathered rock			
5	43	IV	10,250
5	98.5	IV	6500
5	108	IV	5800
28	53	IV	10,580
28	94	IV	16,300
29	45	III-IV	13,300
31	68	IV	8200
105	33	IV	16,190
105	42	IV	12,570
105	55	IV	13,730
105	97	IV	14,685
Slight to moderately weathered rock			
5	42.5	III	6500
5	82.5	III-IV	11,580
29	21	III-IV	6780
29	26.5	III-IV	12,790
29	100.5	III-IV	3080
31	33	III	8503
31	45.5	III	9100
31	53	III-IV	5680
31	59	III-IV	6160
31	60	III-IV	3729
31	75.5	III-IV	4660
39	71	III	8280
40	39.5	III	11,330
104	77	III-IV	2880
104	118	III-IV	4660
Weathered rock			
5	47	II-III	988
5	88.5	II-III	1470
39	62	III	620
40	44	II-III	2400

Figure 2.5-1
SITE SURFICIAL GEOLOGY MAP

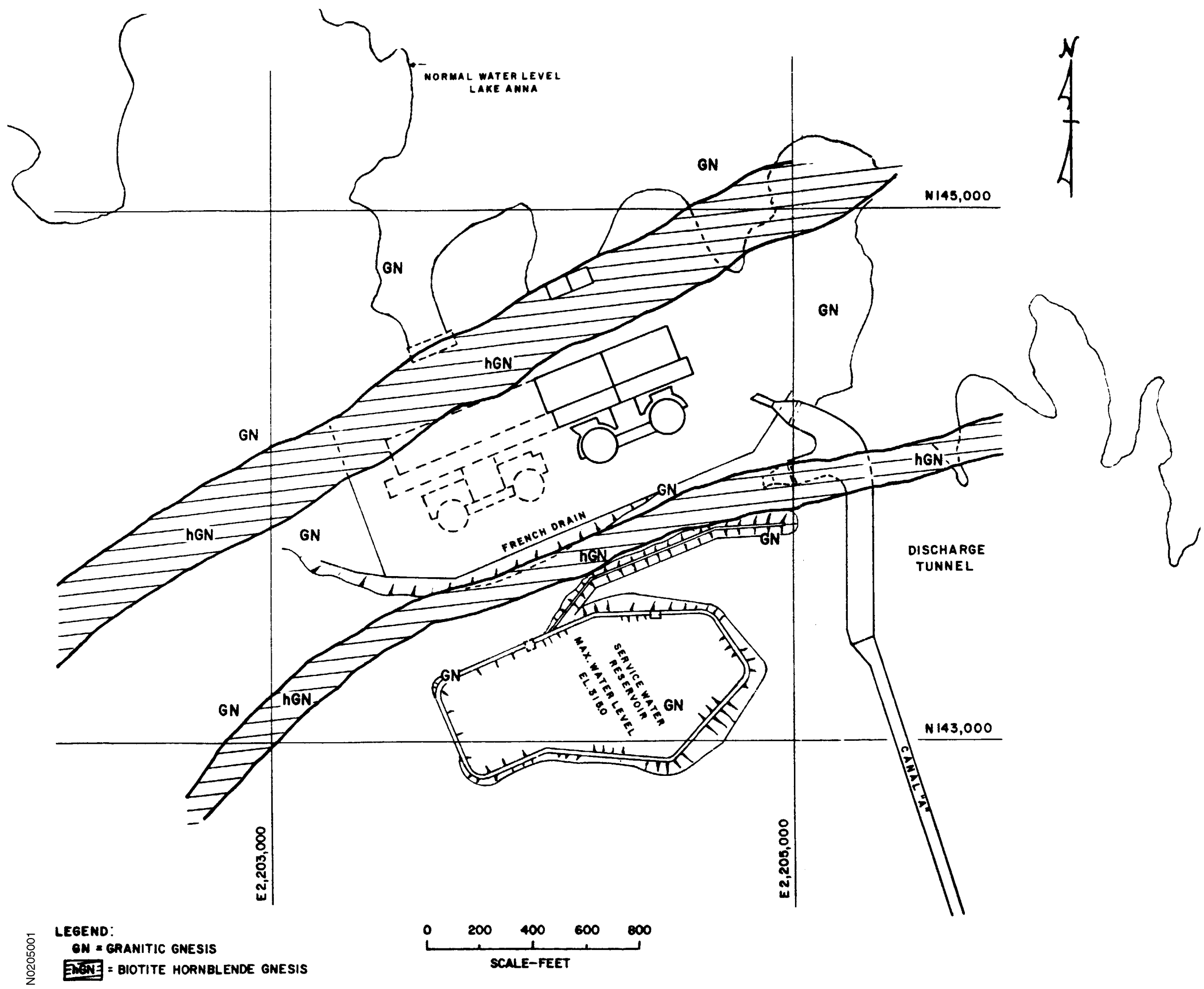
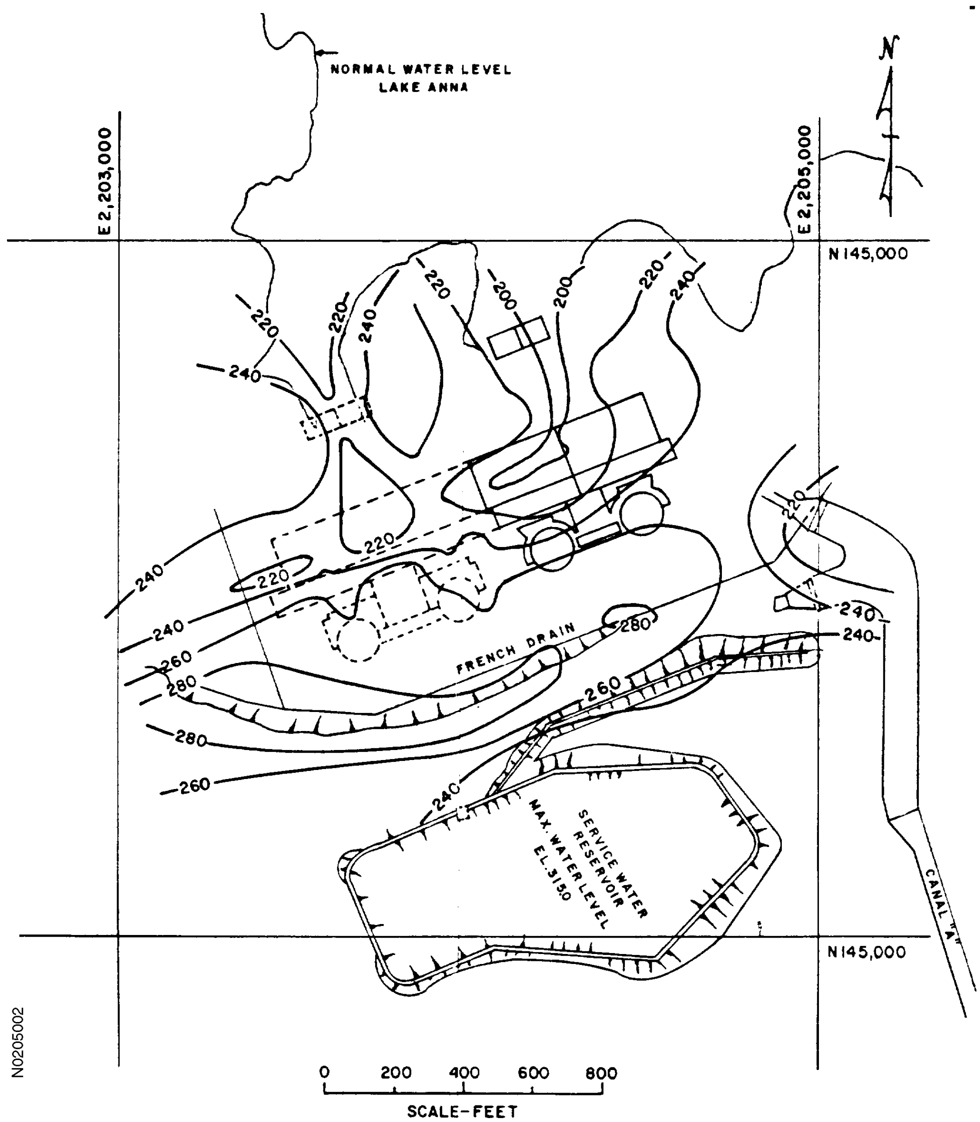


Figure 2.5-2
BEDROCK CONTOUR MAP



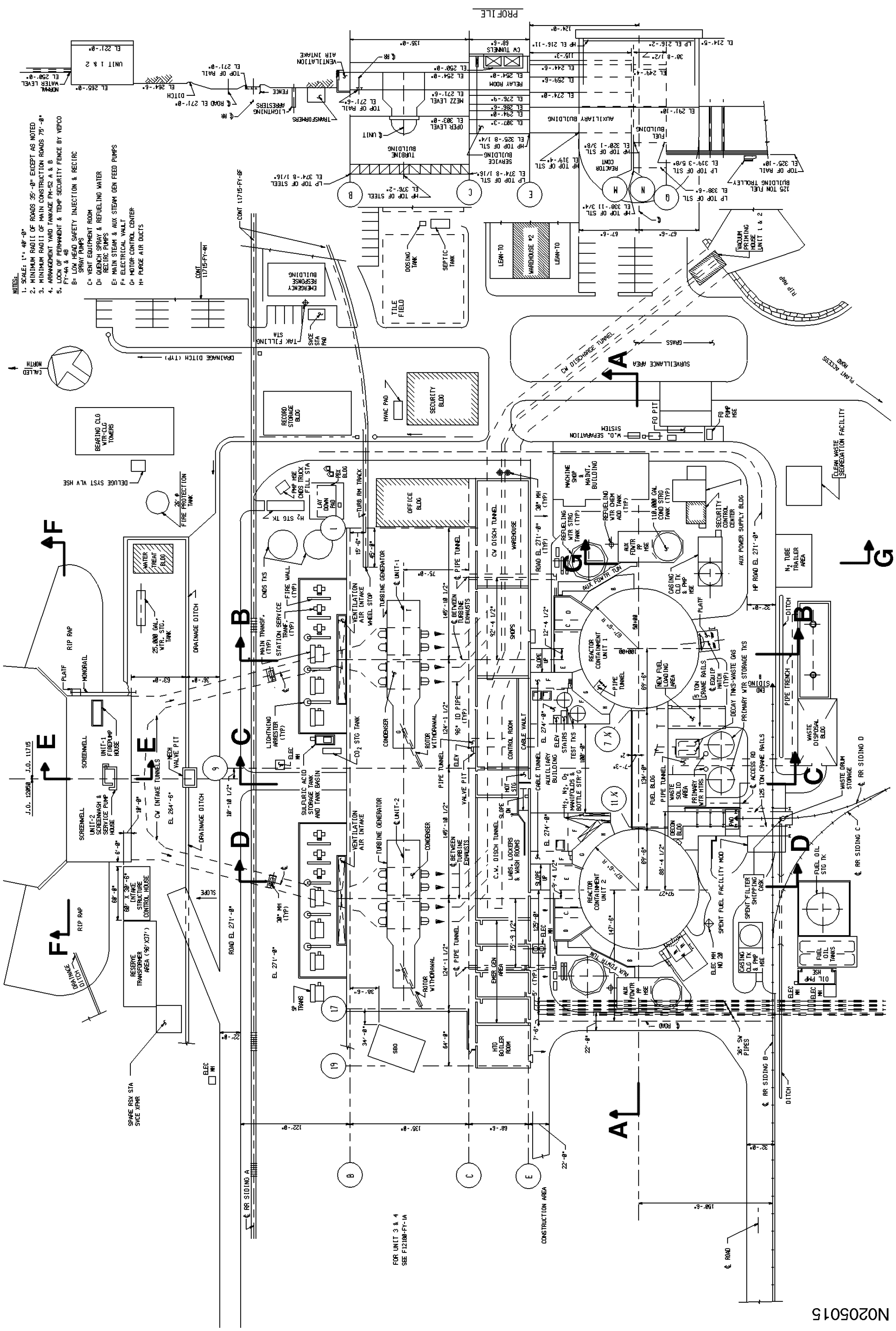


Figure 2.5-3
PLAN SITE GEOTECHNICAL PROFILE LOCATIONS

Figure 2.5-4
SECTION A-A - SUBSURFACE PROFILE

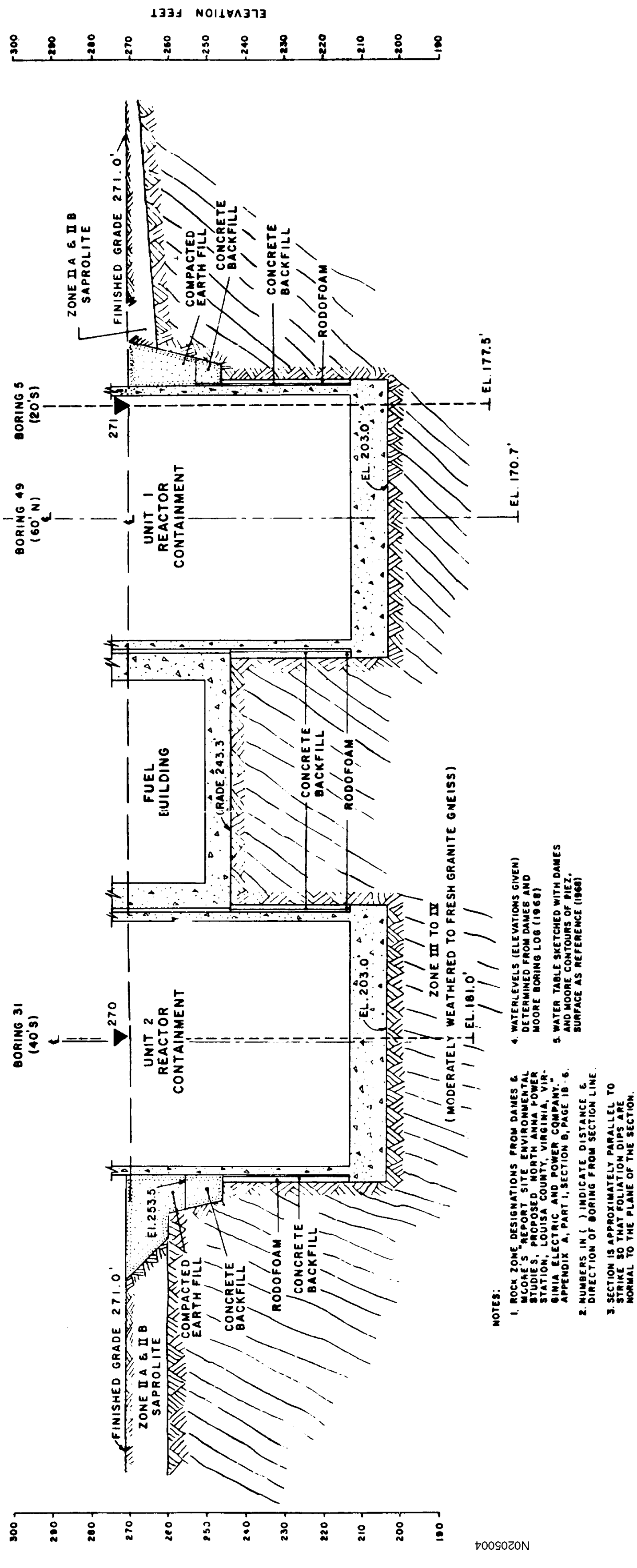
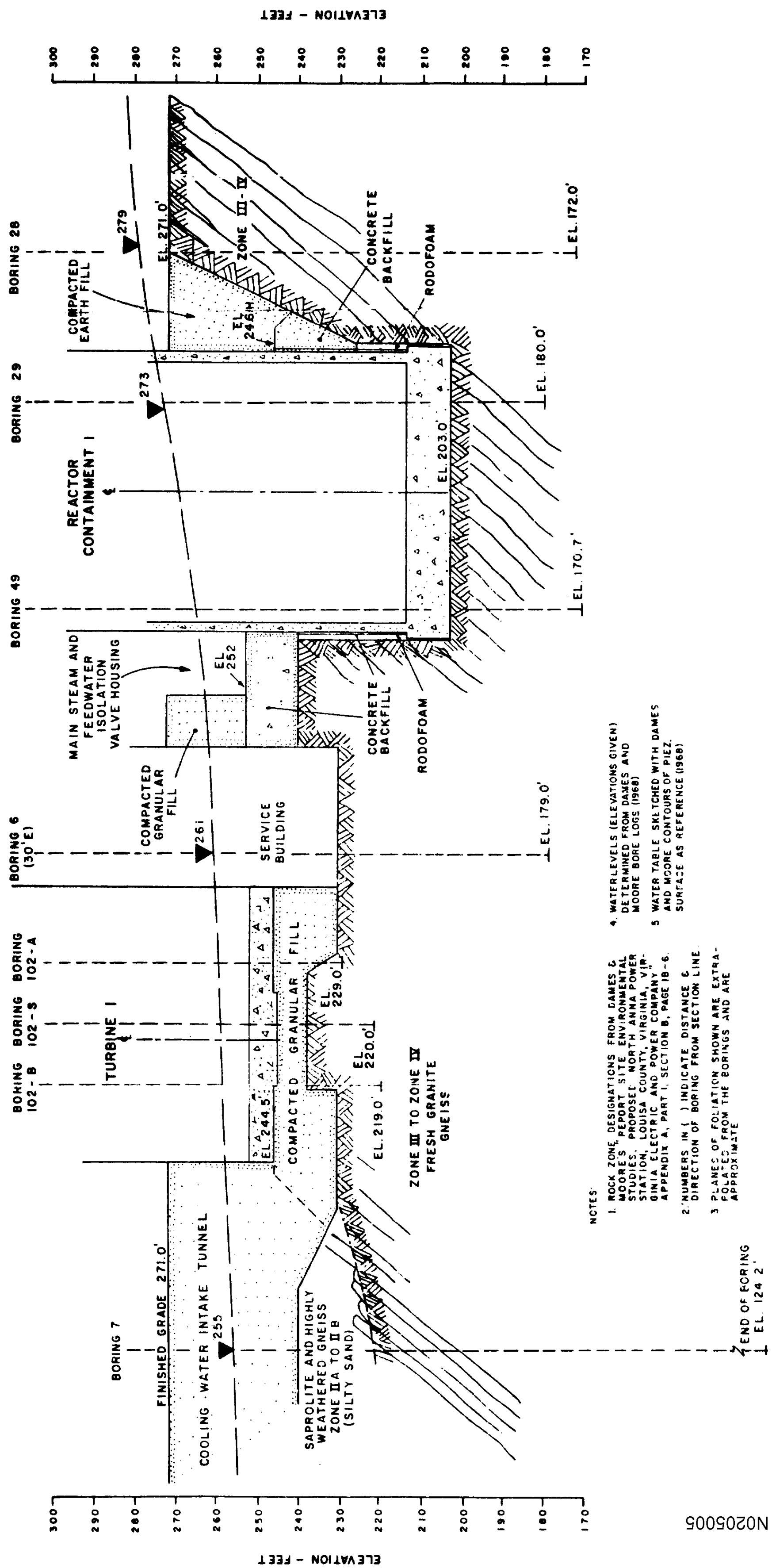


Figure 2.5-5
SECTION B-B - SUBSURFACE PROFILE



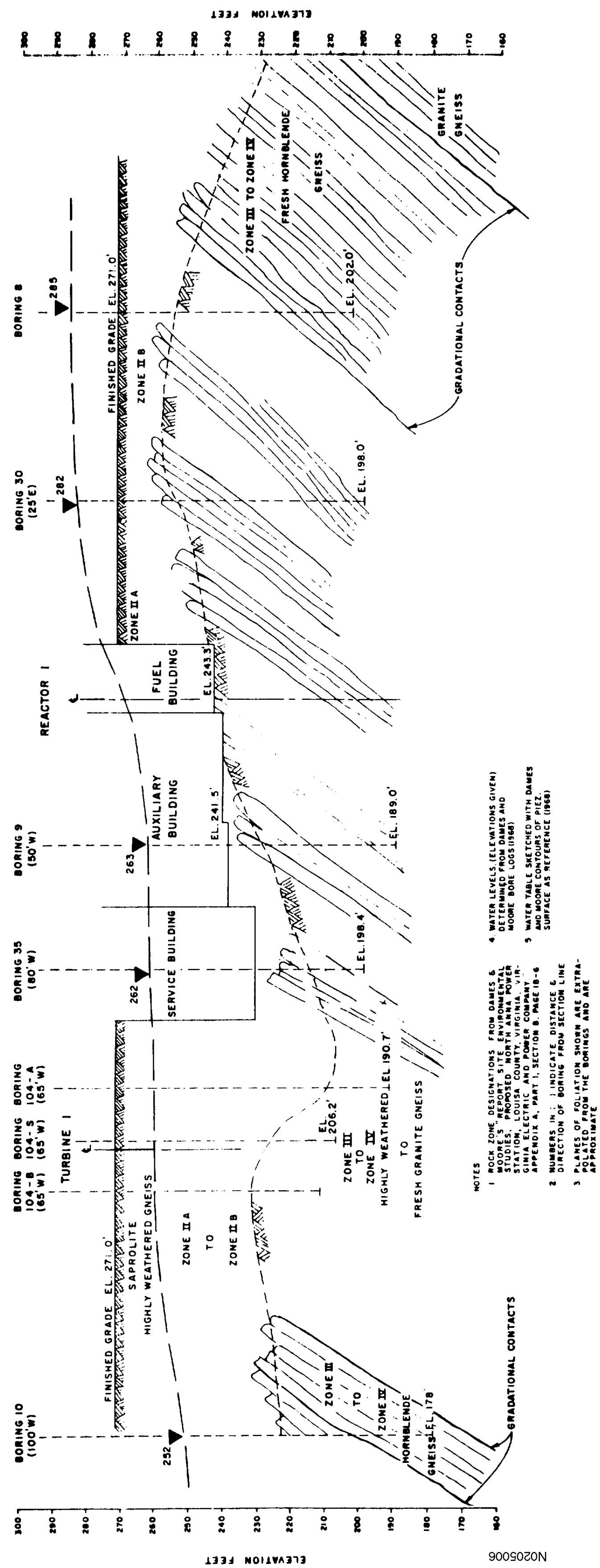


Figure 2.5-6
SECTION C-C - SUBSURFACE PROFILE

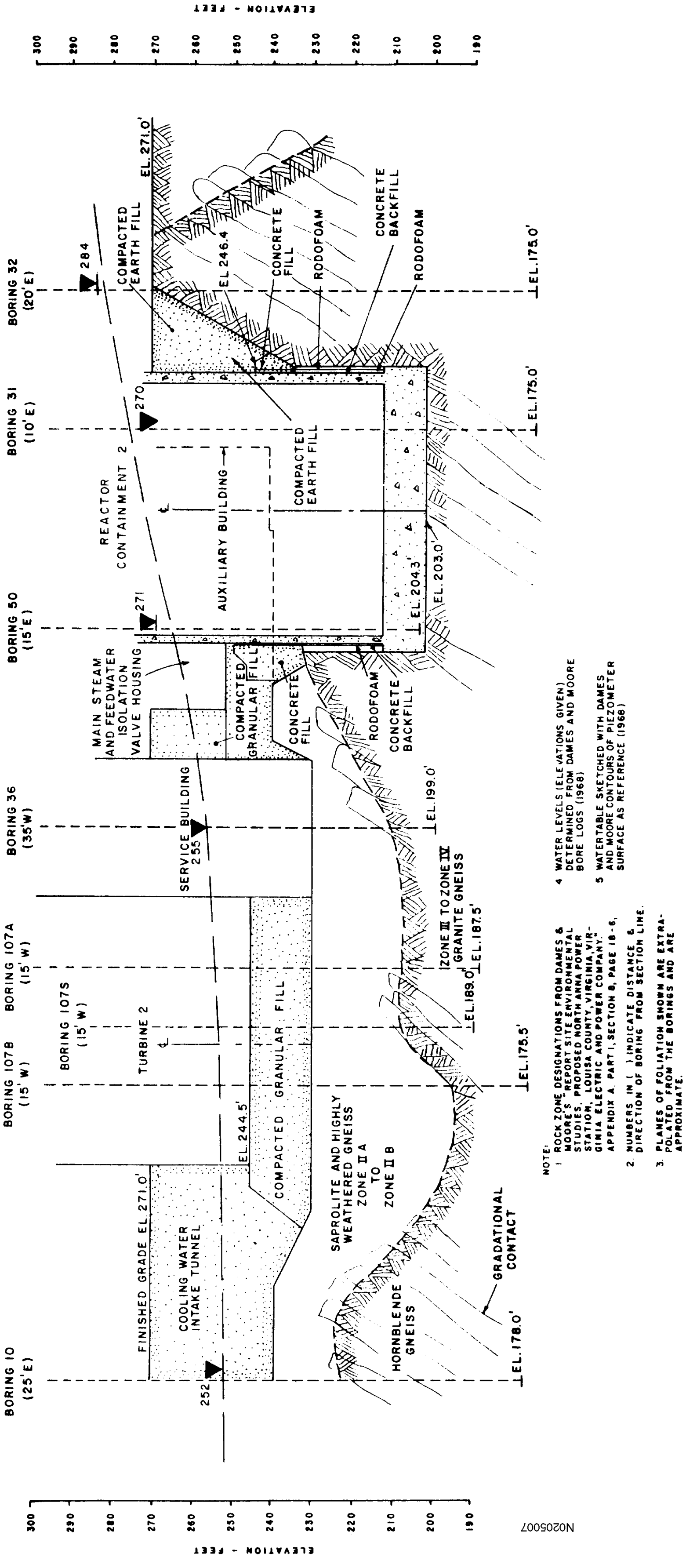
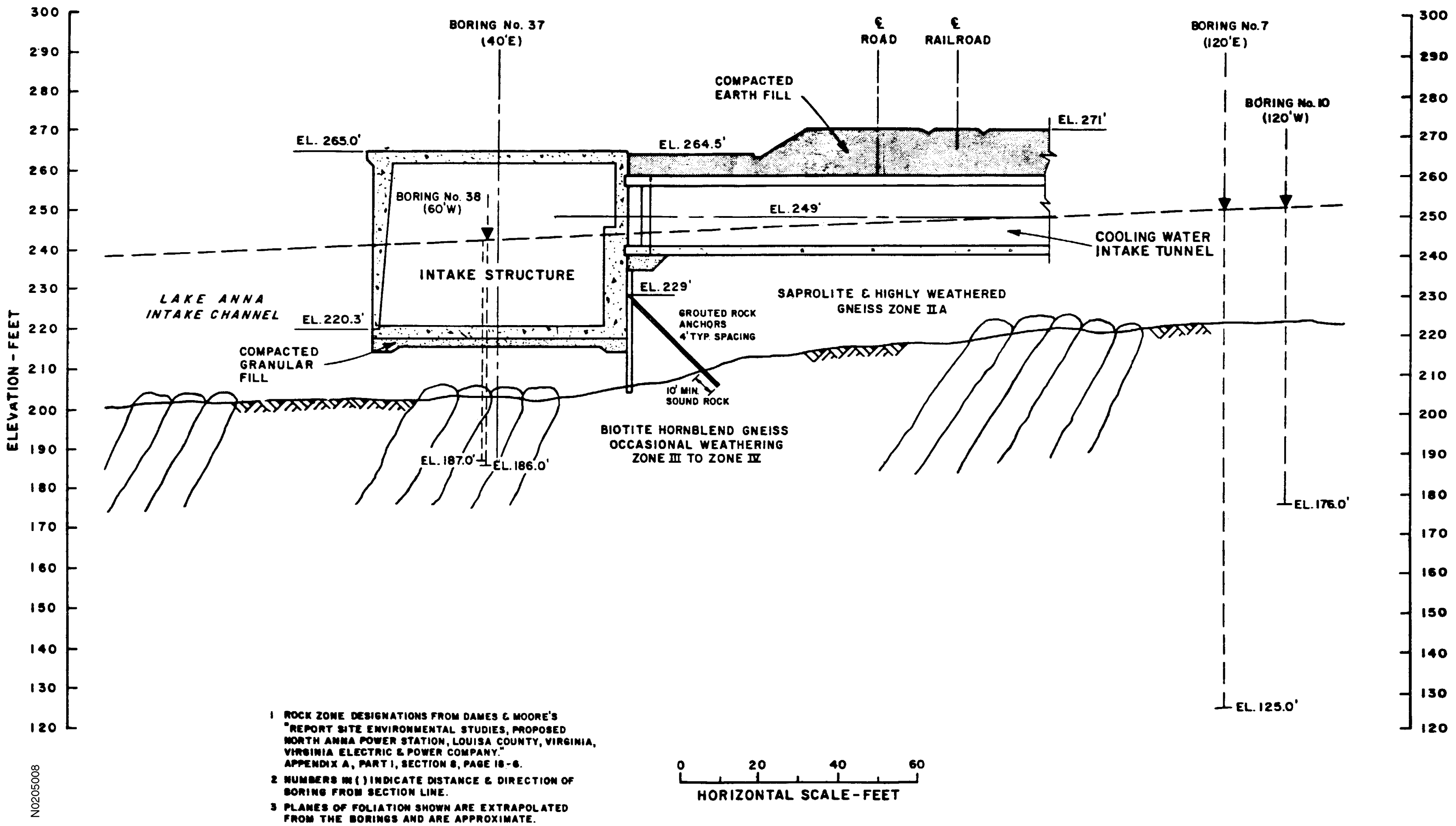


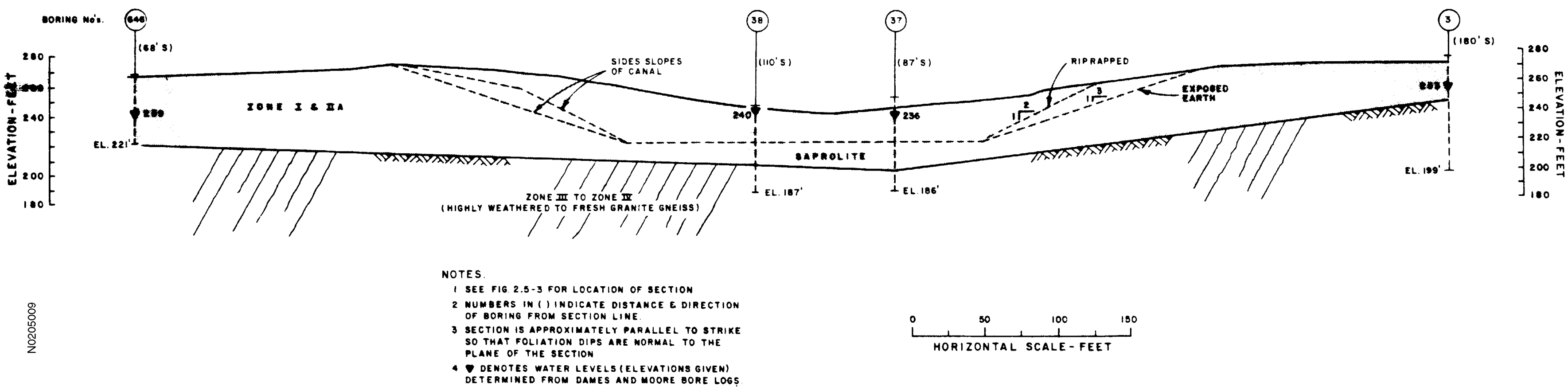
Figure 2.5-7
SECTION D-D - SUBSURFACE PROFILE

Figure 2.5-8
SECTION E-E - SUBSURFACE PROFILE



1 ROCK ZONE DESIGNATIONS FROM DAMES & MOORE'S "REPORT SITE ENVIRONMENTAL STUDIES, PROPOSED NORTH ANNA POWER STATION, LOUISA COUNTY, VIRGINIA, VIRGINIA ELECTRIC & POWER COMPANY." APPENDIX A, PART I, SECTION 8, PAGE 18-6.
2 NUMBERS IN ( ) INDICATE DISTANCE & DIRECTION OF BORING FROM SECTION LINE.
3 PLANES OF FOLIATION SHOWN ARE EXTRAPOLATED FROM THE BORINGS AND ARE APPROXIMATE.
4 WATER LEVELS (ELEVATIONS GIVEN) DETERMINED FROM DAMES & MOORE BORE LOGS (1968)
5 WATERTABLE SKETCHED WITH DAMES AND MOORE CONTOURS OF PIEZOMETER SURFACE AS REFERENCE (1968)

Figure 2.5-9
SECTION F-F - SUBSURFACE PROFILE



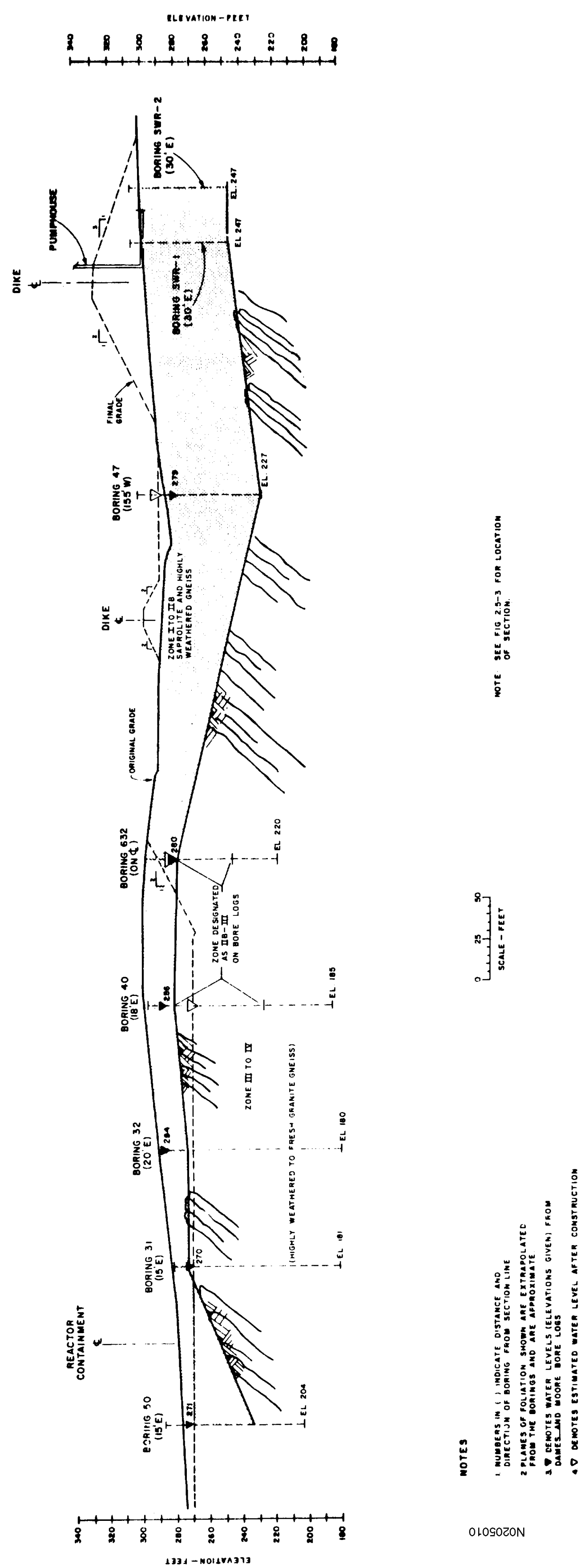


Figure 2.5-10
SECTION G-G - SUBSURFACE PROFILE

Figure 2.5-11
RESPONSE SPECTRA OBE FOR ROCK—0.06G

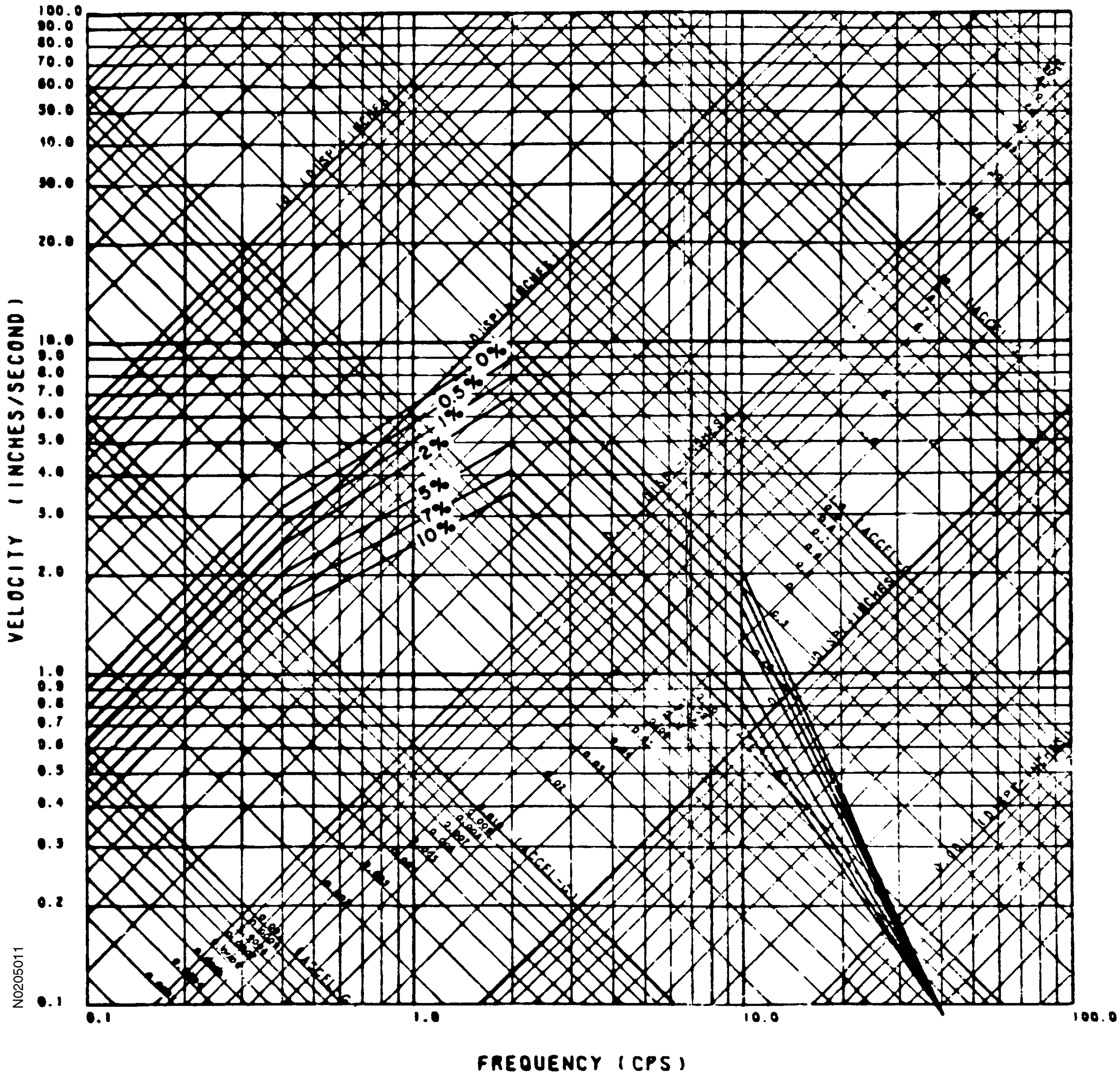


Figure 2.5-12
RESPONSE SPECTRA DBE FOR ROCK—0.12G

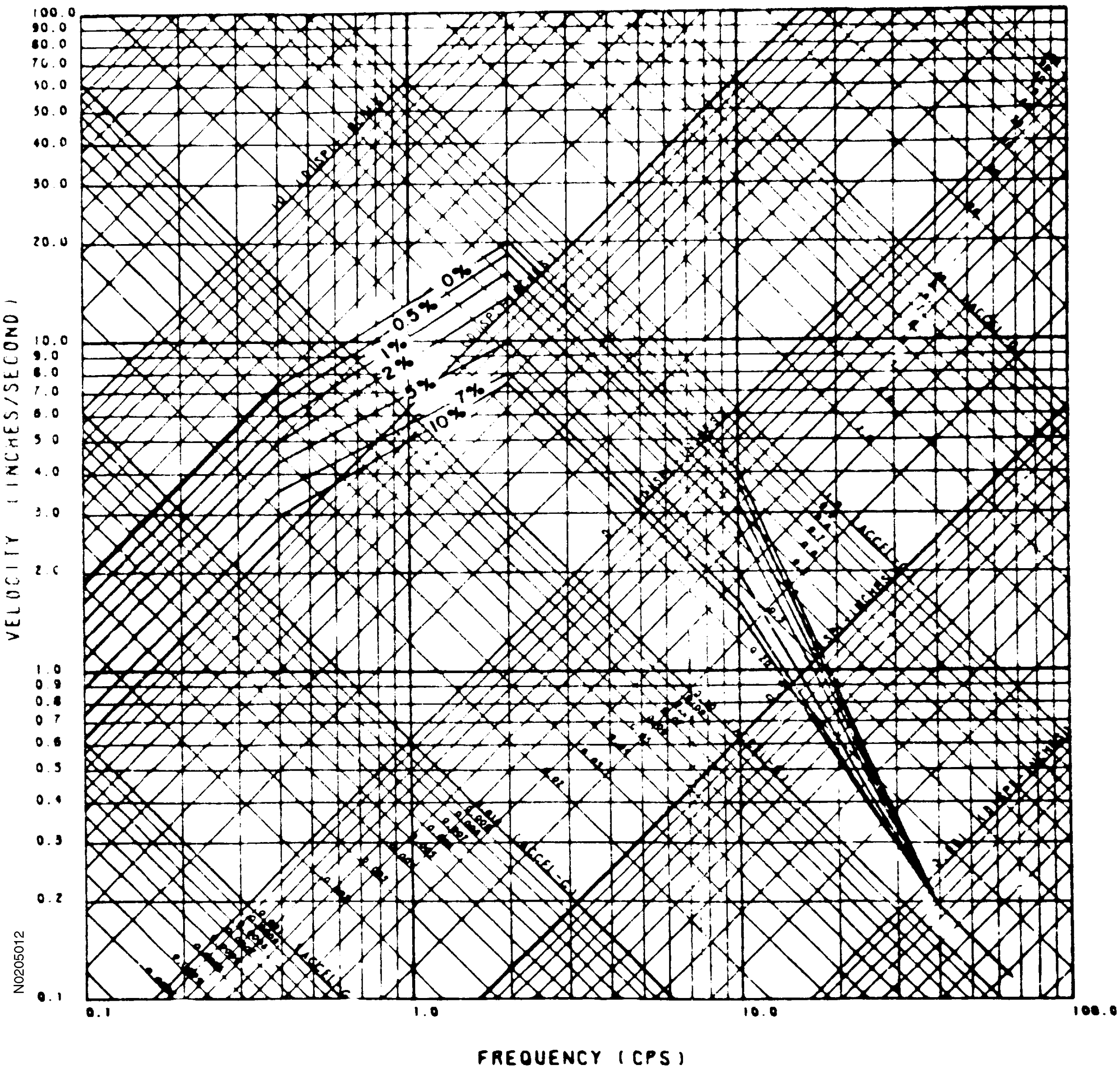


Figure 2.5-13
RESPONSE SPECTRA OBE FOR SOIL SUPPORTED STRUCTURES—0.09G

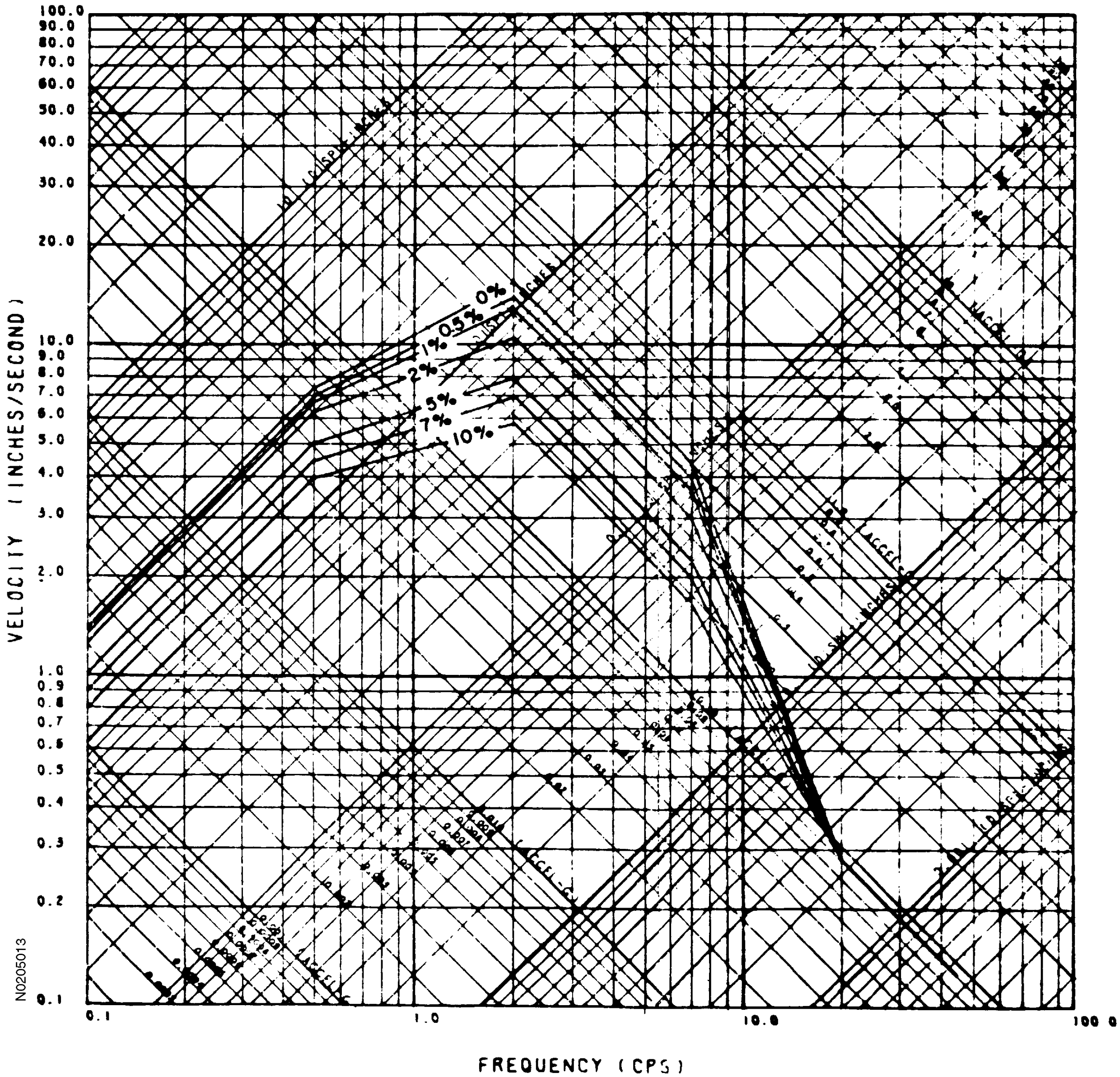


Figure 2.5-14
RESPONSE SPECTRA DBE FOR SOIL SUPPORTED STRUCTURES—0.18G

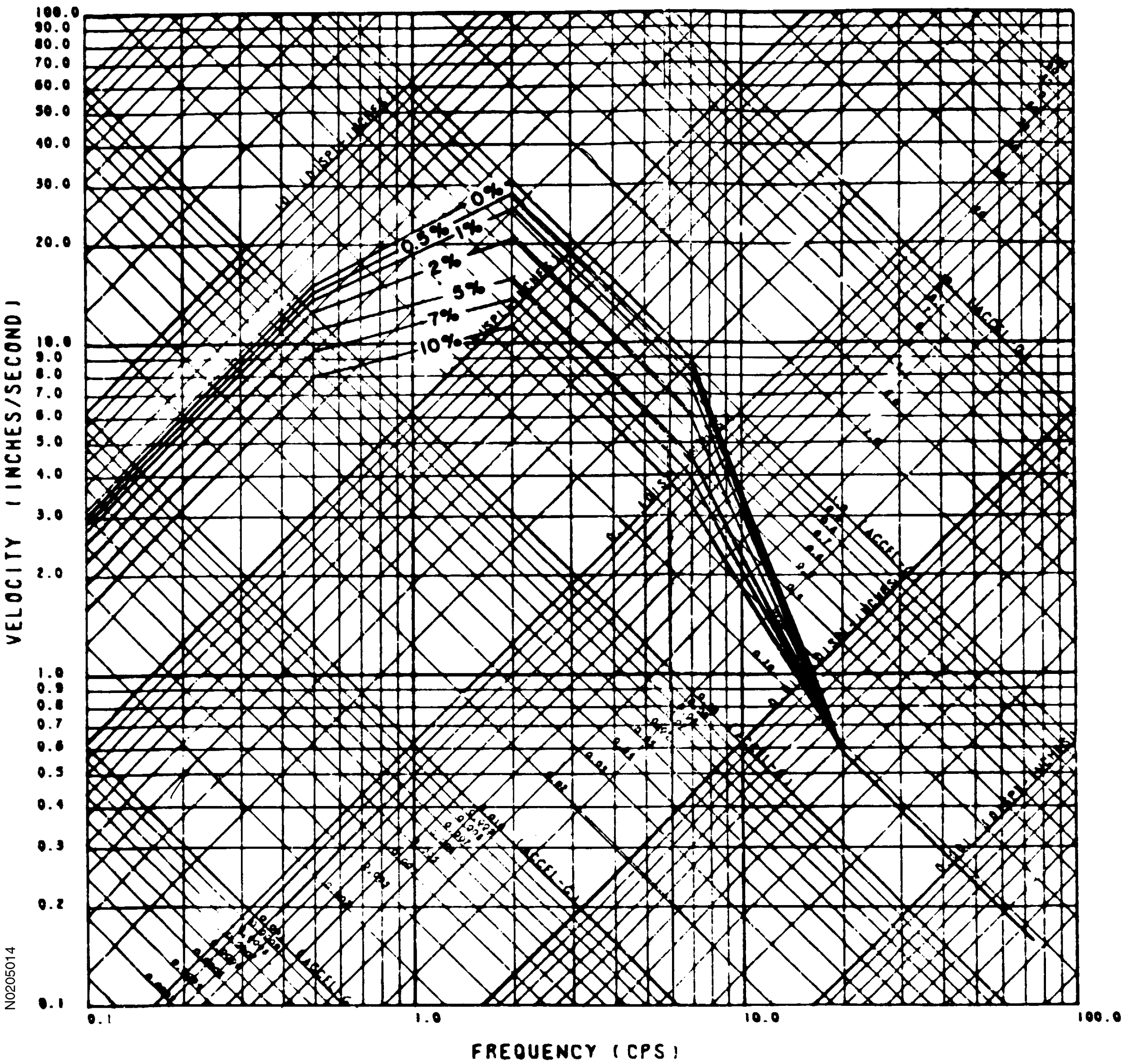


Figure 2.5-15
RESPONSE SPECTRA AT CONTAINMENT BASEMAT FROM THE AUGUST 23, 2011 M5.8 EARTHQUAKE COMPARED TO ROCK-BASED DBE RESPONSE SPECTRUM - HORIZONTAL DIRECTION, 5% DAMPING

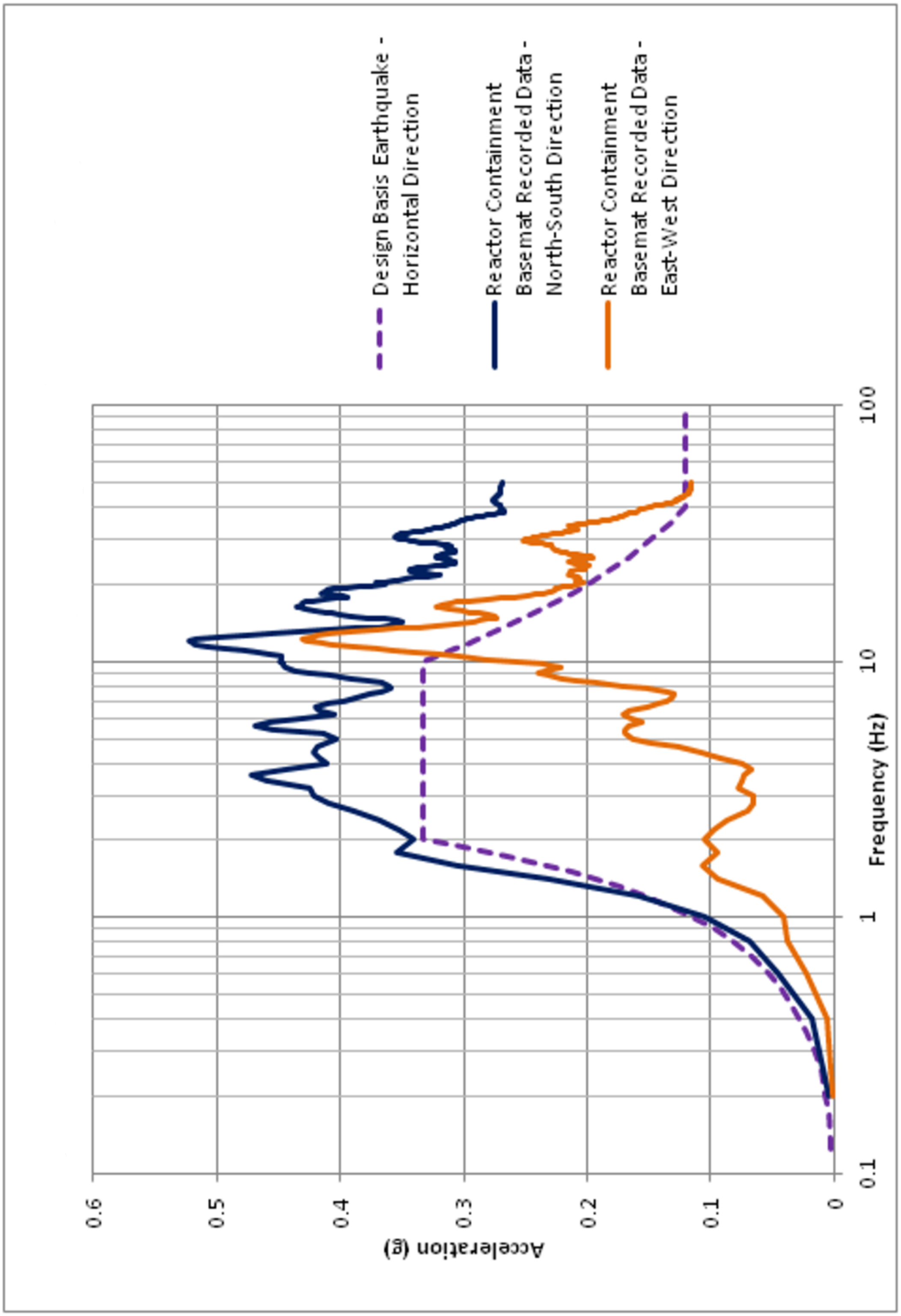
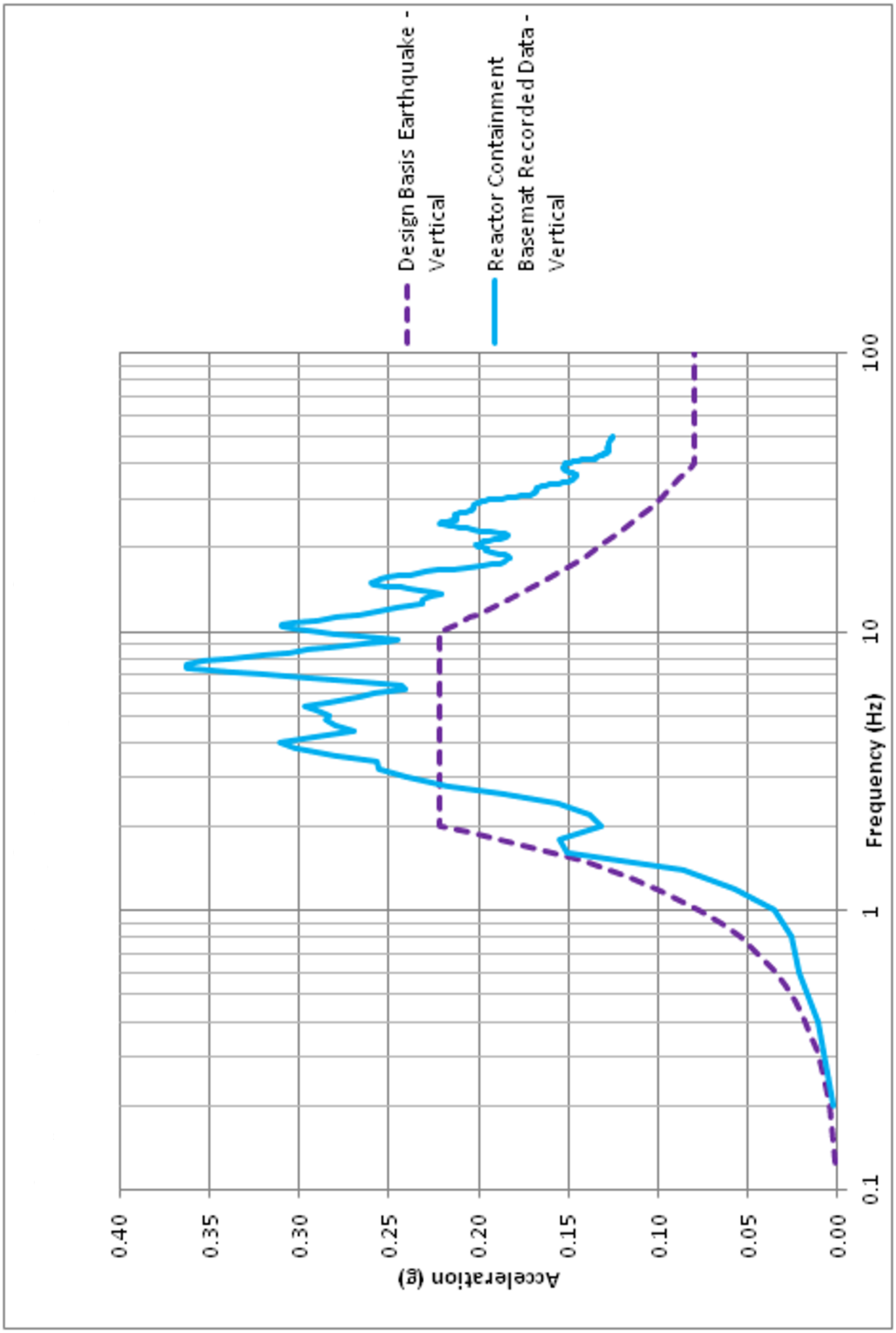


Figure 2.5-16
RESPONSE SPECTRUM AT CONTAINMENT BASEMAT FROM THE AUGUST 23, 2011 M5.8 EARTHQUAKE COMPARED TO ROCK-BASED DBE RESPONSE SPECTRUM - VERTICAL DIRECTION, 5% DAMPING



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Appendix 2A[1]
Revised Analysis, Probable Maximum Flood, North Anna Units 1 and 2, Virginia Electric and Power Company
June 18, 1976

1. Formerly Appendix J to the Final Safety Analysis Report (Docket Nos. 50-338 and 50-339).

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2A.1 INTRODUCTION

Revised Analysis, Probable Maximum Flood, North Anna Units 1 and 2, Virginia Electric and Power Company

The probable maximum flood analysis shown in the North Anna Units 1 and 2 FSAR (Reference 1) and the Units 3 and 4 PSAR (Reference 2) is inconsistent with the observed behavior of Lake Anna since its filling. The analysis has been revised to reflect actual field data gathered since the closure of Lake Anna Dam in 1972. The field data show higher earlier inflow peaks with resultant higher lake stages than the original analysis for a given rainfall. A conservative analysis of the lake stage associated with the probable maximum flood shows an upper bound of Elevation 264.2 (all elevations given are in feet above mean sea level), an increase of 9.7 feet from the original peak stage of the probable maximum flood (References 1 & 2). The combined effects of wind surge, wave runup, and the backwater effect of 3.1 feet are added to Elevation 264.2, totaling Elevation 267.3 at the station site. Since the station can be maintained in a safe condition for flood levels above this new level, no safety impact is indicated by this revised analysis.

2A.2 FLOOD ANALYSIS

2A.2.1 Introduction

A total of four storms, June 1972 (Hurricane Agnes), April 1973, September 1974, and March 1975, were used in the most recent investigation of the response of the Lake Anna drainage basin to precipitation. These rainstorms all show higher earlier inflow peaks than those predicted by the original runoff model. The higher earlier inflow peaks result in a higher peak reservoir stage for any given rainstorm. Conservative upper-bound calculations show that the still-water level associated with the probable maximum flood is less than 9.7 feet greater than that indicated by the original analysis.

For the original flood studies, 6-hour unit hydrographs were derived from actual stream flow records at Doswell, Virginia, from which a composite unit hydrograph was developed. The composite unit hydrograph was then adjusted for the dam site (14 miles upstream from Doswell) using Snyder's Method (Reference 3). In the revised study, hydrographs for the inflow to Lake Anna were generated using actual precipitation and reservoir records for four storms occurring since the closure of the Lake Anna Dam. The most severe unit hydrograph developed from these recent data was used in the revised probable maximum flood prediction. The composite 6-hour unit hydrograph developed in the original flood study (Reference 1) showed a peak inflow of 6500 cfs with a concentration time of 29.5 hours. The 6-hour unit hydrograph generated using the new data shows a peak inflow of 14,530 cfs with a concentration time of 11 hours. The higher earlier inflow peaks are apparently caused by the spreading of Lake Anna's arms well up into the drainage basin, with the resultant shortening of drainage distances to the lake.

The probable maximum flood is generated using the unit hydrograph of April 1973 and the 48-hour probable maximum precipitation of 27.04 inches. The standard project storm of 13.54 inches in 48 hours (approximately one-half the probable maximum precipitation), is used for antecedent precipitation. The antecedent precipitation is assumed to occur 5 days before the main storm, with 3 rainless days between the storms. The resultant probable maximum flood still-water level is Elevation 264.2. When wind surge and wave runup, due to a 40 mph wind blowing in the most critical direction, 2.9 feet and a backwater allowance of 0.2 foot is added to this, the resultant upper-bound flood stage is Elevation 267.3, 3.7 feet below plant grade.

The determination of the historical unit hydrographs and routing of the probable maximum flood through the reservoir is accomplished using the 1973 version of the U.S. Army Corps of Engineers generalized computer program HEC-1 (Reference 4).

2A.2.2 General Description

The Lake Anna Dam impounds a lake with a surface area of 13,000 acres and 305,000 acre-ft of storage, at its normal-stage elevation of 250 feet, along the channel of the North Anna River. The drainage basin area above the site of the Lake Anna Dam is 343 square miles. The lake will be used by the North Anna Power Station as a cooling pond for condenser circulating water. To improve the thermal performance of the lake, it has been divided by a series of dikes and canals into two parts. The larger, referred to as the North Anna Reservoir, is 9600 acres and receives rainfall runoff from approximately 297 square miles as well as the inflow due to rain falling directly onto its surface. The smaller part, called the Waste Heat Treatment Facility, is 3400 acres and receives rainfall runoff from 25 square miles as well as inflow due to rain falling directly on its surface. The power station withdraws circulating water from the reservoir and discharges it to the Waste Heat Treatment Facility. Water passes from the Waste Heat Treatment Facility to the reservoir through submerged orifices in Dike III, the dike most distant from the station. The crest of the dividing dikes is at Elevation 260, with the exception of Dike III, which is constructed with a saddle at Elevation 253.5 to allow the passage of flood flows.

Discharges from Lake Anna are regulated by a concrete gravity spillway structure, two 8 foot-wide overflow skimmer gates, and three 40 foot-wide radial gates.

A more complete description of Lake Anna and the spillway is given in Section 2.4.

2A.2.3 Available Historic Information

2A.2.3.1 **Lake Anna**

The stage-volume and stage-area relationships are shown in Figures 2A-1 and 2A-2, respectively, for the North Anna Reservoir and the Waste Heat Treatment Facility. These are computed from topographic data taken before the filling of Lake Anna. The stage-volume relationships for the component parts of the Waste Heat Treatment Facility, which were used in

the inflow analysis (Section 2A.2.4.1), are developed by prorating the total storage of the Waste Heat Treatment Facility by the fraction of the total surface area of the Waste Heat Treatment Facility, at Elevation 250, attributable to each of the four components.

A stage-flood storage relationship used for routing the probable maximum flood to produce the upper-bound still-water level, as described in Section 2A.2.5.1, is developed from Figures 2A-1 and 2A-2 and is shown as Figure 2A-3.

The arrangement and the cross section of the dikes and canals are shown in Figures 2A-4 and 2A-5 and in Appendix 2A, Attachment 4. The detailed information of the flows through the dikes and canals is shown in Appendix 2A, Attachment 4.

The discharge capacity of the North Anna spillway is calculated by the method of Reference 5, Hydraulic Design Chart 122-1. The form of the spillway is shown in Figures 2A-6 and 2A-7. The discharge capacity of the radial gate section is shown on Figure 2A-8. The discharge capacity of the skimmer gates is shown on Figure 2A-9. For lake stages above Elevation 255, the capacity can be determined by extrapolation. To avoid the impingement of the lower lip of the radial gate upon the upper nappe of the spillway discharge during probable maximum flood conditions, the instructions call for a maximum radial gate opening of 36 feet.

The reservoir operating rule curve is shown on Figure 2A-10. Historical operation data for Lake Anna during the storms of June 1972 (Hurricane Agnes), April 1973, September 1974, and March 1975, consisting of lake stages and spillway discharges, are shown on Table 2.A-1. The discharges are calculated from stage and gate-opening records using Figures 2A-8 and 2A-9.

2A.2.3.2 **Rainfall Data**

Copies of the U.S. Weather Bureau precipitation data sheets for the stations used in this study are included in Appendix 2A, Attachment 1.

Thiessen polygons used for the examination of historic storms are shown as Figures 2A-11 through 2A-16. Precipitation weightings used for rain falling directly on the reservoir and the waste heat treatment facility surface are shown in Table 2.A-2. The differences between the total of the hourly precipitation readings for a given day and the daily precipitation reading for that day result from the U.S. Weather Bureau practice of taking daily readings at times other than midnight. The resolved precipitation values, including the infiltration loss calculations, printouts (Reference 4) are shown in the HEC-1 in Appendix 2A, Attachment 2.

Values of probable maximum precipitation and standard project storm are calculated from Reference 6 and are shown in the Reference 4 computer run in Appendix 2A, Attachment 3. The probable maximum precipitation and standard project storm are broken down into 3-hour increments and are slightly different from those given in Reference 1.

2A.2.3.3 **Historic Inflows to the Waste Heat Treatment Facility**

Inflows to the Waste Heat Treatment Facility were calculated for the four historic storms using Snyder's Method (Reference 6). The drainage area feeding to the Waste Heat Treatment Facility was divided into 31 subbasins, synthetic unit hydrographs were developed for each subbasin, and inflows were calculated using HEC-1 (Reference 4) and historical rainfall. The unit hydrographs for the 31 subbasins and the historical inflow values are shown in Appendix 2A, Attachment 2. The basin map with unit hydrograph parameters is shown as Figure 2A-4. Since the drainage area for the Waste Heat Treatment Facility is less than 10% of the total drainage area, the use of a synthetic method to derive the flood inflows for the Waste Heat Treatment Facility has a negligible effect on the accuracy of the whole computation.

Inflows due to rain falling directly on the water surface is calculated by assuming that all of the rainfall associated with the storm falls directly onto the 9600-acre reservoir, including that which falls on the Waste Heat Treatment Facility.

These inflows are shown in Appendix 2A, Attachment 3.

2A.2.4 Reservoir Inflow Analysis

2A.2.4.1 **Historical Inflow Calculations**

2A.2.4.1.1 General Description

Lake Anna is divided into two major portions, the North Anna Reservoir and the Waste Heat Treatment Facility, and the Waste Heat Treatment Facility is further subdivided into three cooling lagoons. Four dikes separate the reservoir and the Waste Heat Treatment Facility, and three canals connect the three cooling lagoons of the Waste Heat Treatment Facility (Figure 2A-4). The surface areas at the normal stage (Elevation 250.0) for the Waste Heat Treatment Facility and the North Anna Reservoir are 3400 and 9600 acres, which are about 26% and 74% of the total lake area, respectively. The drainage areas of the Waste Heat Treatment Facility and the North Anna Reservoir are about 31 and 312 square miles, which are about 9% and 91% of the total drainage area, respectively. The orifices in Dike III provide limited flow exchange between the Waste Heat Treatment Facility and the North Anna Reservoir. If the water level is above Elevation 253.5, flow over Dike III will occur. The overtopping of Dikes I, II, III, and IV will occur when the water level is above Elevation 260.

To calculate the flood inflows to the North Anna Reservoir during historic storms, the continuity equations for the reservoir and each component of the Waste Heat Treatment Facility are derived. A computer program was developed to simulate the water levels and flood flows through dikes, canals, and spillways. The formulation of the equations in the program is described in Appendix 2A, Attachment 4. Note that there were no flows over dikes during the historic storms, so that this section of the program is not used.

It was necessary to develop this computer program to account for the differences in water level between the North Anna Reservoir and the Waste Heat Treatment Facility, since ignoring this difference is not necessarily conservative. In addition, an analysis was performed of historic inflows assuming that no differential existed between the reservoir and the Waste Heat Treatment Facility. This is discussed further in Section 2A.2.8.

2A.2.4.1.2 Input Data

Since the closure of Lake Anna Dam, four major storms have occurred in Virginia: June 1972 (Hurricane Agnes), April 1973, September 1974, and March 1975. Inflows for Hurricane Camille (September 1969) were not used in the study, since this storm predates the January 1972 closing of the Lake Anna Dam and would yield no usable data. The required program input data include the storage capacity of the North Anna Reservoir and the three waste heat treatment facility cooling lagoons, the discharge capacity of the dikes and channels, precipitation from historic storms, the water stages of the North Anna Reservoir, spillway discharge during the historic storms, and flood inflows to the waste heat treatment facility cooling lagoons. These inputs are described in Section 2A.2.3.

2A.2.4.1.3 Results

Using the computer program, as described in Appendix 2A, Attachment 4, with the required input data, the inflows to the North Anna Reservoir for the four storms are computed as shown in Appendix 2A, Attachment 2. The computed flood inflows are then used for the optimization of the North Anna Reservoir drainage basin unit hydrograph parameters by HEC-1 (Reference 4), as described in Section 2A.2.4.2. It should be noted that, if the derived inflow is negative at some period of time, it is conservatively assumed that there is no flow at that time.

2A.2.4.2 **Unit Hydrograph Optimization**

Unit hydrograph optimization was performed using HEC-1 (Reference 4) and the calculated historical inflow values discussed in Section 2A.2.4.1 for the drainage basin of the 9600-acre reservoir. Preliminary optimization results showed that the unit hydrograph of the September 1974 storm had a substantially lower peak than did those of the other three storms. Therefore, the final unit hydrograph optimization took into account only the three storms of June 1972, April 1973, and March 1975. The unit hydrographs for all four storms are shown as Figure 2A-17. The HEC-1 (Reference 3) optimization parameters selected are shown in Table 2.A-3. The optimization procedure used is the one suggested on page 7 of Addendum 1 to the user's manual to Reference 4.

2A.2.4.3 **Generation of Inflows from the Probable Maximum Flood and the Standard Project Flood**

Two components of inflow are considered, overland runoff and rain falling directly on the water surface. Overland runoff is calculated using a combination of the unit hydrograph and the

probable maximum precipitation with an antecedent condition of the standard project flood. All inflows are routed through the 9600-acre reservoir. The unit hydrograph used is the one generated for the drainage basin of the-9600 acre reservoir (see Section 2A.2.4.2) with its ordinants increased to account for inflow from the 26 square-mile land area of the waste heat treatment facility drainage basin.

2A.2.5 Routing of the Probable Maximum Flood

2A.2.5.1 **Description of the Analysis and Assumption**

The routing of the probable maximum flood for the North Anna site is accomplished using a very conservative upper-bound type of analysis for lake inflow components. Four inflow components require consideration:

1. Overland flow to the North Anna Reservoir.
2. Rainfall directly on the North Anna Reservoir.
3. Overland flow to the Waste Heat Treatment Facility.
4. Rainfall directly on the Waste Heat Treatment Facility.

Since the exchange flow between the Waste Heat Treatment Facility and the North Anna Reservoir is restricted by the dividing dikes, it is assumed conservatively that all rainfall and runoff is routed through the storage associated with the 9600-acre reservoir until the stage reaches Elevation 260. The storage available from the Waste Heat Treatment Facility is used when the stage of the North Anna Reservoir exceeds Elevation 260, the top of the dividing dike. Only that storage available above Elevation 260 in the Waste Heat Treatment Facility is used. This is equivalent to assuming that the Waste Heat Treatment Facility is full to Elevation 260 at the start of the probable maximum flood, and this assumption is very conservative.

The routing calculation is performed by HEC-1 (Reference 4). A printout showing input parameters and results is given in Appendix 2A, Attachment 3.

2A.2.5.2 **Input Data**

The generation of the inflow hydrograph is discussed in Section 2A.2.4.3.

The stage-volume relationship used for the flood routing is shown as Figure 2A-3.

Discharges from the North Anna Reservoir are in accordance with the reservoir operating rule curve as discussed in Section 2A.2.3.

2A.2.5.3 **Results**

The maximum storage used during the probable maximum flood is 181,732 acre-ft. This corresponds to a stage of Elevation 264.2. The antecedent condition used in the flood routing is one-half the probable maximum precipitation. This is the equivalent of the standard project storm

and results in the standard project flood. The conservative upper-bound routing shows a peak storage of 49,517 acre-ft with a peak stage of Elevation 255.2 for the standard project flood.

2A.2.6 Backwater Profile Analysis

The routing analysis assumes a level reservoir. As an extra measure of conservatism, an additional allowance for backwater effects from the spillway is included. This analysis was performed using the method described in Section 2.4.3.5. The flow used in calculating the backwater effects is the discharge associated with the peak stage during the probable maximum flood, (i.e., 141,600 cfs). The allowance for backwater effects is calculated to be 0.2 foot. A summary of this calculation is shown on Table 2.A-4.

2A.2.7 Wind Wave Analysis

The rise in water level due to wind activity at the time of the maximum flood-water level in Lake Anna was calculated using the methods and procedures recommended by the U.S. Army Coastal Engineering Research Center (Reference 4).

The wind setup (surge) and wave runup were considered in determining the maximum flood-water level. These two parameters were evaluated for two critical locations at the plant site, the shoreline leading up to the plant grade and the face of the Units 1 and 2 circulating water intake structure. The Units 3 and 4 intake structure is sheltered by a point of land so that wind wave effects are not critical.

To calculate the surge and wave runup on the shore and on the face of the intake structure, five parameters, wind speed, fetch, effective fetch, average water depth, and wave steepness, were established. A sustained 40 mph wind was used, in accordance with Regulatory Guide 1.59, Revision 1. The effective fetch was calculated using the method given on page 3-30 of Reference 7. The fetch and effective fetch for the most critical direction (wind from 10 degrees east of north) are 10,600 feet and 4700 feet respectively. The fetch diagram is shown as Figure 2A-18. The average lake bottom is at Elevation 221, which was determined from topographic data taken before the filling of the lake. For the peak still-water level of 264.2 feet the average depth is 43.2 feet.

The fourth parameter, wave steepness, was calculated using the method recommended on page 3-45 of Reference 7. The average height of the highest 1% of the waves expected at North Anna was used. The wave height was calculated by multiplying the significant wave of 1.85 feet by a factor of 1.67, in accordance with Reference 4, yielding a wave height of 3.08 feet. The period of the 1% wave was the period of the significant wave 2.6 seconds increased by 20%, in accordance with Reference 8, to 3.12 seconds. The wave steepness value is 0.00983 for both locations.

Wind setup (surge) was calculated using Equation 3-83 of Reference 7, with $\theta = 0$ and $C = 1.2 \times 10^{-3}$. The setup is 0.04 foot for both locations.

The face of the intake structure consists of a vertical concrete curtain wall and trashracks inclined at a slope of 10 to 1, with an overhanging operating deck at Elevation 265. Runup on the structure was calculated assuming a smooth, impervious face to Elevation 270, using Figure 7-12 of Reference 7 and correcting for scale effects using Figure 7-13 of Reference 7. The runup height is 4.13 feet for the intake structure.

The shoreline slope is inclined at 3 to 1 and falls between the classification of smooth-impervious and rubble mound. Wave runup was computed for both cases. The average of the two values is 2.90 feet. In summary, the total wind wave effects on the intake structure and the plant are 4.2 feet and 2.9 feet respectively.

2A.2.8 Alternative Calculation of Historic Inflow

As a check on the computer program described in Sections 2A.2.4.1 and Appendix 2A, Attachment 4, a hand calculation of inflows due to historic storms was performed using the simplifying assumption that no differential in water level exists between the reservoir and the Waste Heat Treatment Facility.

For this calculation, a water inventory was calculated using the following equation:

$\Delta S = I - 0$

where:

ΔS = change in storage

I = inflow

0 = outflow

Since ΔS is known from reservoir stage records and the stage-volume relationship (Section 2A.2.3) and the outflow 0 is known from the reservoir records (Section 2A.2.3), the inflow I can be calculated.

Because of the nature of the data, the inflow hydrograph values were smoothed. These values of I are corrected for the effect of rain falling directly on the water surface. Unit hydrographs were developed using Reference 4. These unit hydrographs, shown in Figure 2A-19, compare very well with the unit hydrographs derived from the inflows calculated by the computer model described in Appendix 2A, Attachment 4. If the approximate unit hydrographs are used in place of the more exact ones, the peak still-water level of the probable maximum flood is 264.7 feet. The routing of the flood is done in the manner described in Section 2A.2.5. The Reference 4 computer printout showing this routing is reproduced in Appendix 2A, Attachment 3.

2A.2.9 Summary

The upper-bound value of the still-water level associated with the probable maximum flood is 264.2 feet. The addition of 0.2 foot for backwater effects and 2.9 feet for wind and wave effects brings the maximum flood level at the plant site to 267.3 feet. The upper-bound value for the still-water level associated with the standard project flood is 255.2 feet. The addition of 0.2 foot for backwater effects on 2.9 feet for wind and wave effects brings the maximum flood level at the station site to 258.3 feet. Wave runup effects are greater on the circulating water structure than on the station site. The stages associated with the standard project flood and probable maximum flood water structure are Elevation 259.5 and Elevation 268.6, respectively.

2A.3 SAFETY IMPLICATIONS

All station facilities are capable of withstanding the standard project flood.

The analysis shows that circulating water intake structure is subject to wave action during the probable maximum flood to Elevation 268.6, 3.6 feet above its operating deck at Elevation 265.0. Service water pumps are located within a missile-protected structure with a labyrinth-type entranceway on top of the circulating water intake structure. Since these areas are drained and no waves will reach the interior of the missile-protected structure, the stillwater-plus-surge level is the flood elevation that is considered in relation to these pumps. Thus, these pumps will remain operative in the event of the probable maximum flood, since the still-water-plus-surge level of 264.24 feet is below the service water pump motors at Elevation 265.9. In the event that these pumps were unavailable, there would still be no safety impact on the station, since service water is available from the service water reservoir described in Section 9.2, which is more than 45 feet above the station grade.

If there is a failure of the circulating water system pressure boundary within the turbine building during station operation coincident with the failure of one or more circulating water system valves, the turbine building could be flooded to the lake surface elevation. All important areas surrounding the turbine building are flood-protected to Elevation 257. To prevent turbine building flooding from affecting the safety of the station, the station can be taken out of service and the circulating water valves closed when the lake level exceeds 256 feet.

The plant grade is 3.7 feet above the probable maximum flood level (including wind, wave, and backwater effects) of 267.3 feet.

A flood protection dike to the west of the Unit 2 turbine building has been constructed in order to provide flood protection for the turbine building.

The crest of the dam at Elevation 265.0 ft is not overtopped by the still-water level of the probable maximum flood. A failure of the dam would not have any safety impact on the station.

Class I structures not specifically discussed and found below Elevation 271 are not affected by the probable maximum flood, since none of these structures is adjacent to the reservoir.

In summary, under probable maximum flood conditions, the safety of the North Anna Power Station continues to be ensured.

2A.4 CORRECTIVE ACTION IMPLEMENTED

The Technical Requirements Manual restricts station operation when lake levels exceed 256.0 feet.

Station requirements exist that the valve in the flood protection dike drainage pipe be closed when the lake level exceeds Elevation 252.0.

The instructions to the Lake Anna Dam operator call for a maximum radial gate opening of 36 feet.

No other corrective action was required.

2A.5 SUMMARY

With actual field data taken at North Anna, a reanalysis of flood activities has been performed using an ultraconservative upper-bound approach. This analysis shows that all station facilities are capable of withstanding the standard project flood and that the safety of the station is not threatened by a Technical Requirements Manual limit prohibiting plant operation during lake stages above Elevation 256.

2A REFERENCES

1. *Final Safety Analysis Report, North Anna Power Station - Units 1 and 2 - Virginia Electric and Power Company*, Docket Nos. 50-338 and 50-339.
2. *Preliminary Safety Analysis Report, North Anna Power Station - Units 3 and 4 - Virginia Electric and Power Company*, Docket Nos. 50-404 and 50-405.
3. F. F. Snyder, “Synthetic Unit Graphs,” *Transactions American Geophysical Union*, Vol. 19, pp. 447-454, 1938.
4. *Computer Program 723-X6-L2010, HEC-1, Flood Hydrograph Package*, Revised, Hydrologic Engineering Center, U.S. Army Corps of Engineers, 1973.
5. *Hydraulic Design Criteria*, Revised, U.S. Army Corps of Engineers, 1959.
6. *Seasonal Variations of the Probable Maximum Precipitation. East of the 105 Meridian, for Areas From 10 to 1000 Square Miles and Durations of 6, 12, 24, and 48 Hours*, Hydrometeorological Report 33, U.S. Weather Bureau, 1956.
7. *Shore Protection Manual*, second printing, U.S. Army Coastal Engineering Research Center, 1973.
8. *Standards for Determining Design Basis Flooding at Power Reactor Sites (Proposed)*, Draft 3, American Nuclear Society Standards Committee, 1976.

Table 2.A-1
HISTORIC OPERATION DATA - LAKE STAGES AND DISCHARGES
JUNE 1972 OPERATING RECORD - LAKE ANNA

DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)	DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)	DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)
72171	130	238.00	3096.64	72171	145	238.00	2459.94	72171	220	238.20	9324.78
72171	300	238.60	17827.98	72171	330	238.90	27019.68	72171	420	239.00	31104.00
72171	1000	239.00	22695.61	72171	1255	238.80	20665.21	72171	125	238.75	17661.64
72171	240	238.75	15736.32	72171	340	238.75	10347.54	72171	520	238.75	8456.07
72171	620	238.75	6678.15	72171	755	238.75	3905.32	72171	1000	238.75	0.00

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Table 2A-1 (continued)
HISTORIC OPERATION DATA - LAKE STAGES AND DISCHARGES
APRIL 1973 OPERATING RECORD - LAKE ANNA

DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)	DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)	DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)
73115	0	250.00	60.86	73115	100	250.00	60.86	73115	200	250.00	60.86
73115	300	250.00	60.86	73115	400	250.00	60.86	73115	500	250.00	60.86
73115	600	250.00	60.86	73115	700	250.00	60.86	73115	800	250.00	60.86
73115	900	250.00	60.66	73115	1000	250.00	60.86	73115	1100	250.00	60.66
73115	1200	250.00	60.86	73115	1300	250.01	30.92	73115	1400	250.02	62.70
73115	1500	250.03	63.62	73115	1600	250.05	65.48	73115	1700	250.07	499.72
73115	1800	250.09	503.40	73115	1900	250.10	505.25	73115	2000	250.10	505.25
73115	2100	250.10	505.25	73115	2200	250.10	505.25	73115	2300	250.10	505.25
73115	2400	250.10	505.25	73116	100	250.20	3125.26	73116	200	250.20	3125.26
73116	300	250.20	3125.26	73116	400	250.20	3125.26	73116	500	250.20	3125.26
73116	600	250.20	3125.26	73116	700	250.20	3125.26	73116	800	250.20	3125.26
73116	900	250.20	3125.26	73116	1000	250.20	3125.26	73116	1100	250.20	3125.26
73116	1200	250.20	3125.26	73116	1300	250.20	3125.26	73116	1400	250.20	3125.26
73116	1500	250.20	3125.26	73116	1600	250.20	3125.26	73116	1700	250.20	3125.26
73116	1800	250.20	3125.26	73116	1900	250.17	3118.41	73116	2000	250.15	3113.66
73116	2100	250.12	3107.05	73116	2200	250.10	3102.52	73116	2300	250.10	3102.52
73116	2400	250.10	3102.52	73117	100	250.10	3102.52	73117	200	250.13	3109.32
73117	300	250.16	3116.14	73117	400	250.20	3125.26	73117	500	250.20	5726.66
73117	600	250.20	5726.66	73117	700	250.20	5726.66	73117	800	250.20	5726.66
73117	900	250.23	5734.76	73117	1000	250.26	5742.91	73117	1100	250.30	5753.77
73117	1200	250.33	5761.94	73117	1300	250.36	5770.13	73117	1400	250.39	5778.34
73117	1500	250.44	5792.06	73117	1600	250.50	5808.59	73117	1700	250.58	5830.75
73117	1800	250.72	5869.63	73117	1900	250.80	5892.33	73117	2000	250.80	5892.33
73117	2100	250.80	5892.33	73117	2200	250.80	5892.33	73117	2300	250.80	5892.33
73117	2400	250.80	5892.33	73118	100	250.80	5892.33	73118	200	250.80	5892.33
73118	300	250.80	5892.33	73118	400	250.80	5892.35	73118	500	250.70	5864.22
73118	600	250.70	5864.22	73118	700	250.70	5864.22	73118	800	250.70	5864.22
73118	900	250.70	5864.22	73118	1000	250.70	5864.22	73118	1100	250.70	5864.22
73118	1200	250.70	5864.22	73118	1300	250.70	5864.22	73118	1400	250.70	5864.22
73118	1500	250.68	5856.62	73118	1600	250.65	5850.24	73118	1700	250.62	5841.66
73118	1800	250.60	5836.31	73118	1900	250.60	5836.31	73118	2000	250.55	5822.43
73118	2100	250.50	5808.59	73118	2200	250.50	5800.59	73118	2300	250.40	5781.08
73118	2400	250.38	5775.60	73119	100	250.36	3162.10	73119	200	250.34	3157.46
73119	300	250.32	3152.84	73119	400	250.30	3148.22	73119	500	250.30	3148.22
73119	600	250.30	3148.22	73119	700	250.30	3148.22	73119	800	250.30	3148.22
73119	900	250.30	3148.22	73119	1000	250.30	3148.22	73119	1100	250.30	3148.22
73119	1200	250.30	3148.22	73119	1300	250.30	3148.22	73119	1400	250.30	3148.22
73119	1500	250.27	3141.31	73119	1600	250.25	3136.71	73119	1700	250.22	3129.63
73119	1800	250.20	3125.26	73119	1900	250.20	3125.26	73119	2000	250.20	3125.26
73119	2100	250.20	3125.26	73119	2200	250.17	3118.41	73119	2300	250.13	3109.32

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Table 2A-1 (continued)
HISTORIC OPERATION DATA - LAKE STAGES AND DISCHARGES
APRIL 1973 OPERATING RECORD - LAKE ANNA

DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)	DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)	DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)
73119	2400	250.10	3102.52	73120	100	250.10	3102.52	73120	200	250.10	3102.52
73120	300	250.10	3102.52	73120	400	250.10	3102.52	73120	500	250.08	3098.00
73120	600	250.05	3091.23	73120	700	250.05	3091.23	73120	800	250.05	752.87
73120	900	250.05	752.87	73120	1000	250.05	752.87	73120	1100	250.05	752.87

N02F0022

Table 2A-1 (continued)
HISTORIC OPERATION DATA - LAKE STAGES AND DISCHARGES
SEPTEMBER 1974 OPERATING RECORD - LAKE ANNA

DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)	DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)	DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)
74247	0	250.16	2727.59	74247	100	250.16	2727.59	74247	200	250.16	2727.59
74247	300	250.15	2727.22	74247	400	250.15	2727.22	74247	500	250.14	2726.86
74247	600	250.13	2726.50	74247	700	250.13	2726.50	74247	800	250.11	2725.77
74247	900	250.10	2725.40	74247	1000	250.10	2725.40	74247	1100	250.10	2725.40
74247	1200	250.10	2725.40	74247	1300	250.08	2724.67	74247	1400	250.05	2723.57
74247	1500	250.05	2723.57	74247	1600	250.04	2723.20	74247	1700	250.03	2722.84
74247	1800	250.02	2722.47	74247	1900	250.00	752.60	74247	2000	250.00	752.60
74247	2100	250.00	752.60	74247	2200	250.00	752.60	74247	2300	250.00	752.60
74247	2400	250.00	752.60	74248	100	250.00	376.30	74248	200	250.00	158.12
74248	300	250.00	158.12	74248	400	250.00	158.12	74248	500	250.00	158.12
74248	600	249.99	55.35	74248	700	249.99	55.35	74248	800	249.99	55.35
74248	900	249.99	55.35	74248	1000	249.98	54.79	74248	1100	249.98	54.79
74248	1200	249.98	54.79	74248	1300	249.98	54.79	74248	1400	249.98	54.79
74248	1500	249.98	54.79	74248	1600	249.98	54.79	74248	1700	249.98	54.79
74248	1800	249.98	54.79	74248	1900	249.98	54.79	74248	2000	249.98	54.79
74248	2100	249.98	54.79	74248	2200	249.98	54.79	74248	2300	249.98	54.79
74248	2400	249.98	54.79	74249	100	249.98	54.79	74249	200	249.98	54.79
74249	300	249.98	54.79	74249	400	249.98	54.79	74249	500	249.98	54.79
74249	600	249.98	54.79	74249	700	249.99	55.35	74249	800	250.01	341.27
74249	900	250.01	341.27	74249	1000	250.02	342.35	74249	1100	250.02	752.71
74249	1200	250.02	752.71	74249	1300	250.04	752.82	74249	1400	250.04	752.82
74249	1500	250.04	752.82	74249	1600	250.06	752.92	74249	1700	250.06	752.92
74249	1800	250.08	2724.67	74249	1900	250.10	2725.40	74249	2000	250.11	2725.77
74249	2100	250.14	4700.37	74249	2200	250.14	4700.37	74249	2300	250.18	4703.08
74249	2400	250.20	6041.76	74250	100	250.19	6040.66	74250	200	250.21	6042.66
74250	300	250.20	6041.76	74250	400	250.20	6041.76	74250	500	250.20	6041.76
74250	600	250.18	6039.99	74250	700	250.18	5721.07	74250	800	250.18	5721.07
74250	900	250.17	5720.23	74250	1000	250.17	5720.23	74250	1100	250.17	5720.23
74250	1200	250.17	5720.23	74250	1300	250.17	5720.23	74250	1400	250.16	5719.39
74250	1500	250.15	5718.55	74250	1600	250.14	5717.71	74250	1700	250.12	5716.05
74250	1800	250.12	5716.05	74250	1900	250.10	5714.38	74250	2000	250.08	5712.70
74250	2100	250.06	4058.33	74250	2200	250.05	4057.75	74250	2300	250.04	2405.00
74250	2400	250.04	2405.00	74251	100	250.03	2404.69	74251	200	250.02	2404.37
74251	300	250.02	2404.37	74251	400	250.02	2404.37	74251	500	250.00	752.60
74251	600	250.01	752.66	74251	700	250.01	752.66	74251	800	250.00	752.60
74251	900	250.01	752.66	74251	1000	250.00	752.60	74251	1100	250.00	752.60
74251	1200	250.00	752.60	74251	1300	250.00	752.60	74251	1400	250.00	752.60
74251	1500	250.01	752.66	74251	1600	250.00	752.60	74251	1700	250.00	752.60
74251	1800	250.00	752.60	74251	1900	250.00	752.60	74251	2000	250.00	752.60
74251	2100	250.00	752.60	74251	2200	250.00	752.60	74251	2300	250.00	752.60

N02F0023

Table 2A-1 (continued)
HISTORIC OPERATION DATA - LAKE STAGES AND DISCHARGES
SEPTEMBER 1974 OPERATING RECORD - LAKE ANNA

DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)	DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)	DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)
74251	2400	250.00	752.60	74252	100	249.99	533.60	74252	200	249.99	533.60
74252	300	249.99	533.60	74252	400	249.99	376.28	74252	500	249.99	242.53
74252	600	249.99	242.53	74252	700	249.99	242.53	74252	800	249.98	84.78
74252	900	249.98	84.78	74252	1000	249.98	84.78	74252	1100	249.98	84.78
74252	1200	249.98	84.78	74252	1300	249.98	84.78	74252	1400	249.98	84.78
74252	1500	249.99	85.42	74252	1600	249.99	85.42	74252	1700	249.99	85.42
74252	1800	249.99	85.42	74252	1900	249.99	85.42	74252	2000	249.99	85.42
74252	2100	249.99	85.42	74252	2200	249.99	85.42	74252	2400	250.00	86.07
74253	100	250.00	86.07	74253	200	250.00	86.07	74253	300	250.00	86.07
74253	400	250.00	86.07	74253	500	250.00	86.07	74253	600	250.00	86.07
74253	700	250.00	86.07	74253	800	250.00	86.07	74253	900	250.00	86.07
74253	1000	250.00	86.07	74253	1100	250.00	86.07	74253	1200	250.00	86.07
74253	1300	250.00	86.07	74253	1400	250.00	86.07	74253	1500	250.00	86.07
74253	1600	250.00	86.07	74253	1700	250.00	86.07	74253	1800	250.00	86.07
74253	1900	250.00	86.07	74253	2000	250.00	86.07	74253	2100	250.00	86.07
74253	2200	250.00	86.07	74253	2300	250.00	86.07	74253	2400	250.00	86.07

N02F0024

Table 2A-1 (continued)

HISTORIC OPERATION DATA - LAKE STAGES AND DISCHARGES

MARCH 1975 OPERATING RECORD - LAKE ANNA

DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)	DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)	DATE	HOUR	STAGE (FT)	DISCHARGE (CFS)
75078	0	250.00	752.60	75078	100	250.02	752.71	75078	200	250.02	752.71
75078	300	250.02	752.71	75078	400	250.03	752.76	75078	500	250.03	752.76
75078	600	250.03	752.76	75078	700	250.01	752.66	75078	800	250.02	752.71
75078	900	250.05	4056.60	75078	1000	250.04	4057.16	75078	1100	250.06	4058.33
75078	1200	250.12	4061.79	75078	1300	250.1[illegible]	4062.93	75078	1400	250.14	4062.93
75078	1500	250.16	4064.06	75078	1600	250.20	4066.38	75078	1700	250.20	4066.38
75078	1800	250.25	4074.20	75078	1900	250.36	4075.56	75078	2000	250.44	5742.73
75078	2100	250.62	5757.70	75078	2200	250.70	5764.33	75078	2300	250.75	5768.47
75078	2400	250.82	5774.27	75079	100	250.85	5776.75	75079	200	250.90	5780.88
75079	300	250.92	5782.54	75079	400	250.92	5782.54	75079	500	250.92	5782.54
75079	600	250.92	5782.54	75079	700	250.90	5780.88	75079	800	250.89	5780.06
75079	900	250.87	5778.40	75079	1000	250.86	5777.57	75079	1100	250.84	5775.93
75079	1200	250.84	5775.93	75079	1300	250.82	5774.27	75079	1400	250.78	5770.96
75079	1500	250.78	5770.96	75079	1600	250.76	5769.30	75079	1700	250.74	5767.65
75079	1800	250.68	5761.02	75079	1900	250.64	5759.36	75079	2000	250.62	5757.70
75079	2100	250.60	5756.04	75079	2200	250.57	5753.55	75079	2300	250.55	5751.88
75079	2400	250.53	5750.23	75080	100	250.50	5747.73	75080	200	250.48	5746.07
75080	300	250.46	5744.40	75080	400	250.42	5741.07	75080	500	250.40	5739.41
75080	600	250.38	5737.75	75080	700	250.36	5736.08	75080	800	250.32	5732.75
75080	900	250.30	5731.06	75080	1000	250.28	5729.41	75080	1100	250.25	5726.91
75080	1200	250.22	5724.40	75080	1300	250.18	5721.07	75080	1400	250.16	5719.39
75080	1500	250.14	4062.93	75080	1600	250.12	4061.79	75080	1700	250.10	4060.63
75080	1800	250.10	2406.66	75080	1900	250.07	2405.94	75080	2000	250.07	2405.94
75080	2100	250.07	2405.94	75080	2200	250.05	2405.31	75080	2300	250.05	2405.31
75080	2400	250.05	2405.31	75081	100	250.05	2405.31	75081	200	250.05	2405.31
75081	300	250.04	2405.00	75081	400	250.04	2405.00	75081	500	250.02	2404.37
75081	600	250.00	2403.74	75081	700	250.00	2403.74	75081	800	250.00	752.60
75081	900	249.99	752.55	75081	1000	250.00	752.60	75081	1100	250.00	752.60
75081	1200	250.00	752.60								

N02F0025

Table 2.A-2
WATER SURFACE PRECIPITATION RELATIVE WEIGHTINGS[a]

	June 1972 March 1975 April 1973		September 1974	
Station	Reservoir	WHTF [b]	Reservoir	WHTF [b]
Daily Data				
Piedmont Research Station	0	0	0.10	0
Partlow	0.775	1	0.879	1
Louisa	0.204	0	0	0
Fredricksburg National Park	0	0	0	0
Hourly Data				
Piedmont Research Station	0.704	191	0.704	191
Partlow	0	0	0	0
Louisa	0	0	0	0
Fredricksburg National Park	0.275	23	0.275	23

a. Weightings given are those utilized in Reference 4 computer runs and are arbitrary scales which are not necessarily uniform from storm to storm.
b. WHTF = Waste Heat Treatment Facility.

Table 2.A-3
HEC-1 OPTIMIZATION PARAMETERS

STORM	ERAIN	RTIOL	STRKR
June 1972	0.55	3.86	0.44
April 1973	0.34	22.07	0.14
March 1975	0.52	10.39	0.12
Average	0.47	12.11	0.233

Table 2.A-4
SUMMARY BACKWATER PROFILE ANALYSIS

Reach	Assumed Average Stage (ft)	Average Area (ft^2)	Average Hydraulic Radius (ft)	Velocity (ft/sec)	Slope (ft/ft)	Length (ft)	Stage Increase (ft)	
0 +00 to 65 +00	264.225	170,400	34.0	0.831	0.255×10^{-5}	6500	0.017	264.217
65 +00 to 155 +00	264.260	160,500	24.7	0.882	0.380×10^{-5}	9000	0.034	264.251
155 +00 to 215 +00	264.275	103,800	27.4	1.36	0.912×10^{-5}	6000	0.055	264.306
215 +00 to 301 +00	264.328	135,500	34.7	1.045	0.393×10^{-5}	8600	0.034	264.34

Note: Total backwater effect at plant = 264.34 - 264.2 = 0.14 ft. Use 0.20 ft.

Figure 2A-1
STAGE VOLUME RELATIONSHIP RESERVOIR AND THE WHTF

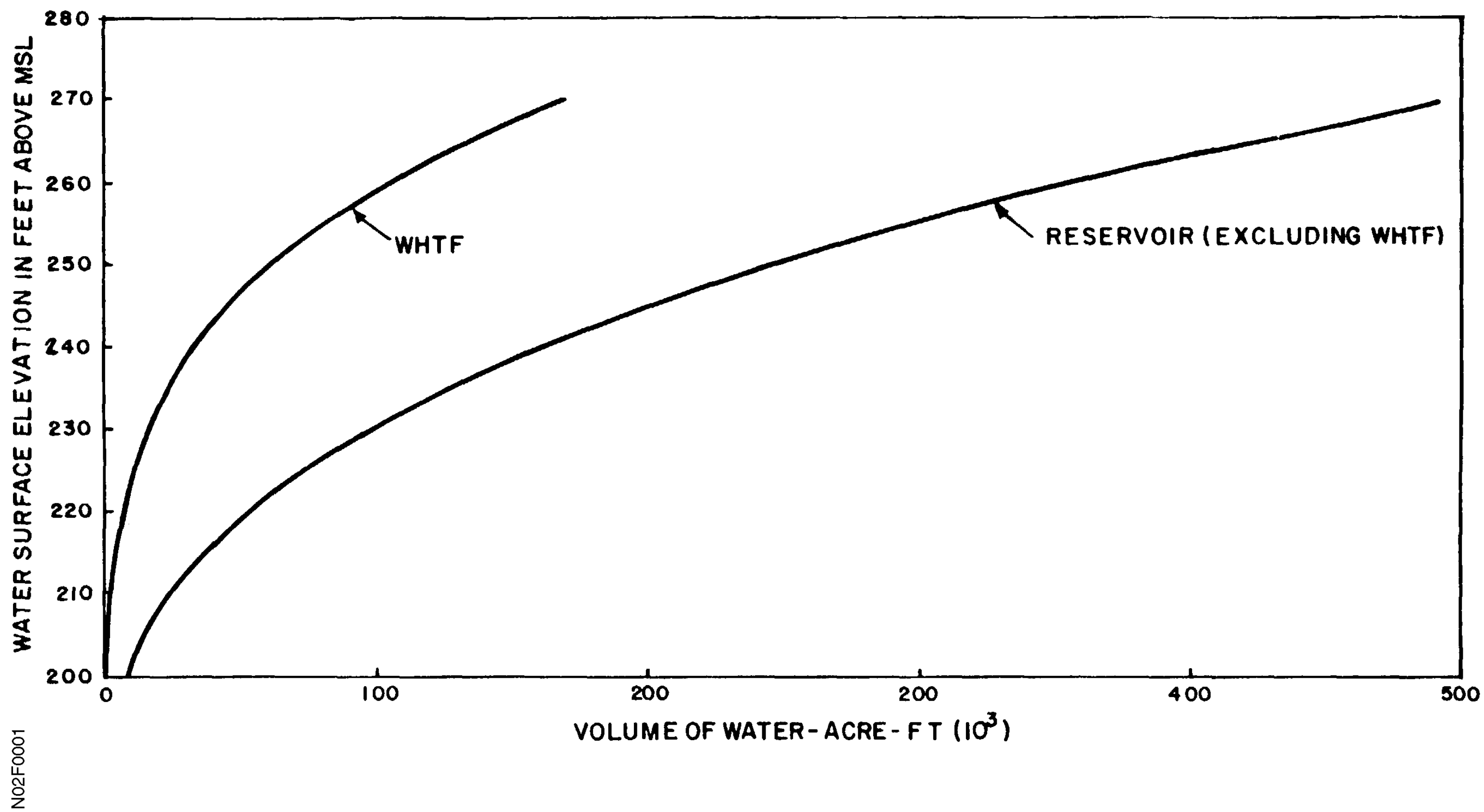


Figure 2A-2
SURFACE AREA VERSUS ELEVATION LAKE ANNA

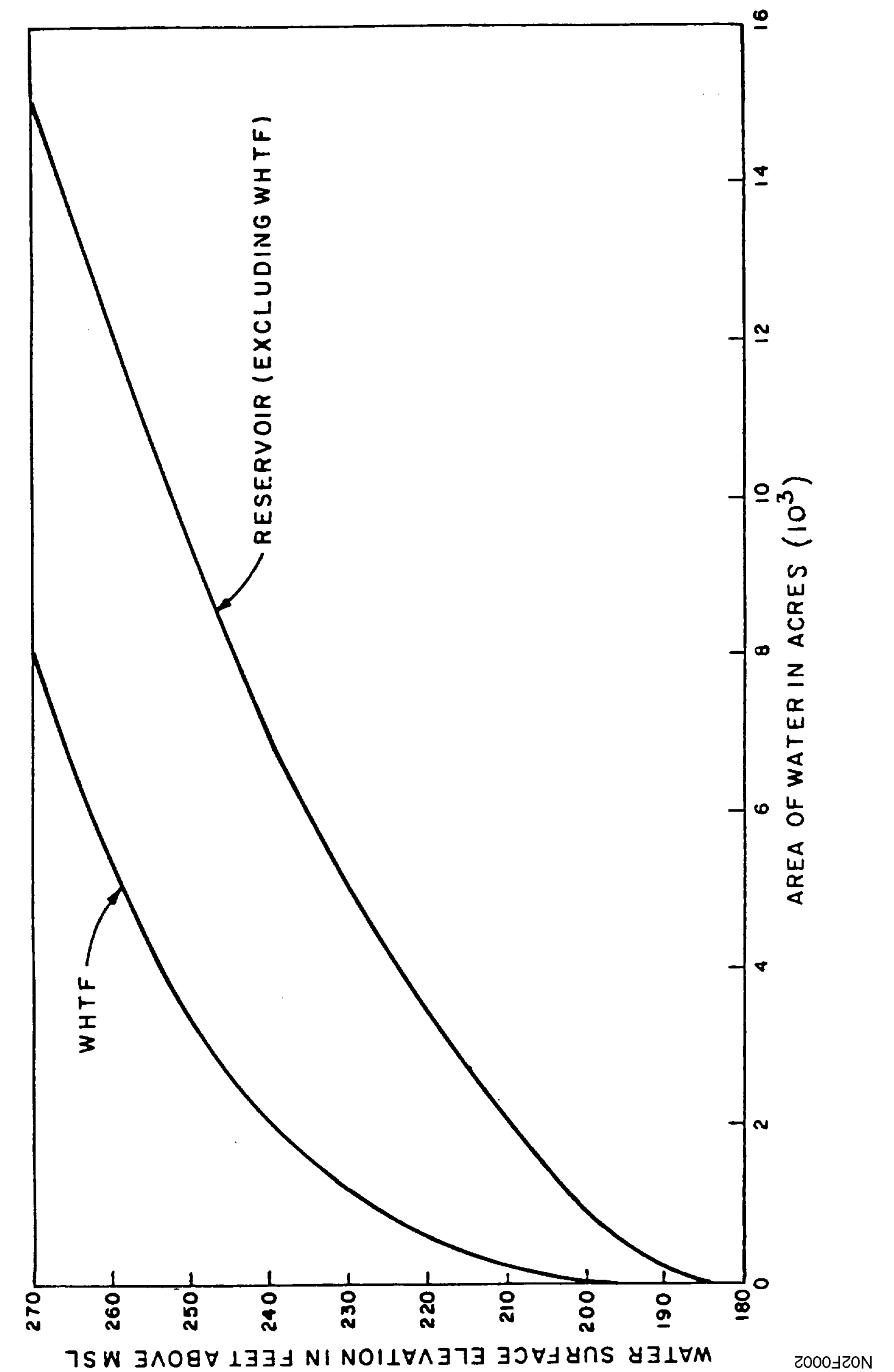


Figure 2A-3
STAGE - FLOOD STORAGE RELATIONSHIP FOR FLOOD ROUTING

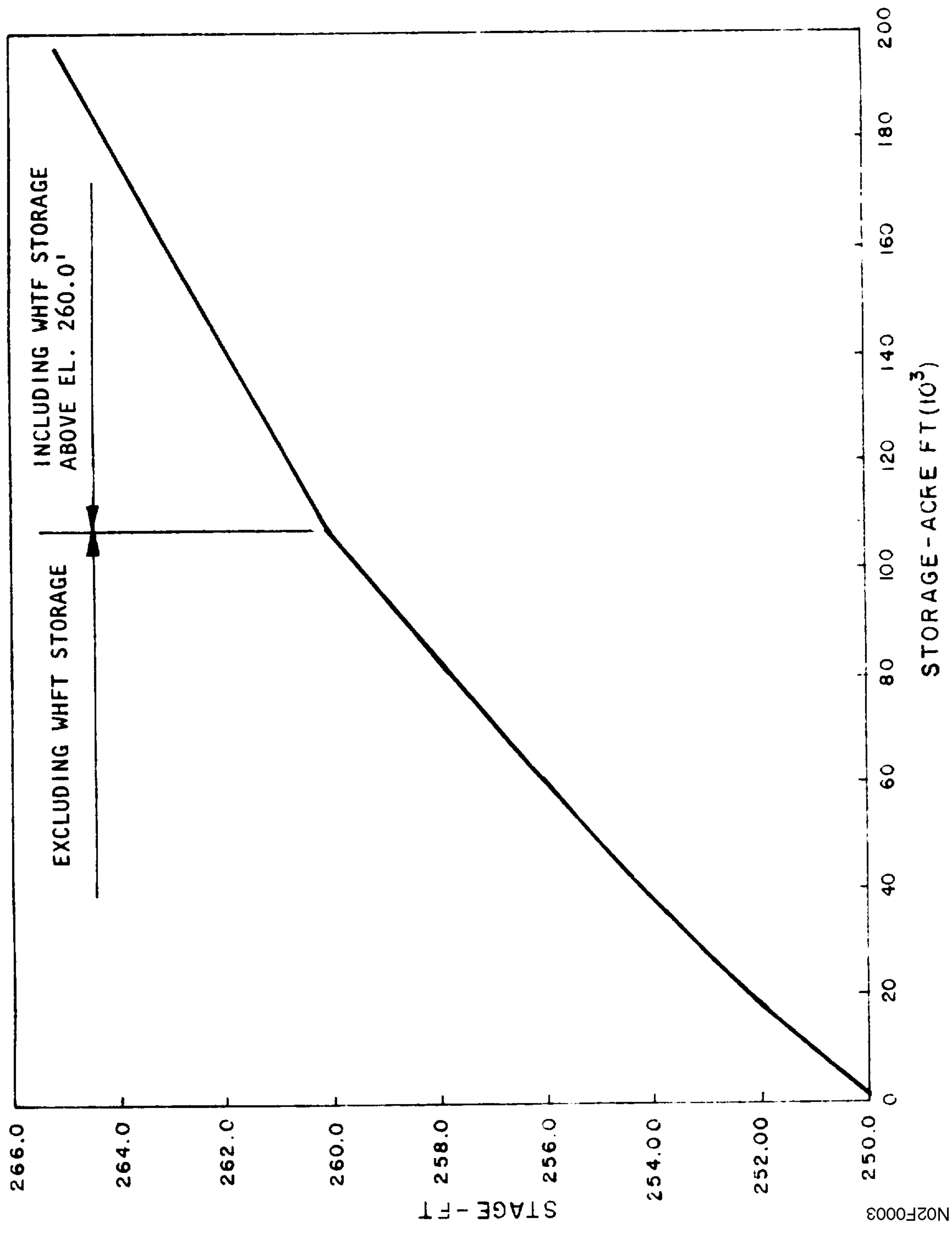
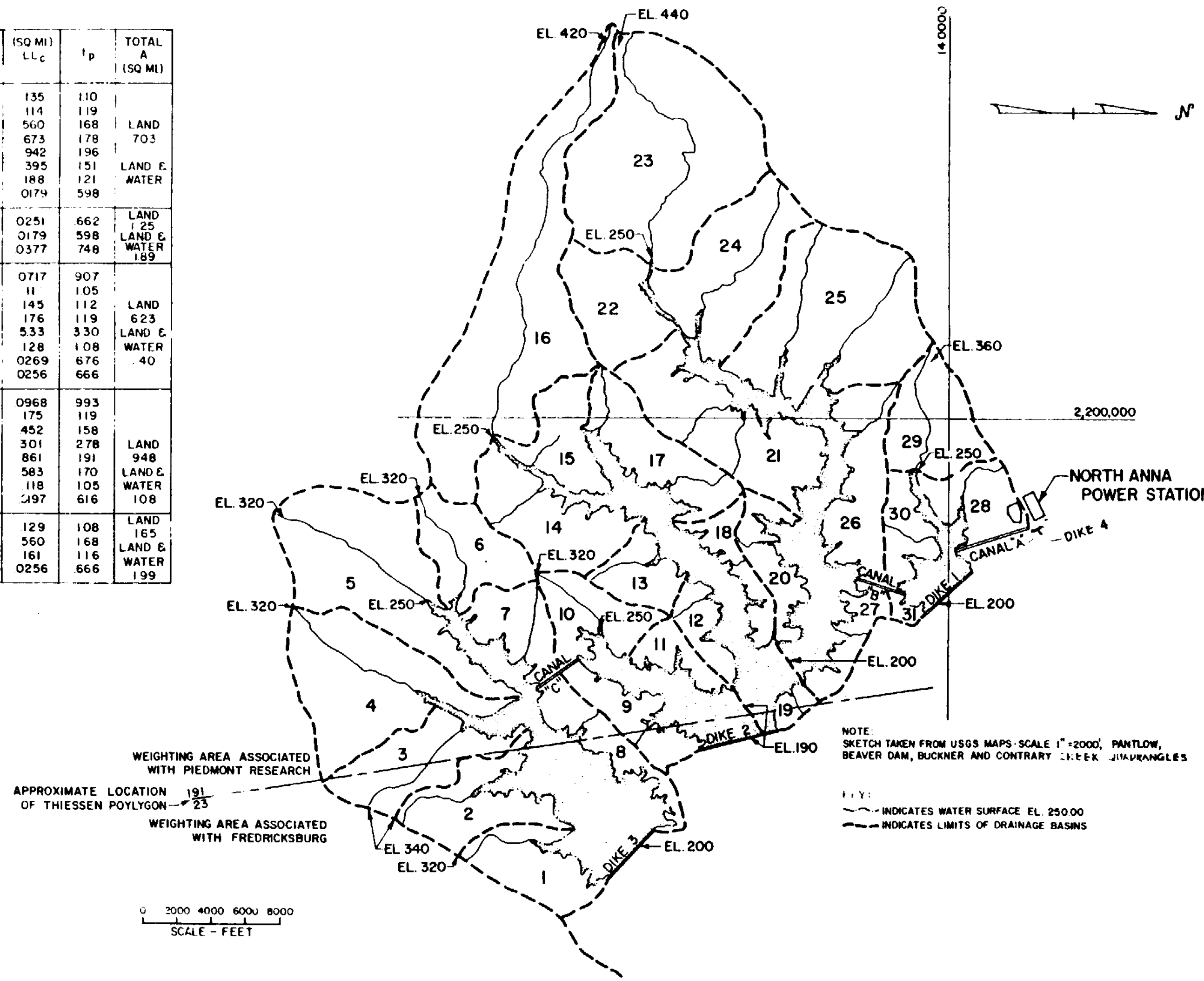


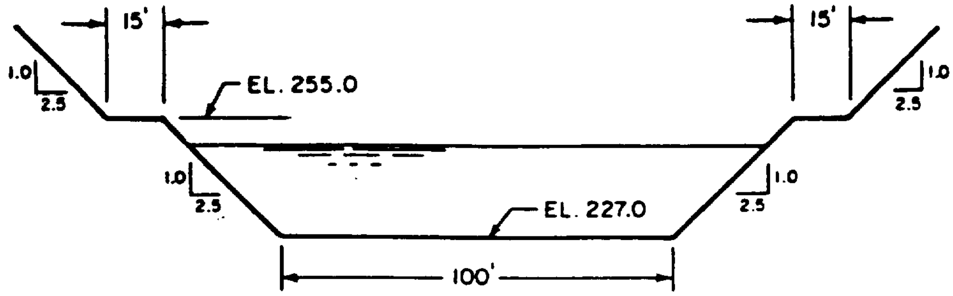
Figure 2A-4
DRAINAGE MAP - WASTE HEAT TREATMENT FACILITY
VIRGINIA ELECTRIC AND POWER COMPANY

DRAINAGE SUB BASIN I	(FT) L	(FT) L_c	(SQ IN) A	(SQ MI) A	(SQ MI) LL_c	t_p	TOTAL A (SQ MI)
1	3750	1000	4 30	617	135	1.10	
2	4250	750	5 00	717	114	1 19	
3	6250	2500	5 50	789	560	168	LAND
4	7500	2500	10 6	1 52	673	178	703
5	8750	3000	12 3	1 76	942	196	
6	5500	2000	490	703	395	151	LAND &
7	3500	1500	340	488	188	121	WATER
8	1000	500	305	437	0179	598	
9	1000	700	306	439	0251	.662	LAND 1 25
10	4000	1250	386	554	0179	598	LAND &
11	1500	700	1.78	255	.0377	748	WATER 1.89
12	2000	1000	1 75	251	0717	907	
13	3000	1100	265	380	11	1.05	
14	3000	1350	6 19	.888	145	1 12	LAND
15	3500	1400	382	548	176	1 19	623
16	22000	6750	202	2 90	5.33	3 30	LAND &
17	3250	1100	552	792	.128	1 08	WATER
18	1500	500	232	333	0269	676	.40
19	1100	650	975	140	0256	666	
20	3000	900	2.71	389	.0968	993	
21	3250	1500	8.68	1.25	175	119	
22	4500	2800	5.33	.765	452	158	
23	14000	6000	18 98	2.72	301	2 78	LAND
24	8000	3000	878	1.26	861	191	948
25	6500	2500	1389	199	583	170	LAND &
26	3000	1100	549	.788	.118	1.05	WATER
27	1000	550	218	313	.0197	616	108
28	3000	1200	329	.472	.129	108	LAND 165
29	6250	2500	542	778	560	168	LAND &
30	3000	1500	238	.341	161	116	WATER
31	1100	650	419	0601	.0256	.666	199

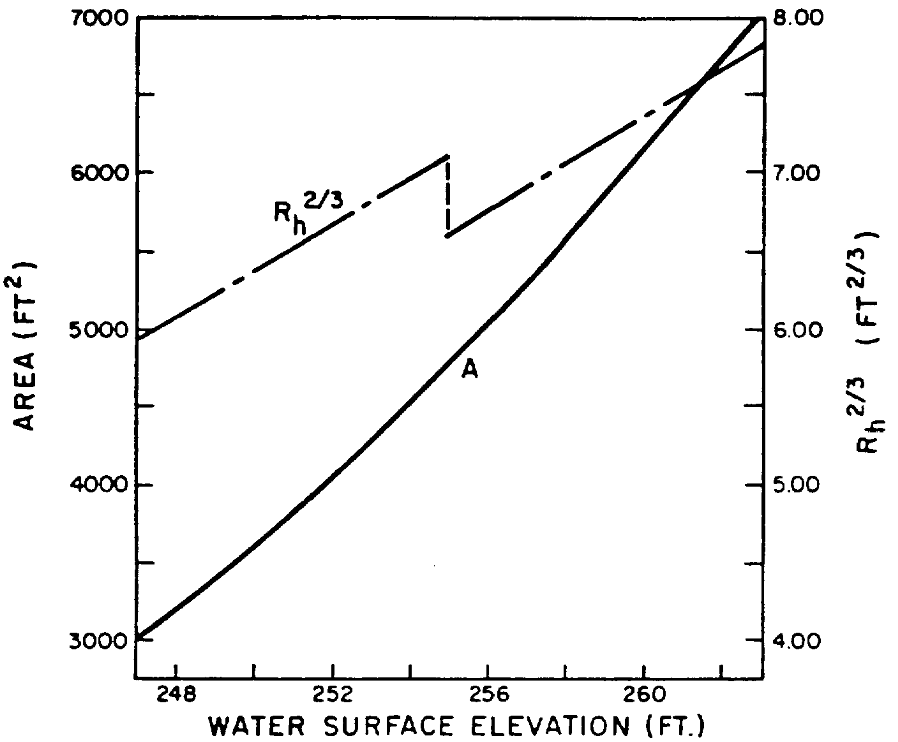


N02F0004

Figure 2A-5
CANALS WASTE HEAT TREATMENT FACILITY LAKE ANNA



TYPICAL SECTION



AREA & HYDRAULIC RADIUS

CANAL	INVERT LENGTH
A	3910'
B	3000'
C	4310'

N02F0005

Withheld under 10 CFR 2.390 (d) (1)

Figure 2A-6

[redacted]

Figure 2A-7
PLAN AT EL. 250.0± SPILLWAY LAKE ANNA DAM

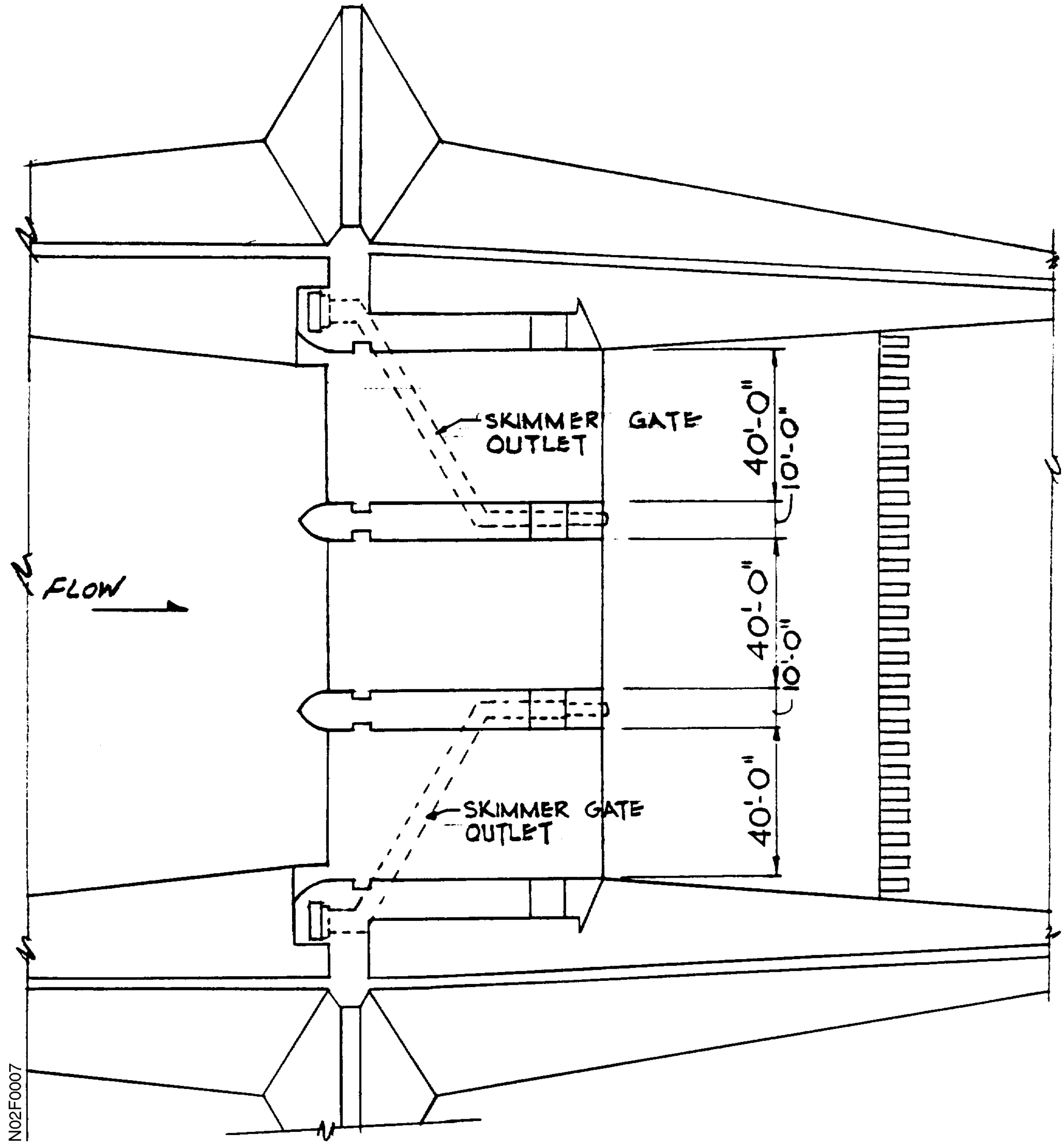


Figure 2A-8
RADIAL GATES SPILLWAY DISCHARGE CAPACITY

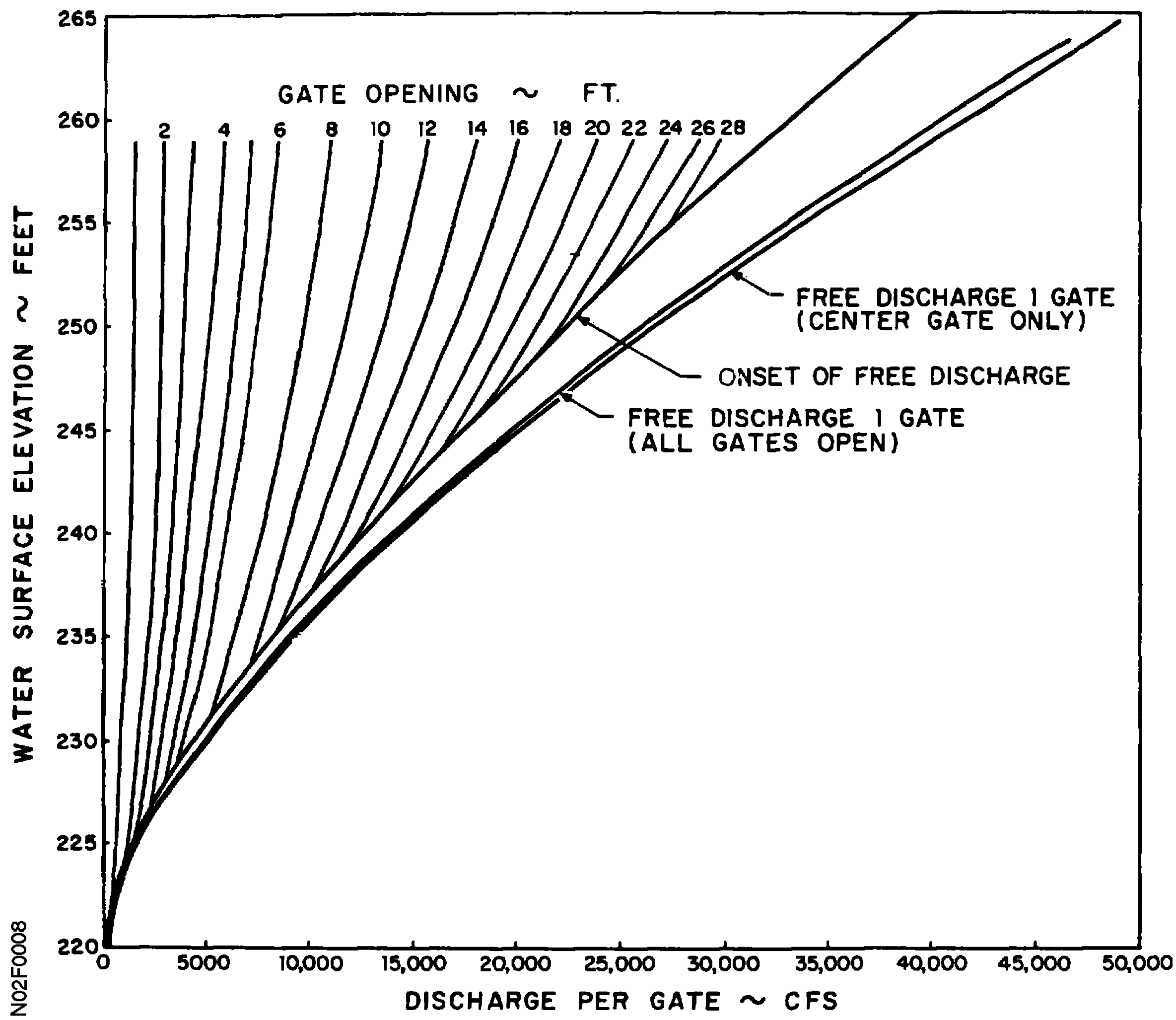


Figure 2A-9
SKIMMER GATE DISCHARGE CAPACITY LAKE ANNA DAM

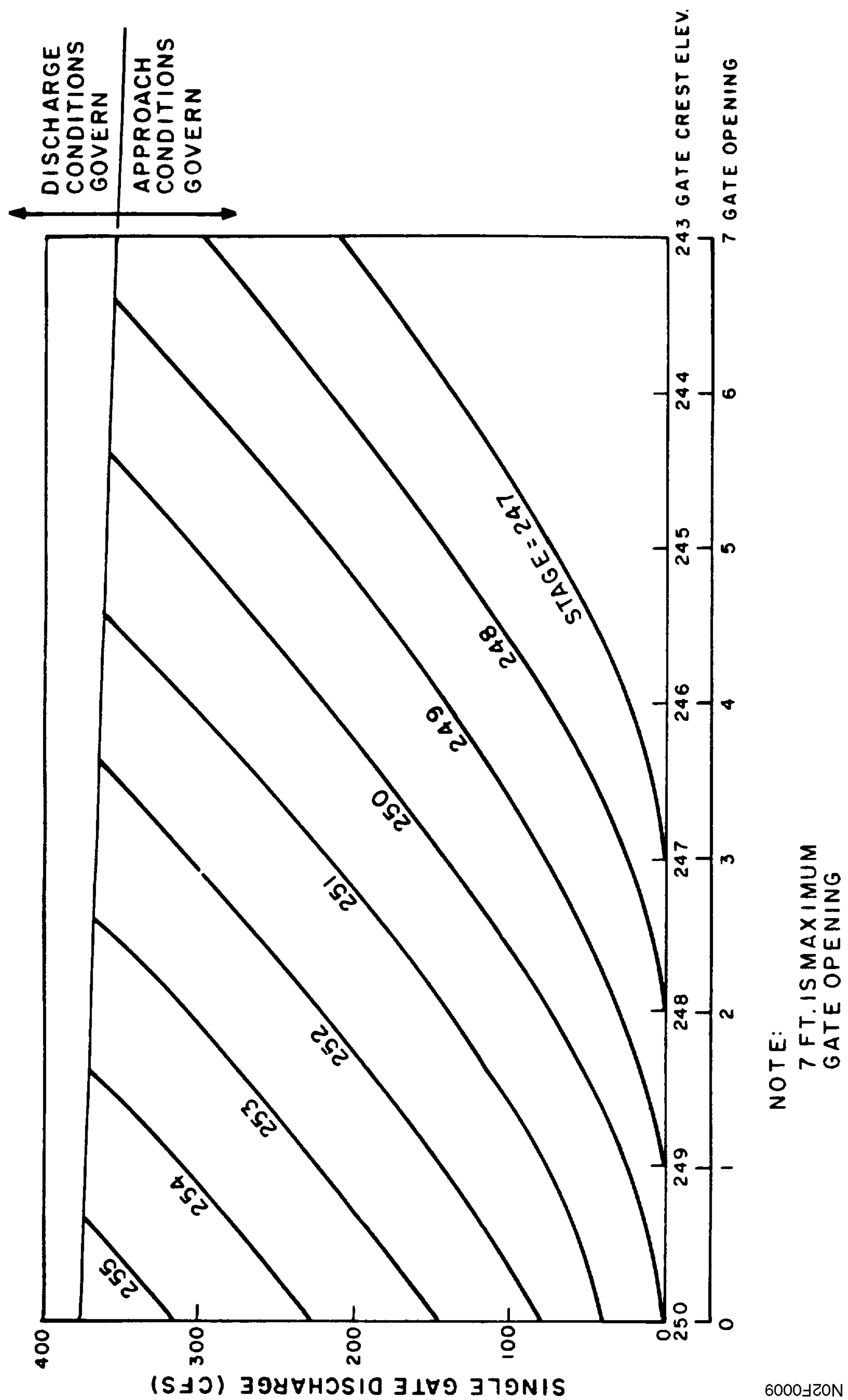


Figure 2A-10
RESERVOIR OPERATING RULE CURVE

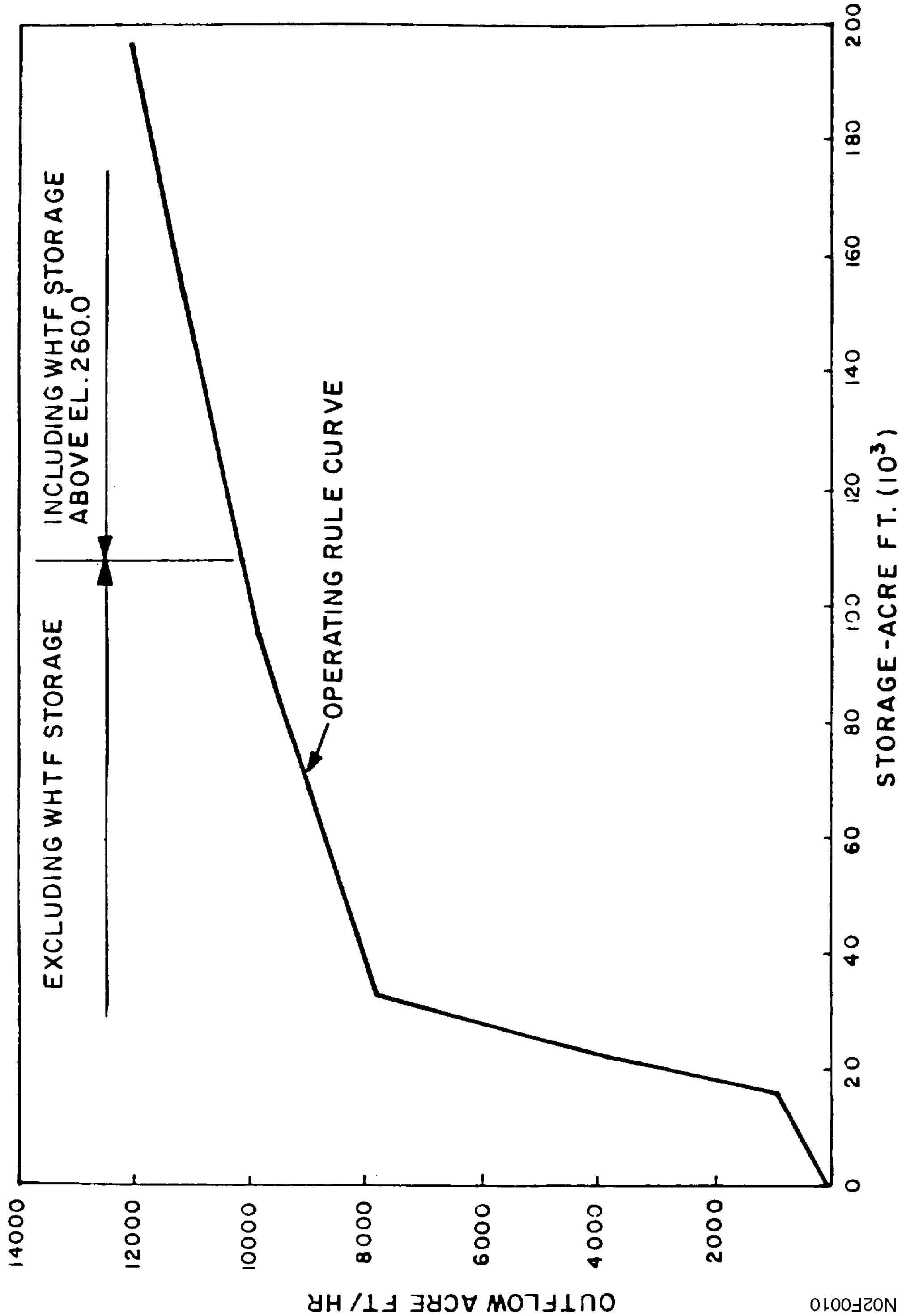
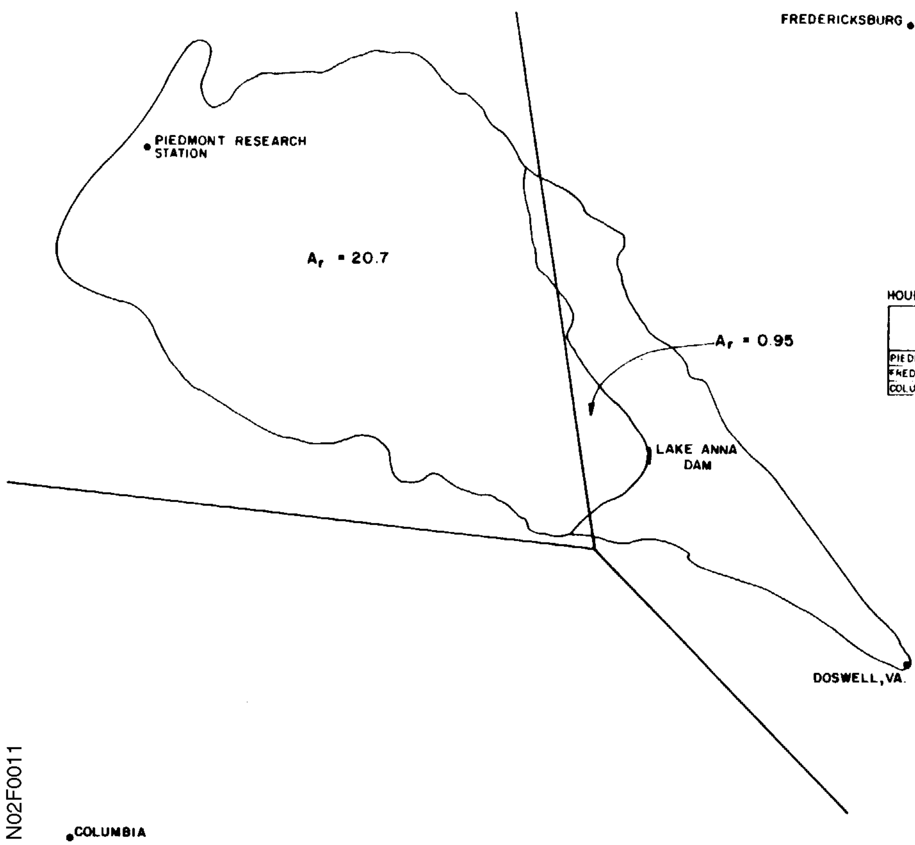


Figure 2A-11
APRIL 24-28, 1973
HOURLY RAINFALL DISTRIBUTION THIESSEN POLYGON
LAKE ANNA DRAINAGE BASIN



DAILY DATA (RAINFALL IN INCHES)

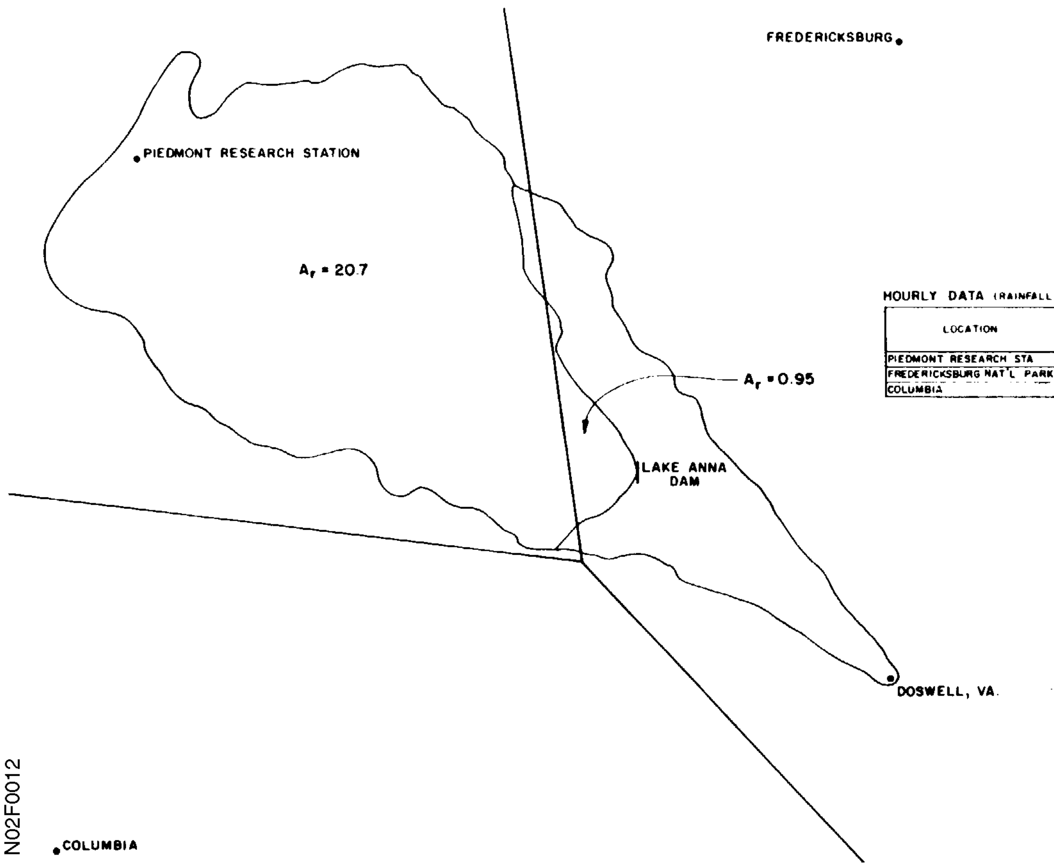
LOCATION	DATE				
	24	25	26	27	28
PIEDMONT RESEARCH STA		47	110	127	28
GORDONSVILLE		63	155	144	31
COLUMBIA		40	118	1.46	32
FREDERICKSBURG NAT'L PARK		36	42	184	
CORBIN		.05	67	111	10
PARTLOW		90	40	200	
LOUISA		113	28	175	
ASHLAND	03	75	45	1.31	

HOURLY DATA (RAINFALL IN INCHES)

LOCATION	DATE		
	25	26	27
PIEDMONT RESEARCH STA	2 3 3 2 1 1 1 1 1 1	1	3 1 2 3 3 1 1 1
FREDERICKSBURG NAT'L PARK	1 1 1 1 1 2	1	2 2 2 4 5 1 1 1
COLUMBIA	3 1 1 2 1 1 1 1 3	1	2 2 2 2 4 2 1 1

NOTE
A_r STANDS FOR "RELATIVE AREA"

Figure 2A-12
JUNE 20-24, 1972
HOURLY RAINFALL DISTRIBUTION THIESSEN POLYGON
LAKE ANNA DRAINAGE BASIN



DAILY DATA (RAINFALL IN INCHES)

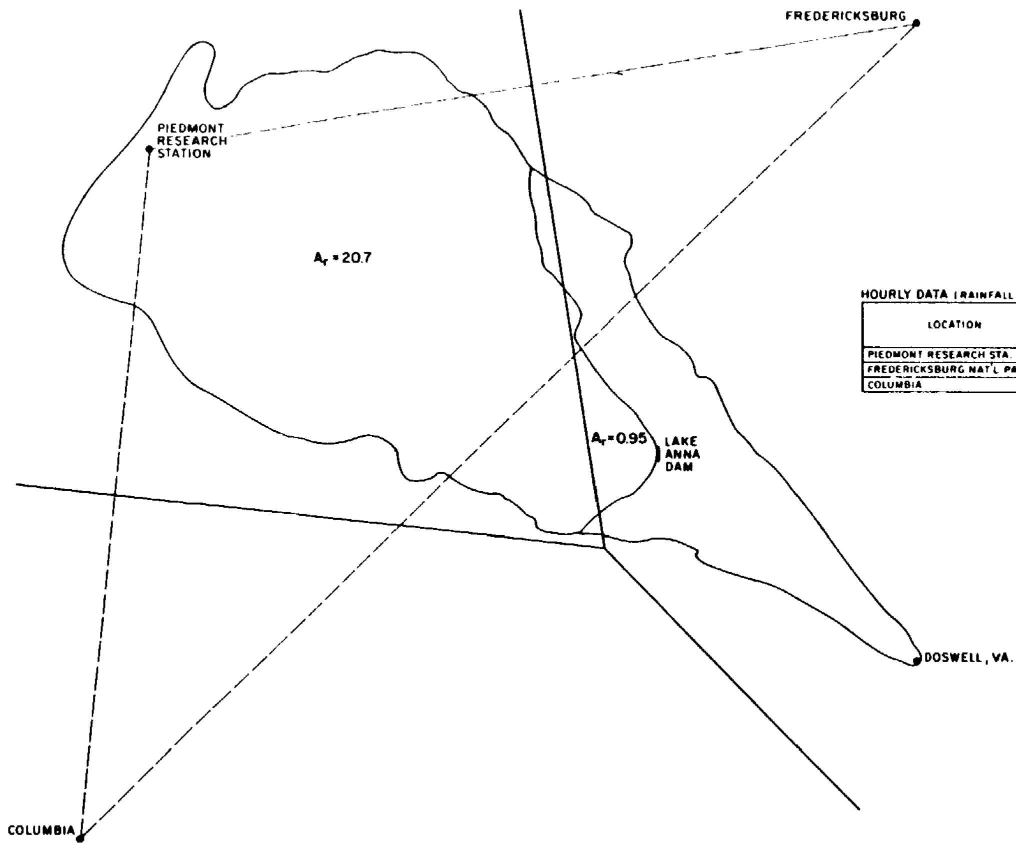
LOCATION	DATE							
	17	18	19	20	21	22	23	24
PIEDMONT RESEARCH STA	25	85	30	04	65	785	40	05
GORDONSVILLE	39	88	123	01	98	685	47	
COLUMBIA	18	04	.13		.70	6 95	44	.11
FREDERICKSBURG NAT'L PARK	25	11	08	13	.92	5 65	.49	.01
CORBIN	16	02	17		53	7 45	50	03
PARTLOW	30	40	20	20	2 50	4 40	70	
LOUISA	22	02	1 13	20	4 89	2 30	69	
ASHLAND		48	24	17	1 21	4 11	44	

HOURLY DATA (RAINFALL IN INCHES)

LOCATION	DATE		
	20	21	22
PIEDMONT RESEARCH STA	[illegible]	[illegible]	[illegible]
FREDERICKSBURG NAT'L PARK	[illegible]	[illegible]	[illegible]
COLUMBIA	[illegible]	[illegible]	[illegible]

NOTE:
A_r STANDS FOR "RELATIVE AREA"

Figure 2A-13
MARCH 19-20, 1975
HOURLY RAINFALL DISTRIBUTION THIESSEN POLYGON
LAKE ANNA DRAINAGE BASIN



DAILY DATA (RAINFALL IN INCHES)

LOCATION	DATE		
	18	19	20
PIEDMONT RESEARCH STA		1 05	.79
GORDONSVILLE	.09	.91	1 11
COLUMBIA		.57	.92
FREDERICKSBURG NAT'L PARK		.84	1 10
CORBIN		.27	2 48
PARTLOW		.85	1 80
LOUISA		1 19	.62
ASHLAND		1 22	.19

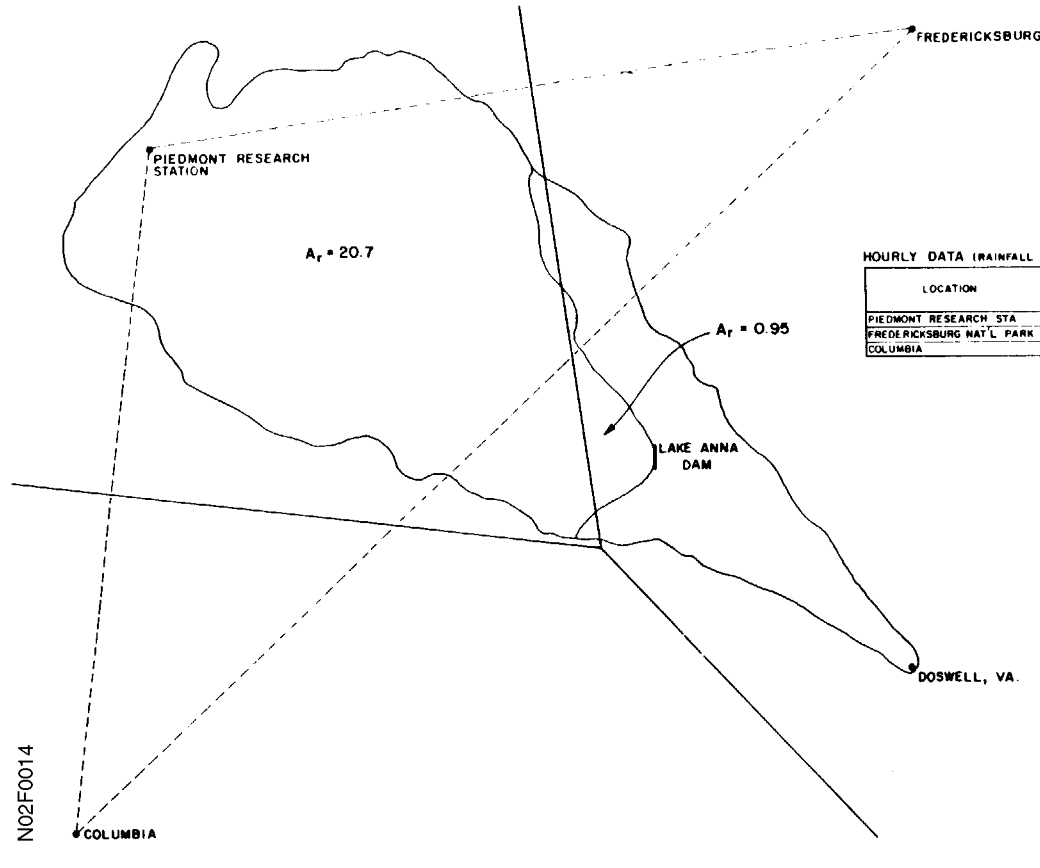
HOURLY DATA (RAINFALL IN INCHES)

LOCATION	DATE		
	18	19	20
PIEDMONT RESEARCH STA.	[illegible]	[illegible]	
FREDERICKSBURG NAT'L PARK		[illegible]	
COLUMBIA	[illegible]	[illegible]	

NOTE
A_r STANDS FOR "RELATIVE AREA"

N02F0013

Figure 2A-14
SEPTEMBER 6-8, 1974
HOURLY RAINFALL DISTRIBUTION THIESSEN POLYGON
LAKE ANNA DRAINAGE BASIN



DAILY DATA (RAINFALL IN INCHES)

LOCATION	DATE		
	6	7	8
PIEDMONT RESEARCH STA	01	1 95	01
GORDONSVILLE		2 03	03
COLUMBIA	13	3 25	02
FREDERICKSBURG NAT'L PARK			
CORBIN	35	2 74	02
PARTLOW	1.70	1.90	
ASHLAND	2 25	1 64	

HOURLY DATA (RAINFALL IN INCHES)

LOCATION	DATE	
	6	7
PIEDMONT RESEARCH STA	1 1 1 1 1 1 2 2 2 2 2 1 1	1
FREDERICKSBURG NAT'L PARK	1 1 1 1 1 1 2 1 2 2 2 2 2 2 2	1 1 1
COLUMBIA	1 1 1 1 2 2 2 2 3 2 3 4 2 3 2	1 1

NOTE
A_r STANDS FOR "RELATIVE" AREA

Figure 2A-15
SEPTEMBER 6-18, 1974
HOURLY RAINFALL DISTRIBUTION THIESSEN POLYGON
LAKE ANNA DRAINAGE BASIN

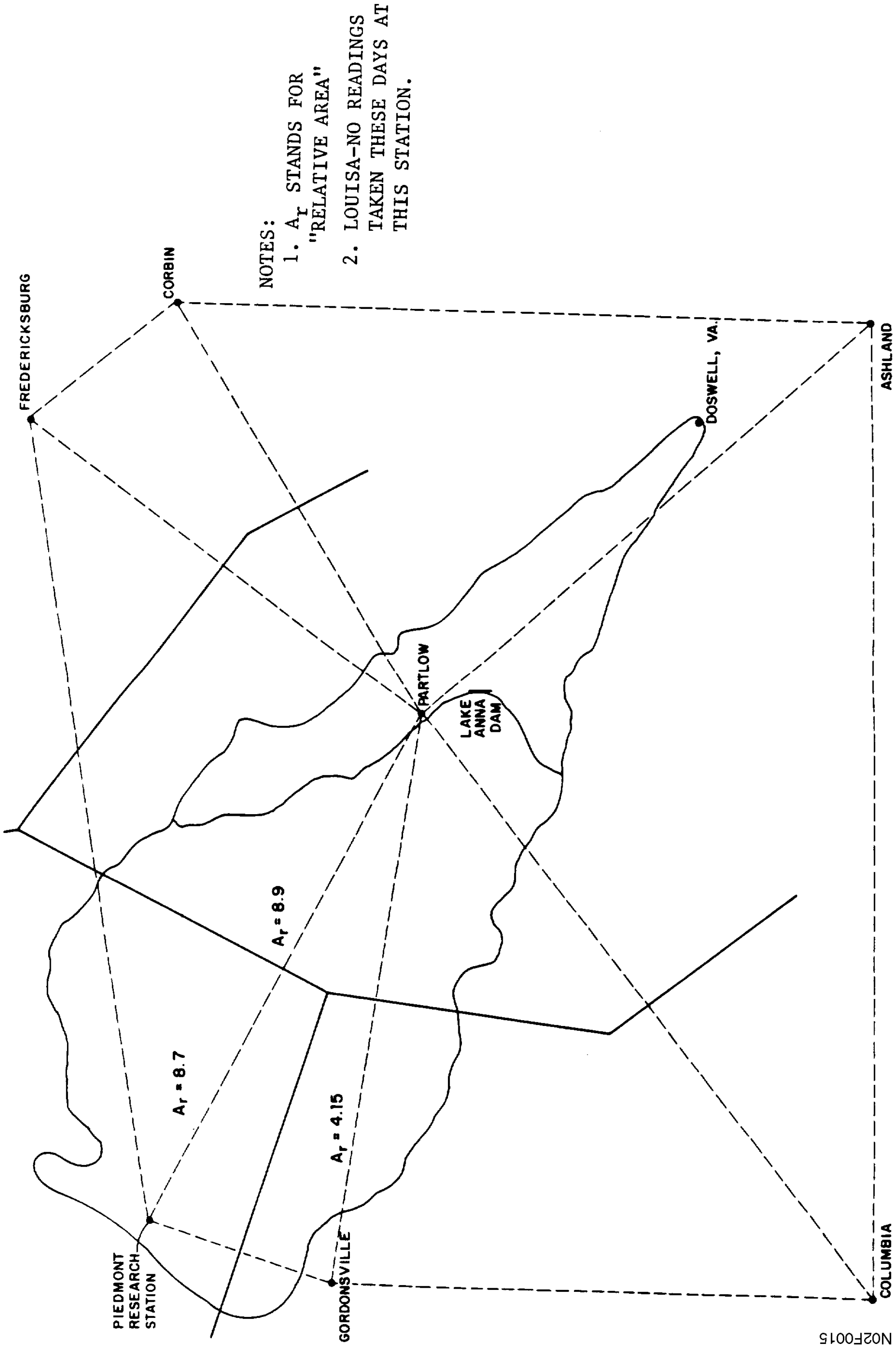
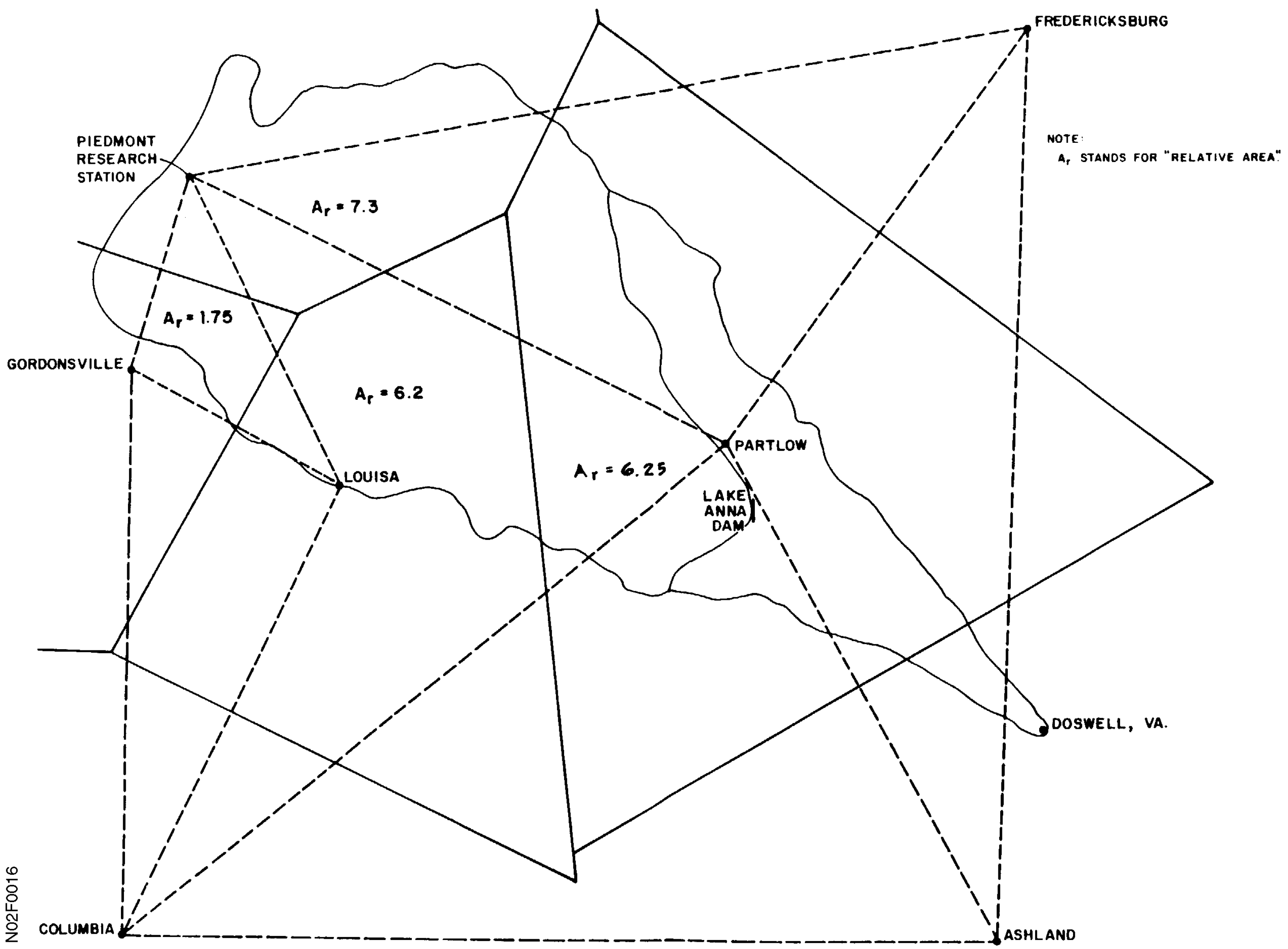


Figure 2A-16
JUNE 1972; APRIL 1973; MARCH 1975; DAILY RAINFALL DISTRIBUTION
THIESSEN POLYGON LAKE ANNA DRAINAGE BASIN



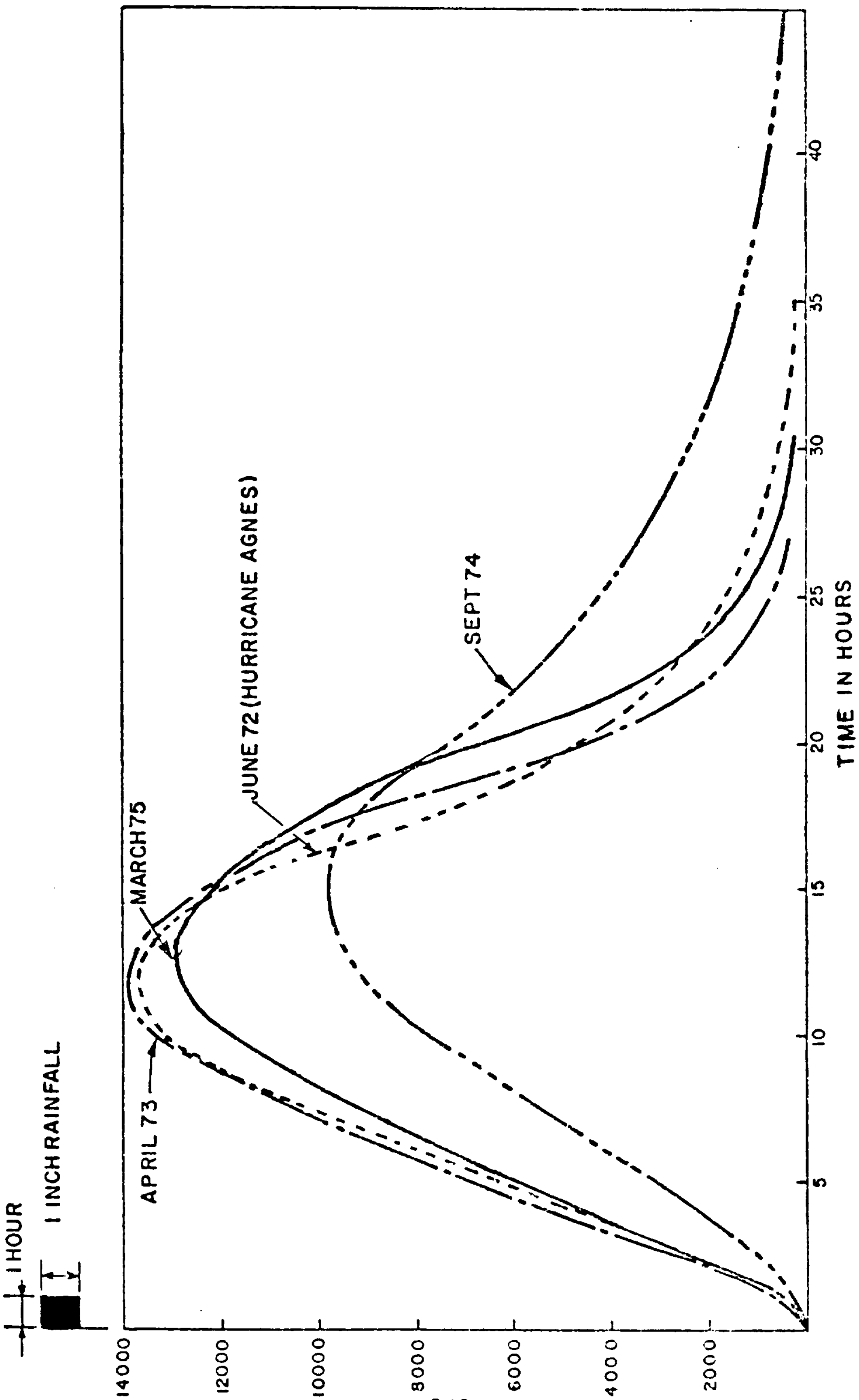


Figure 2A-17
1 HOUR UNIT HYDROGRAPHS: HISTORICAL STORMS

Figure 2A-18
FETCH DIAGRAM FOR SURGE AND WAVE RUNUP

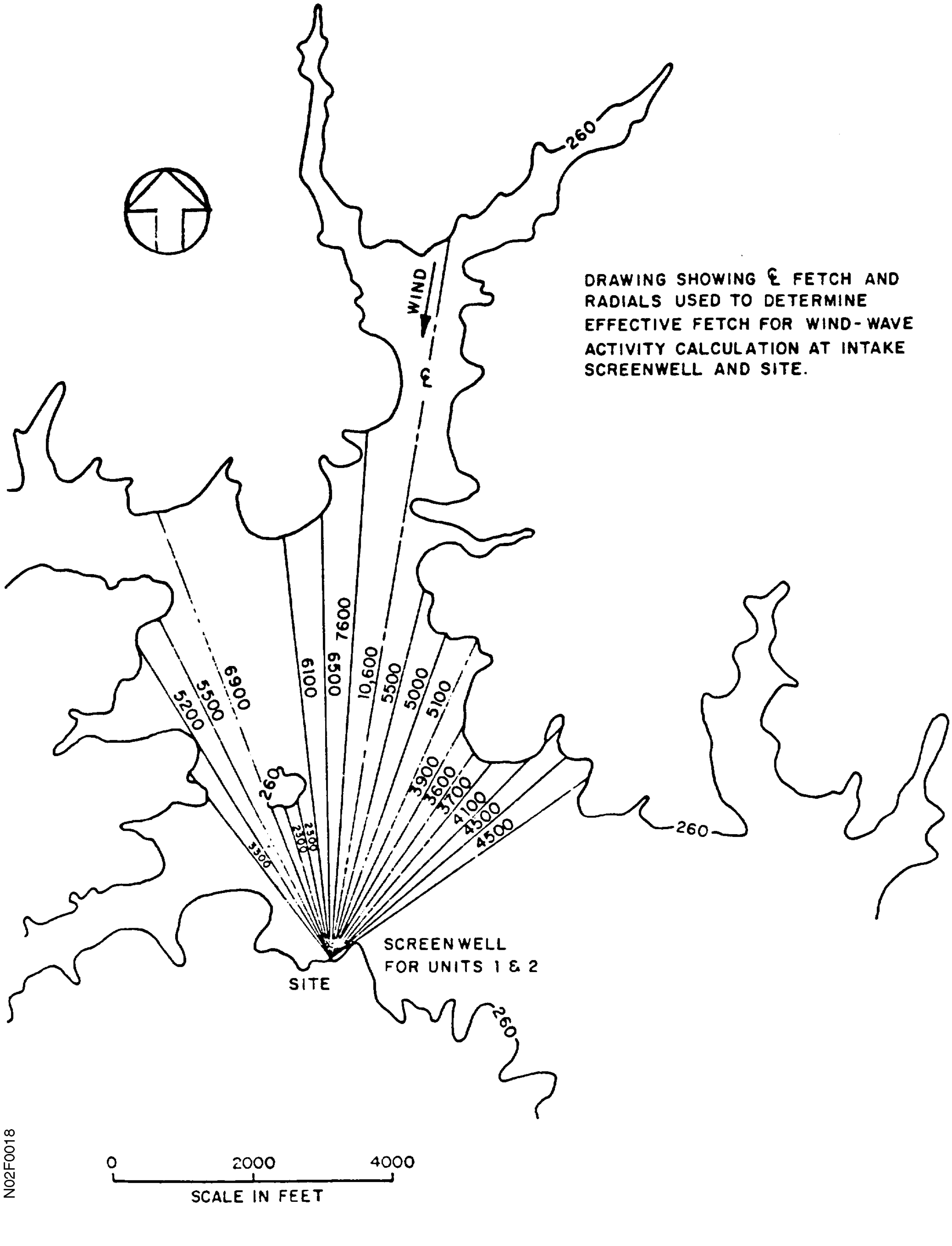
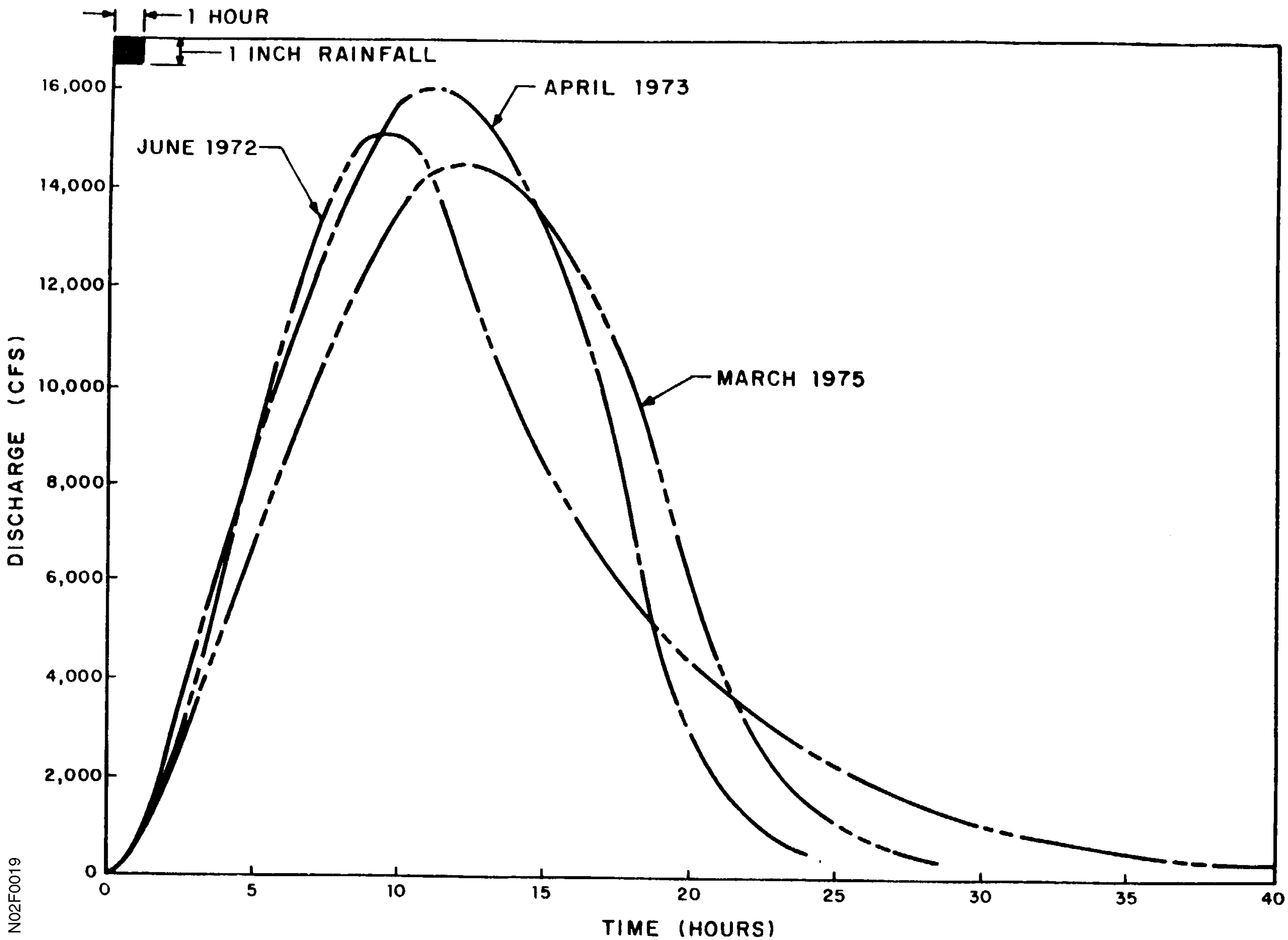


Figure 2A-19
1 HOUR UNIT HYDROGRAPHS; HISTORICAL STORMS: APPROXIMATE ANALYSIS



Appendix 2A
Attachment 1[1]
Historical Data U.S. Weather Bureau Data Sheets

1. Attachment 1 to Appendix 2A was submitted as Appendix J, Section 7.2 in the original FSAR.

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VEPCO-NORTH ANNA HOURLY PRECIPITATION

HOURLY PRECIPITATION

VIRGINIA
JUNE 1972

Station	A.M. 1	2	3	4	5	6	7	8	9	10	11	12	P.M. 1	2	3	4	5	6	7	8	9	10	11	12	Total
—21st—																									
PHILPOT DAM 2	.2	.1	.5	.5	.5	.5	.9	.7	.3	.2	.1														4.5
PIEDMONT RESEARCH STA								.1		.2	.1	.4	1.4	1.7	1.0	1.0	.7	.2	.3	.2	.2	.2	.2	.1	8.0
PULASKI 2 F	.2	.5	.2	.1	.1		.1	.1									.1								1.4
RANDOLPH 5 NNE			.1		.1	.7	.8	.7	.5	.6	.5	.9	.2			.2									5.3
RICHMOND WSO AP							.03	.01			.07				.06		.07	.69	.52	.28	.28	.17	.17	.08	2.43
ROANOKE WSO AP	.16	.09	.18	.10	.38	.30	.42	.34	.29	.20	.11	.05													2.60
ROCKY MOUNT	.2		.1	.3	.3	.4	.5	.5	.2	.1	.1	.1													2.8
SPRING CREEK 2	.05	.09				.05	.05	.08																	.28
STAR TANNERY		.1	.3	.1	.3	.1				.1					.1	.2	.2	.1	.2	.4	.1	.2	.3	.2	3.0
THE PLAINS 2 NNE			.1							.1	.1			.3	1.0	2.1	1.9	.8	.8	.7	.6	.4	.7	.2	9.3
TROUT DALE	.11	.12	.09	.05	.10	.05	.05																		.53
WALLOPS ISLAND WSO					.14	.01		.02										.08							.25
WASH NATIONAL WSO AP						.01	.01			.03	.01			.07	.36	.40	.04		.29	.45	1.10	1.20	1.25	.89	6.11
WHITE GATE	.48	.27	.15	.05	.05	.10	.15	.05								.05									1.35
WILLIAMSBURG 2 N			.1													.1		.1	.1		.4	.1	.4	.7	2.0
WISE 1 SE	.03	.02	.05																						.10
WOOLWINE 4 S	-	.38	.49	.50	.34	.52	.38	.23	.07	.02	.03	.02													-
WYTHEVILLE 1 S	.30	.42	.48	.19	.05	.06	.05																		1.55
—22d—																									
COLUMBIA																					.1	.1			.2
ELKWOOD 6 SE	.1																		.1	.1	.1		.1	.1	.6
FREDERICKSBURG NATL PK	.2	.3	.4																			.1	.1		1.1
HURLEY																			.06			.01	.01		.08
LYNCHBURG WSO AP																					.01				.01
MC GAHEYSVILLE 2 S																		.1	.1					.1	.3
PAINTER 2 W	.1	.2	.1						.1																.5
PIEDMONT RESEARCH STA																				.1				.1	.2
RICHMOND WSO AP	.04																							.02	.06
SPRING CREEK 2																			.01	02	.02				.05
STAR TANNERY	.3	.4	.3	.6	.6	.4	.2																	.1	2.9
THE PLAINS 2 NNE	.2	.3	.4	.2															.1	.1	.1	.1	.1	.1	1.7
WALLOPS ISLAND WSO	.02	.03	.26	.11	.25	.27	.01																		.95
WASH NATIONAL WSO AP	.13	.11	.03	.05	.26	.35	.16	.01											.03	.02	.06	.06	.04	.10	1.41
WILLIAMSBURG 2 N	.2																								.2
—23d—																									
ALTAVISTA				.03									.02												.05
COLUMBIA	.1	.1							.1				.1												.4
ELKWOOD 6 SE		.1	.1												.1	.1									.4
FREDERICKSBURG NATL PK	.1		.1			.1																			.3
HURLEY																			.01	.03					.04
LYNCHBURG WSO AP													.01		.02	.01									.04
MC GAHEYSVILLE 2 S		.1		.1	.1	.1			.1																.5
NORFOLK WSO AP								.02	.01																.03
PAINTER 2 W						.1		.2	.1	.1	.1														.6
PIEDMONT RESEARCH STA	.1					.1																			.2
RANDOLPH 5 NNE			.1										.1		.1										.3
RICHMOND WSO AP	.02	.03	.04	.04	.03	.02	.01	.01	.02	.03	.04	.01				.01									.31
STAR TANNERY	.1	.1		.2	.1	.1	.2	.3	.2	.2		.1													1.6
THE PLAINS 2 NNE	.1	.1		.1		.1			.1																.5
TROUT DALE																								.02	.02
WALLOPS ISLAND WSO		.01	.01	.02	.01	.01	.05	.20	.12	.13	.12	.05													.73
WASH NATIONAL WSO AP	.05	.08	.06	.08	.04	.04	.03	.01																	.39
WILLIAMSBURG 2 N				.1				.1		.1															.3
—24th—																									
DAVENPORT 2 NE			.03	.01	.01	.04	.02																		.11
ELKWOOD 6 SE																				*	*	*	*	*	*
GROSECLOSE							.02																		.02
HURLEY	.02	.01	.02																						.05
PIEDMONT RESEARCH STA																							.1		.1
SPRING CREEK 2	.01	.01	.01	.04	.04	.02																			.13
TROUT DALE	.01	.01	.01																						.03
WASH NATIONAL WSO AP																				.03				.03	.06
—25th—																									
WASH NATIONAL WSO AP	.02																								.02
—27th—																									
CHURCHVILLE																.01	.07								.08
FREDERICKSBURG NATL PK																		.1							.1
MC GAHEYSVILLE 2 S																.2	.3								.5
—28th—																									
ABINGDON													.02												.02
ALTAVISTA											.05						.02				.03	.02			.12
BIG MEADOWS		.2																	.3	.5	.4	.2		.2	1.8
CHATHAM 2 NE														.1		.5									.6
CHURCHVILLE																	.02	.07	.14	.20	.57	.43	.32	.11	1.86
COLUMBIA																					.1				.1
DAVENPORT 2 NE																	*	*	*	*	*	*	*	*	*
FREDERICKSBURG NATL PK															.2	1.4									1.6
GROSECLOSE														.32											.32
HONAKER																	.02	.01							.03
HOT SPRINGS																	.1	.1	.1	.1	.1	.1	.1		.7
HURLEY																		.02	.02	.01					.05
INDIAN VALLEY							.33	.27																	.60
JOHN W FLANNAGAN LAKE			.02	.50								.19	.01												.72
JORDAN MINES 1 NE																			.02	.03		.05			.10
LYNCHBURG WSO AP											.28	.02	.01	.01			.02	.01				.01	.01		.37
MC GAHEYSVILLE 2 S																				.1	.1	.3	.3	.1	.9
NORFOLK WSO AP																.04	.45			.07	.38	.27	.01		1.22
PHILPOT DAM 2					.1					1.2					.2				.2	.3	.1				2.1
PIEDMONT RESEARCH STA																			.1		.1	.1	.2	.1	.6
PULASKI 2 F							.1	.2						.9											1.2
RANDOLPH 5 NNE											.3					.1									.4
RICHMOND WSO AP																	.04			.11	.09	.08	.01		.33
ROANOKE WSO AP						.07		.02	.06	.04						.11	.23		.18	.01	.01	.01			.74
ROCKY MOUNT										.1	.1								.1	.2					.5
SPRING CREEK 2																	.02	.03	.03						.08
STAR TANNERY																								.1	.1
TROUT DALE												.07	.03												.10

HOURLY PRECIPITATION

VIRGINIA
JUNE 1972

HOURLY PRECIPITATION

NMJ
B4B

Station	A.M. Hour Ending 1	2	3	4	5	6	7	8	9	10	11	12	P.M. Hour Ending 1	2	3	4	5	6	7	8	9	10	11	12	Total
—18th—																									
																	.1	.2							.4
ELKWOOD 6 SE	.1												.1							.1					.2
FREDERICKSBURG NATL PK																									.03
JORDAN MINES 1 NE		.01	.02																		.01	.01			.03
LYNCHBURG WSO AP						.01																		.4	.4
MONTEBELLO FISH NRSY											.01														.01
NORFOLK WSO AP																									.1
PHILPOTT DAM 2		.1																						.1	.2
PIEDMONT RESEARCH STA	.1																	1.26	1.45	.15	.04	.91	.03	.01	3.91
RICHMOND WSO AP	.01				.04	.01											.02	.02						.05	.17
ROANOKE WSO AP	.01	.06	.01										.1												.1
ROCKY MOUNT																							.1		.1
STAR TANNERY			.1																	.2					.3
THE PLAINS 2 NNE														.08	.62	.14									.84
WASH NATIONAL WSO AP																			.1						.1
WILLIAMSBURG 2 N																		.07	.04						.20
WOOLWINE 4 S	.05	.01	.03																						
—19th—																									
																							.01	.04	.05
ABINGDON																					.18	.01	.01		.23
ALTAVISTA	.03																								.1
BIG MEADOWS							.1														.1				.1
CHATHAM 2 NE																								.02	.24
CHURCHVILLE		.01	.01	.11	.04	.05																	.04	.06	.10
GROSECLOSE																								.02	.02
HONAKER																									.1
HOT SPRINGS					.1													.03	.01	.01	.20	.23	.07		.60
INDIAN VALLEY	.05																						.09	.01	.14
JORDAN MINES 1 NE	.03	.01																				.02			.05
LYNCHBURG WSO AP	.03																								.1
MC GAHEYSVILLE 2 S			.1																				.1		3.7
MONTEBELLO FISH NRSY	.5	1.3	.9	.7	.1	.1																.1			.1
PHILPOTT DAM 2													.1												.2
PIEDMONT RESEARCH STA		.1																						.1	.1
PULASKI 2 E																				.10			.02		.19
ROANOKE WSO AP			.02						.01	.04												.05	.03	.02	.10
SPRING CREEK 2																						.05	.07	.03	.15
TROUT DALE																							.02	.03	.05
WHITE GATE																.1									.1
WILLIAMSBURG 2 N																								.02	.02
WISE 1 SE																					.05	.10	.02	.05	.25
WOOLWINE 4 S	.03																						.08	.07	.15
WYTHEVILLE 1 S																									
—20th—																									
															.10	.05	.15	.60	.50	.32	.08	.10	.12	.06	2.40
ABINGDON	.04	.07	.15	.05	.01										.05		.01	.03	.01			.05	.09	.13	.95
ALTAVISTA				.05	.05	.03	.02	.08	.15	.15	.02	.03													
BIG MEADOWS								.3	.1		.5	.2	.3	.2	.2	.2	.1	.3	.5	.3	.5	.4	.5	.4	5.0
CHATHAM 2 NE							.1	.1	.1	.1						.1				.1	.3	.1	.2	.2	1.4
CHURCHVILLE	.03					.05	.03	.02	.06	.04	.02	.03	.02	.12	.06	.10			.15	.07	.03	.15	.05	.20	1.23
COLUMBIA												.1		.1		.1	.1	.1							.5
																.15	.05	.13	.07	.06	.04	.05			1.00
DAVENPORT 2 NE		.02	.08	.14	.16	.05												.1							.2
ELKWOOD 6 SE											.1									.1		.1			.3
FREDERICKSBURG NATL PK													.1				.09	.22	.30	.30	.40	.20	.09	.05	2.45
GROSECLOSE	.03	.07	.10	.06	.09	.05	.01	.04	.04	.02	.10	.10	.06	.03		.08	.10	.16	.22	.13	.12	.03			1.34
HONAKER	.02	.08	.10	.30														.2	.2	.1	.2	.1	.1	.2	2.3
HOT SPRINGS	.1		.1	.3	.1	.1		.1	.1	.1	.1			.1											.60
HURLEY		.02	.06	.07	.17	.23	.05							.01	.05	.03	.15	.11	.20	.19	.31	.30	.25	.45	2.60
INDIAN VALLEY	.09	.11	.17	.08	[illegible]																.02	.01			.78
JOHN W FLANNAGAN LAKE		.05	.12	.09	.	.17	.03	.02	.03	.05						.01	.03	.01	.02	.03	.05	.13	.12	.64	1.54
JORDAN MINES 1 NE	.01	.09	.05	.05	.09	.01	.04	.02	.04	.05	.04	.01				.05			.05	.01	.01	.04	.09	.07	1.24
LYNCHBURG WSO AP		.03	.01	-.01	.03	.04	.04	.11	.06	.06	.22	.05	.06		.20		.1		.1	.1	.1	.1		.3	1.1
MC GAHEYSVILLE 2 S							.1			.1			.1				.1	.2	.5	.2	.1	.2	.1	.2	4.0
	.1	.2	.1	.2	.1	.1	.2	.1	.2	.2		.1	.3	.3	.2										
MONTEBELLO FISH NRSY														.01			.01		.01					.01	.04
NORFOLK WSO AP																	.1								.1
PAINTER 2 W				.1	.2		.1	.1	.1	.1		.1					.5	.1	.1	.1	.4	.3	.2	.2	2.7
PHILPOTT DAM 2																.1		.2	.1	.1				.1	.6
PIEDMONT RESEARCH STA																.1	.1		.5	.1	.2	.2	.1	.3	2.2
PULASKI 2 E			.1	.1	.1	.2		.1													.1	.1			.6
RANDOLPH 5 NNE					.1				.1	.1			.1							.05		.04	.01	.01	.48
RICHMOND WSO AP											.02		.06	.07	.05	.05	.03	.11	.05		.04	.14	.74	.15	2.15
ROANOKE WSO AP		.03	.04	.15	.12	.07	.07	.04	.06	.18	.01		.02	.01	.01	.07	.04	.11	.1	.1	.1	.3	.3	.3	2.3
ROCKY MOUNT				.1	.1	.1	.2	.1	.1		.1			.35	.1 .20	.10	.2 .20	.20	.22	.08	.03	.07	.10	.05	1.92
SPRING CREEK 2	.05	.13	.12	.02									.2					.1			.1				.4
STAR TANNERY															.1							.1			.2
THE PLAINS 2 NNE																.10	.20	.12	.18	.31	.13	.06	.10	.12	2.02
TROUT DALE	.05	.15	.01	.09	.05	.05	.10		.05	.01	.04		.03	.07				.01	.04	.02	.02	.01			.10
WALLOPS ISLAND WSO															.09	.04	.01			.02	.02	.06	.01		.25
WASH NATIONAL WSO AP																.05		.24	.16	.20	.20	.10	.15	.10	1.70
WHITE GATE	.05	.07	.08	.10	.05		.10	.05										.1							.1
WILLIAMSBURG 2 N									.15								.01	.05	.10	.10	.02	.03			1.19
WISE 1 SE	.03	.07	.08	.15	.25	.05	.10	.05	.10	.08	.14	.03	.04	.06	.10	.10	.15	.13	.17	.25	.53	.62	-	-	-
WOOLWINE 4 S	.02	.08	.20	.24	.11	.05	.40						.04	.01	.04	.01	.08	.06	.31	.30	.20	.10	.05	.15	2.30
WYTHEVILLE 1 S	.05	.03	.07	.10	.10	.15	.07	.08	.15	.05	.04	.06													
—21st—																									
	.31	.01					.04	.02																	.08
ABINGDON	.08	.04	.01	.23	.12	.25	.25	.57	.95	1.20	.85	.45	.15	.05	.05	.04									5.29
ALTAVISTA	.2	.3	.2	.1	.2	.1		.2	.2	.1	.8	.3	.5	1.1											4.3
BIG MEADOWS		.1	.1	.1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	4.6					4.9
CHATHAM 2 NE	.40	.25	.05	.09	.11		.08	.09	.13	.17	.13	.23	.25	.20	.22	.25	.20	.18	.02	.03	.07		.02		3.17
CHURCHVILLE		.1				.1	.1	.2	.2	.2	.1	.3	.5	.9	1.1	1.0	.7	.4	.3	.1	.1	.2			7.2
COLUMBIA						.10	.06	.02		.01		.04	.02												.25
DAVENPORT 2 NE												.5	.9	.1	.7	1.5	1.1	.5	.3	.5	.3	.2	.3	.3	7.3
ELKWOOD 6 SE					.1							.2	.4	.1			.2	.9	1.2	.8	.4	.4	.5	.2	5.6
FREDERICKSBURG NATL PK							.05																		.56
GROSECLOSE	.02	.06	.09	.19	.10	.05	.05					.01													.06
HONAKER																									3.3
HOT SPRINGS	.5	.6	.4	.1	.2	.3	.2	.1	.1	.2	.2	.1	.1												.35
HURLEY	.01	.01				.18	.10	.01			.04														1.63
INDIAN VALLEY	.25	.30	.19	.16	.27	.18	.10	.10		.01	.01	.01				.02	.03								.47
JOHN W FLANNAGAN LAKE	.27			.01	.19										.02	.01									3.39
JORDAN MINES 1 NE	.51	.40	.60	.35	.30	.25	.55	.15	.06	.11	.08				.11	.07	.10	.03	.02						6.02
LYNCHBURG WSO AP	.01			.10	.30	.20	.53	.48	1.04	1.24	.76	.54	.32	.17	.2	.1	.2	.2		.8	.2	.2			4.6
MC GAHEYSVILLE 2 S	.2		.1		.1	.1	.3	.1	.1	.2	.5	.3	.3	.4											-
MONTEBELLO FISH NRSY	.5	-	-	-	-	-	-	-	-	-	-	-	-	-	.03	-	-	.02	.02	.01		.06		.06	.26
NORFOLK WSO AP	.01										.04	.01	.1												.1
PAINTER 2 W																									

DAILY PRECIPITATION

VEPCO - NORTH
DAILY PRECIP

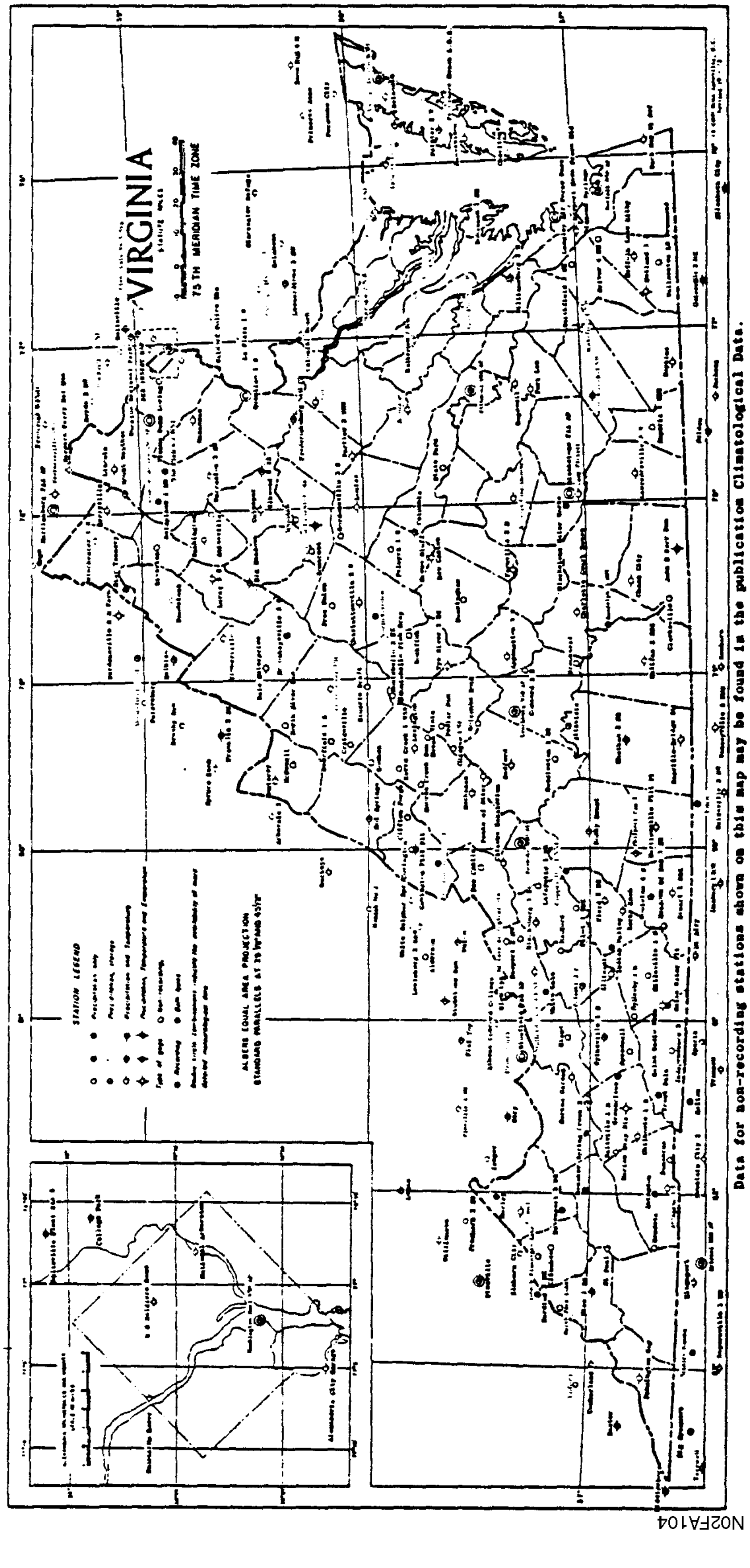
Station	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
TIDEWATER 01																											
BACK BAY NL REF	3.62	.35						1.27			.20				.20							.10	1.35				
BOHANNON 1 NE	5.22	T				.09		.46			.18				1.00			T	.06		.04	.19	.98	.39			
BOYKINS	7.13	.71						.28							.06				.24	.70	1.08	.52	1.12	.64			
BURGESS 1 ESE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
CHERITON	3.36							.95			T				1.57			T			.04	.11	.18	.26			
CHINCOTEAGUE NL REF	7.81										.61				1.26			.79						2.01	.02		
COLONIAL BEACH	11.91			.01		.36	1.30				.12				.25	.01		2.00	.02	.07	.07	.04	6.66	.49	.02		
DIAMOND SPRINGS	5.32	.86						1.89			.05	.03			.55	.04		.13	.20			.10	.27				
DRIVER 4 NE	6.03	.04						1.40			.16				.72			.21	.30	.31	.48	.24	.52	.09			
EMPORIA 1 WNW	5.12	.27						.13			.08	.25			T	T			.32	T	.02	.96	1.84	.21	[illegible]		
FORT LEE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
FREDERICKSBURG NATL PK	10.80	.11				.12	.67	.01			.07				.27			1.25	.11	.08	.12	.92	5.65	.49	[illegible]		
HOLLAND 1 E	4.89	.43						1.02			.06	.33			.35							.40	.71	.05			
HOPEWELL	4.70	.14	T			.02		.74			T				.15		.75			.37	.22	.37	1.28	.40			
LANGLEY AIR FORCE BASE	6.09						.03	1.11		.18	.16			.01	.95			T	.18		.25	.83	.28	.29			
NASSAWADOX	4.49							.73			.18				1.74	.04		.11			.03	.20	.28	.55			
NELSONIA	8.37							.22			.56				1.25	.08			.03		.01	.20	1.79	.90	.01		
NEWPORT NEWS PRESS BLD	5.88	.06						1.39		T	.24	T			.64			.08	T		1.00	.30	.27	.24	.01		
NORFOLK WSO AP	4.93	.01					1.68	T		.08	.04			.01	.32			.99	.01		.04	.26	T	.03			
PAINTER 2 W	6.01							.47			.27				1.32				.68			.17	.67	.62			
PARRAMORE BEACH L B S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
QUANTICO 1 S	10.15	.01			.17		.62							.06	.08		.03	.12	T	T	.53	5.01	2.44	.38	.19	T	
SMITHFIELD 3 NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
STONY CREEK 4 SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
SUFFOLK LAKE KILBY	4.56						1.42	T		.02	.28				.23			.32		.07	.45	.78	.01	T			
TANGIER ISLAND	2.70					.40				.15											.40	.25	.75	.50			
URBANNA	6.09	.76						.80			.35				.28					.20	.02	.33	2.32	.24			
WAKEFIELD 1 NW	6.42						.29				.23				.30			1.40	.09	.34	.51	1.50	.21				
WALKERTON 2 NW	10.88	1.36				.49	T				.04				.22				1.55	2.05	.04	.65	5.40	.40			
WALLACETON LK DRUMMOND	4.54	.37						.94			.20	.50			.04	.34			.30		.12	.37	.07				
WALLOPS ISLAND WSO	7.60	T					.19	T			.40			.11	1.20	.36					.10	.25	.95	.73			
WARSAW 2 NW	10.46	.47				.21	.20	.98			.08				.45				1.57	.60	.03	.40	4.53	.30			
WEST POINT 2 SW	6.96	1.27				.43		.40			.21				.25				.75	.27	.03	.30	2.29	.29			
WILLIAMSBURG 2 N	6.51	T				.01		1.04			.13				.34			1.34	.08	.05	.04	.35	1.99	.35			
EASTERN PIEDMONT 02																											
AMELIA COURT HOUSE	7.92		.76				.07							.08				.02		.04	.05	1.68	4.46	.37			
ASHLAND	8.67	.96				.18		.12			.06				.20				.48	.25	.17	1.21	4.11	.65			
BLACKSTONE FAA AP	10.40	1.17				.02						.08			T				1.12	T	.05	1.30	5.02	1.15	.17		
BREMO BLUFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
BUCKINGHAM	10.36	.20				.27		.02							.10			.19	.15	.19	.03	1.30	7.33	.21	.22		
CHASE CITY	-																		1.92		.50	2.00	-	-			
CLARKSVILLE	7.61	.02										.13				.10			.83	.10	.31	1.74	3.22	.30	.01		
COLUMBIA	9.38	.41				.02		.02			.06				.19			.18	.05	.13		.70	6.95	.44	.11		
CORBIN	11.19	.41				.05		.31			.05				.22			.16	.07	.17		.57	7.53	.50	.13	T	
FARMVILLE 2 N	9.04					.08					.03									.35	T	.87	6.62	.23	.33		
GORDONSVILLE 3 S	13.24	.61				.03									.20			.29	.88	1.23	.01	.98	6.85	.47			
JOHN H KERR DAM	6.7[illegible]	.21						T				.30	T						.5[illegible]	.25	.08	1.92	1.20	.28	.01		
LAWRENCEVILLE 3 W	8.26	.02					.30				.18				.09			.19	.23	.43		4.45	1.11	.32			
LOUISA	10.82	.30	.01			.22	.03				.01				.14		.02	.22	.04	1.13	.20	4.89	2.30	.69			
NEW CANTON	10.19	[illegible]				.03		T			.05				.29			.45	[illegible]	.26	.32		7.81	.53			
PALMYRA 1 S	12.99	.63				.08		T				T			.34	T		1.86	.16	.80		.70	7.60	.42	.05		
[illegible] 3 NW	9.8[illegible]	[illegible]					.40											.30		.20	.20	2.50	4.40	.70			
RICHMOND WSO AP R	8.82				.16	.01	.28			.38	.17			.04	.19			.10	3.91	T	.48	2.43	.06	.31			
STATE FARM	9.67	2.04				.14		.09			.12	.02			.11	.03				.23		1.31	4.66	.35	.12		
WESTERN PIEDMONT 03																											
ALTAVISTA	6.01	.03													.09			.04	.05	T	.27	1.40	4.06	T	.02		
APPOMATTOX 3 W	12.47	.70				.22		T							.04			T	1.00	.32	.07	1.81	8.85	.05	.05		
BEDFORD	7.27	T						.04							.02	.02		.17	.09	.21	.71	3.13	1.68				
BROOKNEAL	9.06	.18				.07		.01			T	T			.03	.02			1.34	.03	.35	1.09	4.70	.05	.11		
CHARLOTTE COURT HOUSE	7.66	.46				.16		.16					.03		T	T			.25	.15	.26	1.15	3.45	.27	.18		
CHARLOTTESVILLE 2 W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHARLOTTESVILLE 1 W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
CHATHAM 2 NE	8.19	.19						.01							.10				.71	T	.30	3.15	2.80	T	T		
CONCORD 5 S	10.85	.55				.04						T			T				1.29	.14	.05	1.73	5.75	.04	.03		
DANVILLE-BRIDGE ST	7.77	.39						.05				.07							.90	.04	.21	2.85	2.33	T			
FREE UNION	11.57	.84				.08									.26				.80	.28	.04	1.23	8.30	.44	.04		
HALIFAX 2 SSE	6.80	.34										.07							.76		.66	1.08	3.40	.05	.06		
HOLCOMBS ROCK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
HUDDLESTON 2 SW	7.30	.11						T							.02	.33		.02	.10	.38	.78	1.95	3.10	.01	.02		
LYNCHBURG WSO AP R	6.58				.08		.02				T			T	.04		.06	T	.03	.05	1.24	6.02	.01	.04			
MARTINSVILLE FILT PL	11.08	.06					T												1.03	1.02	.24	3.44	3.20				
MEADOWS OF DAN 5 SW	10.47							.04			.02				.15			.03	.35	.26	1.25	6.61	.49				
MONTEBELLO 3 NE	17.88			.03		.46		.08							.19			1.81	.61	3.95	1.16	3.80	4.43			.11	
PEDLAR DAM	9.05							T							.10	.12		1.52	.40	1.05	.43	2.40	2.41	.02	T		
PHILPOT DAM 2	10.72	T						.12											1.45		.60	5.47	1.00				
RANDOLPH 5 NNE	7.87	.48				.08															.11	1.18	5.04	.20	.24		
ROCKFISH	11.18	.03				.16		.02			.04				.27	.02		.89	.65	.86	.13	1.58	5.79	.10	.02		
ROCKY MOUNT	7.26	T						.03										.68	.32	T	.40	2.95	1.95				
STUART 1 SSE	6.75						.10			.03	T			.09	T			.06	.61	.09	2.18	3.98			.01		
TYE RIVER 1 SE	10.96	T				.41		.03							.09	.02		.55	.35	1.05	.07	1.74	8.36	T			
WOOLWINE 4 S	11.82							.03											1.52	.12	1.00	8.70	.80				
NORTHERN 04																											
ALEXANDRIA CITY GARAGE	13.17	.26				.57	.07								.21	.04		T	.19	1.39		.65	8.15	.73	.04	.09	
AMISSVILLE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
BERRYVILLE	11.19	.03			.04	.33								.33	.07		.12	.26	.05		.18	1.28	3.45	1.42			
BIG MEADOWS	18.03	.07	T			.10		.10	T		.12	T				.15	T	.10	.25	.03	2.90	9.50	.28	.95	T		.03
CULPEPER	12.15	.77				.16								.01	T	.08		.30	.54	.20	.30	5.30	2.80	.60		.23	
ELKWOOD 6 SE	12.77	.58				.13	.10							.05	.81		T	.14		.44	.14	4.81	2.55	.73		.17	T
GROVETON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
LINCOLN	15.07				.31						.21	.12	.48	.03				.19	.39		1.10	8.26	1.26				
LURAY 5 E	10.71	.05				.37		T			.01				.22	.08		.11		.38	.05	2.01	4.95	1.19	.03		
MANASSAS	12.15						T								.28				.35	T	.45	9.50	.80	.03			
MOUNT WEATHER	14.31	.20				.57	T	.01			T				.84	.84	.01	.30	.05	.11	.01	.39	7.67	1.36	.04	T	
PIEDMONT RESEARCH STA	12.78	.83				.45									.18			.25	.85	.19	.04	.62	7.85	.40	.05	.06	
RAPIDAN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
RIVERTON	7.28					.31								.32			.09		.03	.36	.78	9.50		1.21			
SOMERSET	12.34	.77				.50		T							.19			.12	.31	.30	.25	.85	9.98	.20		T	
THE PLAINS 2 NNE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
VIENNA DUNN LORING	15.14	.33				.44	.86							.41	.08			.15	.02		.82	8.31	6.67	1.32	T	.08	
WARRENTON 3 SE	13.57	.45				.38		T							.28	.08		.10	.61	.63		.39	6.89	1.01	.01	.04	
WASHINGTON	-	.11				.31									.17			.45	.17		-	-	3.71	.61	.11		
WASH. DULLES WSO AP	18.19	T			.50		.03				T			.44	.01	T	.08	.87	.11	T	.55	10.47	1.96	.47	.05	T	

7.2

8.08

7.8

8.99


VIRGINIA
75TH MERIDIAN TIME ZONE
STATION LEGEND
ALBERS EQUAL AREA PROJECTION
Data for non-recording stations shown on this map may be found in the publication Climatological Data.
N02FA104

DAILY PRECIPITATION

VIRGINIA
SEPTEMBER 1974

STATION	TOTAL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
* * * TIDEWATER 01																																
BACK BAY WL REF	4.70		.35	.56	.02		1.52	1.30											.12				.08									
BOHANNON 1 NE	5.45			.12	.80	T	1.92	2.20	.03														.26	T					.04	.19		
BAYKINS	3.45			.03		1.03	.17	1.01	.06									.08	.03				.83						.12	.09		
BURGESS 1 ESE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CHERITON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COLONIAL BEACH	6.44			.64	1.72		1.03	1.56				.30																	1.17	.02		
DIAMOND SPRINGS	4.65			.37	.10	.08	1.01	1.39	.15								-		.10			.08	1.08	.01						.01	.27	
DRIVER 4 NE	5.90		.85	.20	.25		1.30	1.60	.06									.02	.05				1.41						.06	.10		
EMPORIA 1 WNW	4.57		.04	.28	1.66		.07	1.60	.14	T									.08				.41	.07					.03	.20		
FORT LEE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
FREDERICKSBURG NATL PK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
HOLLAND 1 E	3.92			.03	.40	.04	.01	1.41	.22										.06				1.67							.03	.05	
HOPEWELL	5.55		.09	.20	1.74		1.33	2.00	.04														.12						.07			
LANGLEY AIR FORCE BASE	4.71		.05	.12	.15	T	3.81	.49	T			T			T			.02			T	.08	.27						.12			
MASSAWADOX	2.63				.32		.44	1.30	.01									T			.12		.35							.06		
NELSONIA	3.24	.91		.05	.82		.08	1.18													.26		.12	.02								
NEWPORT NEWS PRESS BLD	2.31		.07	.01	.37		.25	.20	.02		.03								.02					1.05	T					.29		
NORFOLK WSO AP	4.40		.64	.13	.06		2.13	.19	T						T			.09			.01	.40	.63						.01	.21		
PAINTER 2 W	2.82				.71		.25	1.34															.28	.03						.21		
PARRAMORE BEACH L B S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
QUANTICO 1 S	5.66	.09	.26	1.87	.07		2.14	.31	.02			.57			T			T				.06	T						.27			
SMITHFIELD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
STONY CREEK 5 SSW	4.93		.10	1.10	1.33	.05	.07	1.55	.18	T									.03		.01		.29	.01						.21		
SUFFOLK LAKE KILBY	5.40		.05	.01	.20		3.09	.25	.03									.04			.02	.22	1.44						.05			
TANGIER ISLAND	3.01			T	1.29		.70	.98																						.04		
URBANNA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
WAKEFIELD 1 NW	4.70		1.20				2.05	.82															.25						.38			
WALKERTON 2 NW	6.01		.02	.81	1.41		1.91	1.29	T			.18						T					.02						.37	T		
WALLACETON LK DRUMMOND	3.74			.04		T		.19	2.05	.17									.07			.01	.95	.17							.13	
WALLOPS ISLAND WSO	1.97			.37	.03		.49	.55					.02								T	.04	.06						.01			
WARSAW 2 NW	5.01			.20	1.18		1.50	1.23				.25						T					.03						.62			
WEST POINT 2 SW	6.69	.80	.03	.05	1.59		2.43	.95															.06						.68			
WILLIAMSBURG 2 N	5.41	T		.08	1.38	.01	2.49	1.13	T									T					.25						.06	.01		
* * * EASTERN PIEDMONT 02																																
AMELIA COURT HOUSE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ASHLAND	6.81		.42	.46	1.51		2.25	1.64	T		.03																	.30				
BREMO BLUFF	6.81		.29	1.12	1.35		.08	3.72	.04														.01						.08	.22		
BUCKINGHAM	6.04		.17	1.59	.48		.10	3.36	.08																				.23	.03		
CAMP PICKETT	5.38	.04	.22	.05	1.86		.15	2.64	.18										.02											.20	.02	
CHASE CITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLARKSVILLE	8.19	.04	1.23	.41	1.49		1.07	3.01	.12														.42	.08					.32			
COLUMBIA	5.51		.07	1.13	.60		.13	3.25	.02			.03						.01					.01						.15	.11		
CORBIN	6.52		.13	.40	1.88		.35	2.74	.02			.68											T							.32		
FARMVILLE 2 N	5.31		.25	.26	.67		.34	3.62					T						.04				.13									
GORDONSVILLE 3 S	4.67		.27	.31	1.50			2.03	.03			.53																				
JOHN H KERR DAM	7.45	.02	.49	.07	3.21	T	.35	2.57	.10	T						.02	T		.11	T	T		.14	.12					.25	T		
LAWRENCEVILLE 5 W	5.81		.20	.21	1.98		2.04	.89	.07									.06					.30						.06			
LOUISA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
NEW CANTON	6.52		.03	1.22	1.32		1.20	2.28					.05															.42				
PALMYRA 1 E	5.95			2.24	.71		.08	2.10	.09			.18																	.10	.45		
PARTLOW 3 WNW	8.35	.10		.20	2.30		1.70	1.90		.10			.60	.70															.75			
RICHMOND WSO AP R	4.83	.06	.12	1.22	.28	.01	2.80	.27	T									T				T	.01						.06			
STATE FARM	6.31		.70	.56	1.31		.46	3.17	.04														.05						T	.02		
* * * WESTERN PIEDMONT 03																																
ALTAVISTA	5.95		.98		.74		.07	3.98	T			.13											.01						.04			
APPOMATTOX 3 W	4.90	.12	.11	1.24	2.15		T	.66	.20	T		.26								.05									.11			
BEDFORD	4.34	.24	.31	.10	.87		.04	2.22	.04		.16			.23															.11	.02		
BROOKNEAL	4.73	T	.24	.10	.37	.01	.08	3.50	.04										.19				.10						.07	.03		
CHARLOTTE COURT HOUSE	6.31		.67	.55	.46		.29	4.10	.04	T									.10				.01						.08	.01		
CHARLOTTESVILLE 2 W	4.49		.21	.98	.35		.11	1.92	.04			.59	T					.01	T										.28	T		
CHATHAM	6.69	.02	1.17	.14	.78		.12	3.80	.04			.07							.03				.07						.44	.01		
CONCORD 5 S	7.31	.20	.42	.83	2.23	T	.12	3.16	.05			.11							.10			T							.07	.02		
DANVILLE-BRIDGE ST	5.52	.05	.55	.44	.43		.23	3.23	.03										.25				T			.02			.16	.13		
FREE UNION	4.80		.38	.66	1.33			1.54				.26	.08	.29				.02											.12	.12		
HALIFAX 2 SSE	10.04	.88	2.77	1.06	.60		.20	4.15	.05										.06										.15	.12		
HOLCOMBS ROCK	4.46		.07	.32	.88		T	2.51	T			.29		.25															.11	.03		
HUDDLESTON 2 SW	7.51	.01	.52	2.08	1.31	.01	.07	3.29	.05			.15																	.01	.01		
LYNCHBURG WSO AP R	5.55	.11	1.55	.31	.06		3.06	.09	T		.13		.07					.02				T	.01					.03	.10	.01		
MARTINSVILLE FILT PL	5.85		1.13	.66	.56		.12	2.79				.05							.20				.23						.11			
MEADOWS OF DAN 5 SW	7.92		.74		.58		.44	2.53	.04			3.02		.04					.25										.27			
MONTEBELLO 2 NE	4.16		.18	.40	.97			1.82	.06					.27	.11			.02											.24	.09		
PEDLAR DAM	3.96	T	.60	.46	.86		T	1.68			T	T		.15	T														.21	T	T	
PHILPOTT DAM 2	7.23		T	.39	.48		.31	2.87	.03	T		3.02	T						.05				.03						.07			
RANDOLPH 5 NNE	7.14		1.13	.51	.35		.18	4.56	T	.08									.18										.06	.09		
ROCKFISH	4.43		.17	.42	.49			2.08				.82		.12				T											.20	.03		
ROCKY MOUNT	5.69	.08	.66	.46	.80		.15	2.39	.11			.86	.04	.02					.04										.06	T		
STUART 1 SSE	5.69	.42	T	.51	.82	T	3.00	.12	.03			.34	T			T		.24					.06						.15			
TYE RIVER 1 SE	4.21		.35	.54	.67		T	2.26				.24		.02															.11	.02		
WOOLWINE 4 S	8.01		T		.80		.40	3.80	.11	T		2.98				.03			.16										.23	.10		
* * * NORTHERN 04																																
ALEXANDRIA CITY GARAGE	4.85			.43	1.77		.20	1.60	T			.26			T			T					.13						.06	.40		
AMISSVILLE	2.95			.75	.60			.80				T	.25			.05							.05						T	.45		
BERRYVILLE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
BIG MEADOWS	3.08	.04	.02	.33	.75	T	.02	1.41	.03	T	T	T	.30	T		T	T		T	T	T	T	.01	T		T	T	T	.17	T		
CULPEPER	6.03			2.47	.29		.76	1.22	T			.65										T							.64			
ELKWOOD 6 SE	6.15	.01			2.04		.77	1.30		T		.84	T																1.19			
LINCOLN	4.19	.79					.36	.76						1.63							.51						.14					
LURAY 5 E	2.59	.06	.10	.98			.87					.26											.04							.27	.01	
MANASSAS	3.85	T	.25	.90	.42			1.28	.12			.21										.06							[illegible]			
MOUNT WEATHER	3.59	.07	[illegible]	.56	1.04		T	.88	T			.21	T		.30			T				.01	.42						T	.06		
PIEDMONT RESEARCH STA	5.68		.02	1.01	1.80		.01	1.95	.01			.34					.01	.03											.10	.40		
RAPIDAN	5.77	.15	.02	1.50	1.03			1.87	T			.68	.02					.04					T						.02	.44		
RIVERTON	2.27	.10		.11	.40			1.00				.35											.22							.09		
SOMERSET	5.56	.10	.24	1.92	.28		.01	1.73	.01	.01			.60	T				.02	T				.02						.55	.09		
THE PLAINS 2 NNE	3.42	.02		.67	.76		T	1.32				.14	T	T	.05					T			.15						.01	.30		
VIENNA DUNN LORING	5.79			1.82	.45		.56	1.32				.18			.03			.01				.10							1.34			
WARRENTON 3 SE	4.56		T	1.93	.38		.01	1.53				.20				T							.08						.07	.37		
WASHINGTON	3.42	.05		.58	.60			1.70				.28																	.11	.10		
WASH. DULLES WSO AP	4.02	T	.25	.82	T		1.32	.32	.01		T	.05			.08			.02				.18						T	.97			
WASH. NATIONAL WSO AP R	4.39		.30	1.87	.02		1.04	.29			T	.26			T			T				.08							.73	T		

SEE REFERENCE NOTES FOLLOWING STATION INDEX

HOURLY PRECIPITATION

HOURLY AMOUNTS

VIRGINIA SEPTEMBER 1974

STATION	DATE	A.M. 1	A.M. 2	A.M. 3	A.M. 4	A.M. 5	A.M. 6	A.M. 7	A.M. 8	A.M. 9	A.M. 10	A.M. 11	A.M. 12	P.M. 1	P.M. 2	P.M. 3	P.M. 4	P.M. 5	P.M. 6	P.M. 7	P.M. 8	P.M. 9	P.M. 10	P.M. 11	P.M. 12	TOTAL
PIEDMONT RESEARCH STA																										
PULASKI 2 E	1														.1											.1
	3																.1	.2								.3
	6						.1		.1	.1		.2	.1		.1	.1	.1	.1		.1						1.1
	9																					.1				.1
	10																	.1								.1
	13																		.1							.1
	21								.1																	.1
	27																					.1				.1
	28								.1																	.1
RANDOLPH 5 NNE	1																	.4	.8	.1						1.3
	2																	.1			.3					.4
	3																		.1				.1			.2
	4		.1				.1																			.2
	6			.1				.1	.2	.3	.6	.2	.1	.1	.5	.5	.2	.2	.4	.4	1.3	.1	.1			5.4
	7			.1			.1																			.2
	17															.1										.1
	28						.1																			.1
RICHMOND WSO AP	1																				.05	.01				.06
	2																						.03	.09		.12
	3																				.54	.19	.21	.12	.16	1.22
	4	.05	.03	.02	.03	.05	.03	.06	.01																	.28
	5																								.01	.01
	6		.02	.06	.10	.02	.01	.01	.08	.19	.19	.18	.13	.12	.16	.15	.22	.04	.15	.20	.21	.22	.12	.08	.14	2.80
	7	.05	.01			.02	.09	.02	.01	.01	.01	.02	.01	.01									.01			.27
	22				.01																					.01
	28			.02					.01	.01				.02												.06
ROANOKE WSO AP	1															.04										.04
	3														.19	.06	.09	.13	.04	.02						.53
	6						.01	.02	.01	.04	.05	.11	.25	.19	.20	.16	.20	.18	.12	.09	.05	.03	.01			1.72
	8			.02	.01		.01																			.04
	9																					.02				.02
	10																			.20	.07					.27
	12																	.10	.04	.01						.15
	17												.01													.01
	27																						.12	.04		.16
	28	.01		.02	.03	.01	.01		.01		.01															.10
ROCKY MOUNT	1															.1	.5									.6
	2																		.4							.4
	3																	.5	.1				.1			.7
	4				.1																					.1
	6						.1		.1	.1	.1	.3	.1	.1	.2	.3	.2	.3	.1	.1	.1		.1			2.3
	7								.1																	.1
	10																			.2	.4	.2				.8
	11															.1										.1
	28																.1									.1

MONTHLY MAXIMUM AMOUNTS (Apply heading as appropriate)

STATION	HOURS / MINUTES	1 / 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
PIEDMONT RESEARCH STA	AMOUNT	1.0	1.5	1.7	1.7	1.8	2.7	
	DATE/TIME OF ENDING	3/5:00P	3/6:00P	3/7:00P	3/7:00P	4/3:00A	3/7:00P	
	AMOUNT	.2	.3	.4	1.0	1.5	1.7	ACC. 1.0
	DATE/TIME OF ENDING	28/7:15A+	28/7:15A+	2/9:30P+	3/5:00P	3/6:00P	3/6:45P	3/5:00P
PULASKI 2 E	AMOUNT	.2	.3	.3	.6	1.0	1.1	
	DATE/TIME OF ENDING	6/11:00A+	6/12:00A+	6/5:00P+	6/4:00P	6/7:00P+	6/7:00P	
	AMOUNT	.1	.1	.2	.2	.3	.3	
	DATE/TIME OF ENDING	28/7:30A+	28/7:30A+	6/10:45A+	6/4:30P+	6/4:30P+	6/4:30P+	
RANDOLPH 5 NNE	AMOUNT	1.3	1.7	2.1	3.0	4.8	5.5	
	DATE/TIME OF ENDING	6/8:00P	6/8:00P	6/8:00P	6/8:00P	6/8:00P	7/6:00A	
	AMOUNT	.6	1.0	1.2	1.3	1.7	2.1	
	DATE/TIME OF ENDING	1/5:15P	1/5:15P	1/5:30P	6/8:00P	6/8:15P+	6/8:15P+	
RICHMOND WSO AP	AMOUNT	.54	.73	.94	1.27	1.97	2.85	
	DATE/TIME OF ENDING	3/8:00P	3/9:00P	3/10:00P	4/1:00A	6/9:00P	7/1:00A	
ROANOKE WSO AP	AMOUNT	.25	.44	.64	1.18	1.64	1.72	
	DATE/TIME OF ENDING	6/12:00A	6/1:00P	6/2:00P	6/5:00P	6/8:00P	6/10:00P	
ROCKY MOUNT	AMOUNT	.5	.6	.8	1.2	2.0	2.3	
	DATE/TIME OF ENDING	3/5:00P+	10/9:00P+	10/9:00P+	6/7:00P+	6/8:00P+	6/10:00P	

HOURLY PRECIPITATION

HOURLY AMOUNTS

VIRGINIA
SEPTEMBER 1974

STATION	DATE	A.M. 1	A.M. 2	A.M. 3	A.M. 4	A.M. 5	A.M. 6	A.M. 7	A.M. 8	A.M. 9	A.M. 10	A.M. 11	A.M. 12	P.M. 1	P.M. 2	P.M. 3	P.M. 4	P.M. 5	P.M. 6	P.M. 7	P.M. 8	P.M. 9	P.M. 10	P.M. 11	P.M. 12	TOTAL
MOUNT WEATHER	7	.1		.1		.1																				.3
	11						.1		.1																	.2
	13																							.1	.1	.2
	14	.1																								.1
	21															.4										.4
	28									.1																.1
NORFOLK WSO AP	2															.13	.01	.10	.07	.16	.17					.64
	3																								.13	.13
	4									.01		.01	.03	.01												.06
	6		.04	.36	.45	.01	.10	.01	.02	.02	.06	.01		.01		.05	.11		.10	.11	.13	.25	.28	.01		2.13
	7	.02						.01			.04	.04	.03	.01	.04											.19
	17																.01	.04	.03	.01						.09
	20														.01											.01
	21																						.28		.12	.40
	22	.13	.10	.03	.11	.04		.08	.01		.03															.53
	28									.01																.01
	29															.21										.21
NORTH GARDEN	2																			.1	.2	.3				.6
	3																	.2			.1					.3
	6								.1	.1	.1		.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2		.1	2.1
	7			.1																						.1
	10																						.1	.7		.8
	28		.1				.1																			.2
PAINTER 2 W	4	.2	.5																							.7
	6								.1						.1						.1			.1	.1	.5
	7	.2	.1	.1	.1	.1					.1			.1			.1									.9
	21																						.2			.2
	22																.1									.1
	28																							.1		.1
	29																.1									.1
PHILPOTT DAM 2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	22	-																								-
	27																							.1		.1
PIEDMONT RESEARCH STA	2																			.1	.1	.4	.3			.9
	3	.1						.1										1.0	.5	.2						1.9
	4			.1																						.1
	6									.1			.1		.1	.1	.1	.1	.2	.2	.2	.2	.2	.1	.1	1.8
	7		.1																							.1
	10																							.1	.1	.2
	11		.1																							.1
	13											.1														.1
	28					.1		.1	.3																	.5

MONTHLY MAXIMUM AMOUNTS

(Apply heading as appropriate)

STATION	HOURS / MINUTES	1 / 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
MOUNT WEATHER	AMOUNT	.4	.6	.9	1.0	1.0	1.6	
	DATE/TIME OF ENDING	21/3:00P+	3/7:00P+	3/7:00P	3/8:00P	3/8:00P	3/8:00P	
	AMOUNT	.2	.3	.4	.4	.8	1.0	
	DATE/TIME OF ENDING	21/2:45P+	21/3:00P+	21/3:00P+	21/3:00P+	3/6:45P+	3/7:30P	
NORFOLK WSO AP	AMOUNT	.45	.81	.85	.97	1.09	2.15	
	DATE/TIME OF ENDING	6/4:00A	6/4:00A	6/4:00A	6/7:00A	6/1:00P	7/1:00A	
NORTH GARDEN	AMOUNT	.7	.8	.8	1.2	1.7	2.2	
	DATE/TIME OF ENDING	10/11:00P	10/11:00P	10/11:00P	6/10:00P	6/12:00P+	7/3:00A	
	AMOUNT	.2	.4	.6	.7	.8	.8	
	DATE/TIME OF ENDING	10/10:45P+	10/10:45P+	10/10:45P	10/11:00P	10/11:00P	10/11:00P	
PAINTER 2 W	AMOUNT	.5	.7	.7	.7	.9	1.2	
	DATE/TIME OF ENDING	4/2:00A	4/2:00A	4/2:00A	7/5:00A+	7/10:00A+	7/4:00P+	
	AMOUNT	.3	.5	.6	.6	.7	.7	
	DATE/TIME OF ENDING	4/1:15A	4/1:15A	4/1:30A	4/1:30A	4/2:00A	4/2:00A	
PHILPOTT DAM 2	AMOUNT	-	-	-	-	-	-	
	DATE/TIME OF ENDING							
	AMOUNT	-	-	-	-	-	-	
	DATE/TIME OF ENDING							

HOURLY PRECIPITATION

HOURLY AMOUNTS

VIRGINIA
SEPTEMBER 1974

STATION	DATE	A.M. Hour Ending 1	2	3	4	5	6	7	8	9	10	11	12	P.M. Hour Ending 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
COVINGTON FILTER PLT	1											.2			.1	.1										.4
	2																.2	.1								.3
	3																		.1							.1
	6											.1		.2	.1	.1	.2		.1	.1			.1			1.0
	17																				.1					.1
	21								.1																	.1
	27																				.1		.2			.3
	28								.1																	.1
DAVENPORT 2 NE	1										.12	.15				.01	.04									.32
	3												.17	.03	.10											.30
	6							.01	.02	.01	.02	.02	.04	.05	.04	.02	.02	.01	.02	.01		.01	.01			.31
	7			.01																						.01
	9																			.57		.01				.58
	10															.06	.56	.01	.01							.64
	12																		.01	.06	.04	.03				.14
	13																		.05	.01						.06
	21						.02	.10	.07		.03						.05	.01		.01	.01	.01				.31
	27																-	-	-	-	-	-	-	-	-	-
	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ELKWOOD 6 SE	2																					.1	.2	.1	.1	.5
	3									.1									1.0	.2	.1					1.4
	6							.1	.1			.1		.1		.1	.1		.2	.1	.2	[illegible]	.1	.2	.2	1.8
	7	.1		.1																						.2
	11				.8																					.8
	14												.1													.1
	28										.8	.2	.1													1.1
FREDERICKSBURG NATL PK	2																							.1	.1	.2
	3	.1																	.1	1.2	.1	.1	.1			1.7
	4				.1																					.1
	6					.1	.1		.1		.1				.1	.1	.2	.1	.2	.2	.2	.2	.2	.2	.2	2.3
	7	.1	.1			.1																				.3
	11			.1	.4																					.5
	28										.1	.2		.1												.4
GALAX WATER PLANT	3													.6		.4	.1	.1								1.2
	6				.1	.1	.3	.3	.3	.2	.1	.1	.1	.1	.1	.1	.1	.1								2.1
	10																			.6	.1	.1				.8
	12																					.1				.1
	17											.1		.1	.1											.3
	27																						.2	.7	.2	1.1
	28			.1					.1																	.2

MONTHLY MAXIMUM AMOUNTS

(Apply heading as appropriate)

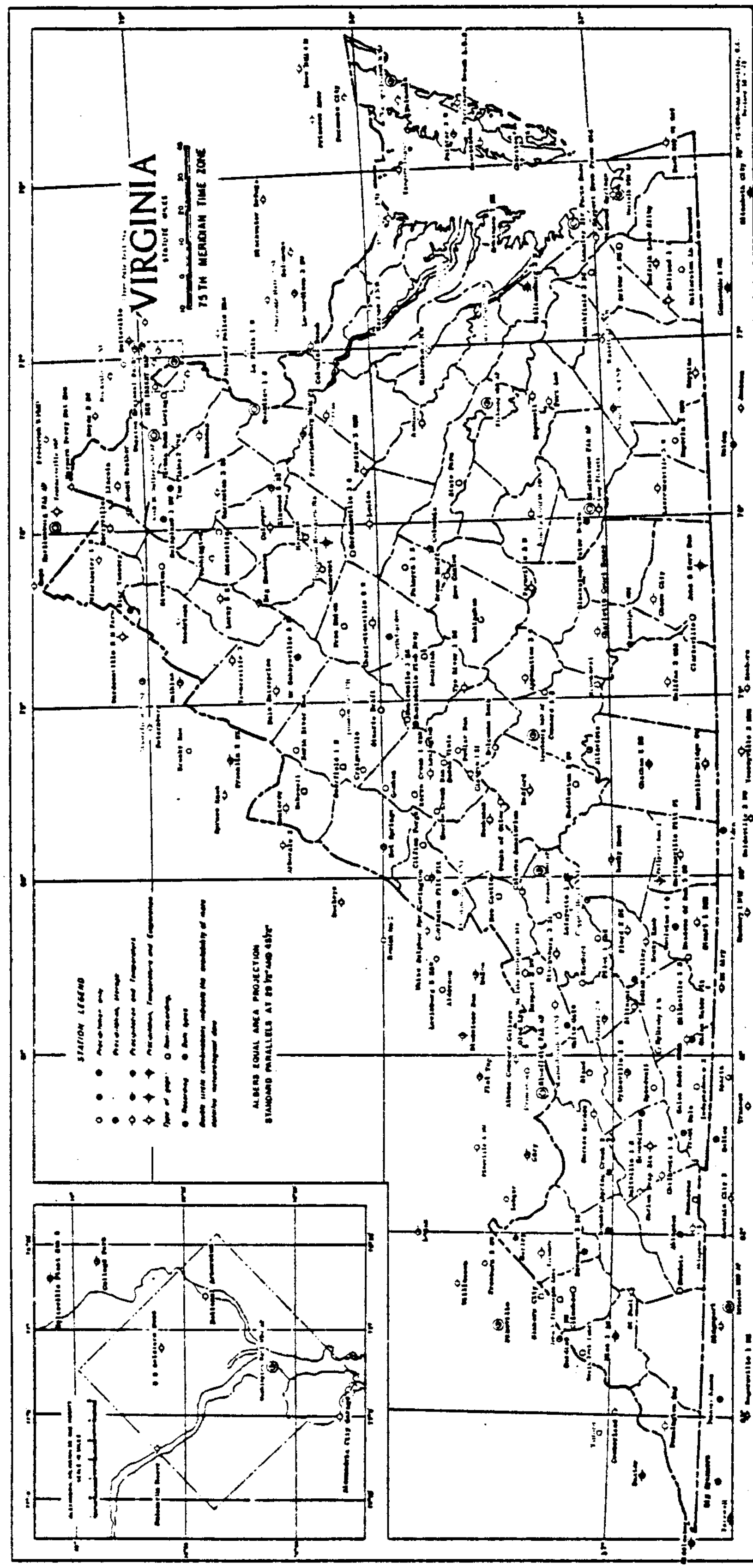
STATION		HOURS 1 / MINUTES 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
COLUMBIA	AMOUNT	-	-	-	-	-	-	
	DATE/TIME OF ENDING							
COVINGTON FILTER PLT	AMOUNT	.2	.3	.4	.7	1.0	1.0	
	DATE/TIME OF ENDING	27/10:00P+	6/4:00P+	6/4:00P+	6/6:00P+	6/10:00P	6/10:00P	
	AMOUNT	.2	.2	.2	.2	.3	.4	
	DATE/TIME OF ENDING	2/3:15P	2/3:15P+	27/9:45P+	27/9:45P+	27/9:45P+	6/5:15P+	
DAVENPORT 2 NE	AMOUNT	-	-	-	-	-	-	
	DATE/TIME OF ENDING							
ELKWOOD 6 SE	AMOUNT	1.0	1.2	1.3	1.3	1.5	2.0	
	DATE/TIME OF ENDING	3/6:00P	3/7:00P	3/8:00P	3/8:00P	7/3:00A+	7/3:00A	
	AMOUNT	.5	.8	.9	1.0	1.2	1.3	
	DATE/TIME OF ENDING	3/5:15P	3/5:30P	3/5:45P	3/6:00P	3/7:00P	3/7:45P	
FREDERICKSBURG NATL PK	AMOUNT	1.2	1.3	1.4	1.6	2.0	2.5	
	DATE/TIME OF ENDING	3/7:00P	3/8:00P+	3/9:00P+	3/10:00P	7/2:00A+	7/5:00A+	
	AMOUNT	.5	.8	1.1	1.2	1.4	1.5	
	DATE/TIME OF ENDING	3/6:15P	3/6:30P	3/6:45P	3/7:00P+	3/7:15P	3/8:15P	
GALAX WATER PLANT	AMOUNT	.7	.9	1.1	1.3	1.9	2.1	
	DATE/TIME OF ENDING	27/11:00P	27/12:00P+	27/12:00P	6/11:00A+	6/5:00P+	6/5:00P	

HOURLY PRECIPITATION

HOURLY AMOUNTS

VIRGINIA
SEPTEMBER 1974

STATION	DATE	A. M. Hour Ending												P. M. Hour Ending												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
		MONTHLY MAXIMUM AMOUNTS																								
			HOURS			1			2			3			6			12			24			ACCUMULATION		
			MINUTES			15			30			45			60			120			180					
		(Apply heading as appropriate)																								
ABINGDON	1								.01	.09	.13	.07							.08	.04	.03	.01				.46
	2																		.12	.04						.16
	3									.10			.05	.35		.01			.01		.01					.53
	6					.02	.01	.02	.07	.03	.08	.08	.06	.14	.12	.03	.04	.01								.71
	9																					.02	.01			.03
	13																	.05								.05
	17					.02		.01		.01	.07	.01	.01													.13
	21						.20	.16	.14	.04	.03	.11	.11	.03	.07											.89
	27																	.18	.01		.01					.20
	29				.05	.02																				.07
			AMOUNT			.35			.40			.30			.68			.89			.89					
			DATE/TIME OF ENDING			3/1:00P			3/1:00P			21/8:00A			21/11:00A			21/2:00P			21/2:00P					
ALTAVISTA	1																.92	.11								1.03
	2																		.09	.14						.23
	3																	.60	.14	.02						.76
	4		.04																							.04
	6			.01	.03	.01	.02	.03	.09	.09	.23	.28	.30	.35	.25	.30	.52	.53	.43	.34	.13	.08	.02	.04	.06	4.14
	7	.04	.01		.01																					.06
	10																					.11	.04			.15
	27																							.02		.02
	28				.02																					.02
			AMOUNT			.92			1.05			1.48			2.38			3.75			4.19					
			DATE/TIME OF ENDING			1/4:00P			6/5:00P			6/6:00P			6/6:00P			6/8:00P			7/2:00A					
BIG MEADOWS	2																				.1	.1	.1			.3
	3																.2	.2	.2		.1					.7
	6											.1	.1	.1		.2	.1	.1	.1	.1	.1	.1	.1		.1	1.3
	7	.1		.1																						.2
	11		.2	.1																						.3
	28									.1																.1
			AMOUNT			.2			.4			.6			.7			1.2			1.5					
			DATE/TIME OF ENDING			11/2:00A+			3/6:00P+			3/6:00P			6/8:00P+			6/10:00P			7/3:00A					
			AMOUNT			.2			.3			.4			.4			.5			.6					
			DATE/TIME OF ENDING			11/2:00A+			3/4:15P			3/4:15P			3/4:15P			3/5:45P+			3/5:45P					
CAMP PICKETT	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-																			-
	6					.1		.1	.1	.1		.1	.1	.1	.1	.2	.2				1.0	.1	.2	-	-	-
	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			AMOUNT			-			-			-			-			-			-					
			DATE/TIME OF ENDING																							
			AMOUNT			-			-			-			-			-			-					
			DATE/TIME OF ENDING																							
CHATHAM	1																	1.0	.1	.1						1.2
	2																		.1							.1
	3																			.5						.5
	4					.5	.1																			.6
	6				.1				.1	.1	.3	.3	.3	.2	.3	.2	.6	.4	.5	.4	.1	.1		.1		4.1
	7				.1																					.1
	11														.1											.1
	22		.1																							.1
	28				.3	.1									.1											.5
			AMOUNT			1.0			1.1			1.5			2.4			3.7			4.1					
			DATE/TIME OF ENDING			1/5:00P			1/6:00P			6/6:00P			6/7:00P			6/9:00P+			7/4:00A+					
			AMOUNT			.5			.8			1.0			1.1			1.1			1.5					
			DATE/TIME OF ENDING			4/4:15A+			1/4:45P			1/5:00P			1/5:15P			1/5:15P			6/6:30P+					
COLUMBIA	1																			.1						.1
	2																					.4	.7			1.1
	3																		.3	.2	.1					.6
	6						.1			.1	.1		.2	.2	.2	.2	.2	.3	.2	.3	.4	.2	.3	.2		3.2
	7	.1			.1																					.2
	28	-	-	-	-	-	-	-	-	-	-	-	-	-												-
			AMOUNT			-			-			-			-			-			-					
			DATE/TIME OF ENDING																							


VIRGINIA
75TH MERIDIAN TIME ZONE
STATION LEGEND
ALBERS EQUAL AREA PROJECTION
Data for non-recording stations shown on this map may be found in the publication Climatological Data.

N02FA110

DAILY PRECIPITATION

VIRGINIA
APRIL 1979

Station	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
TIDEWATER 01																																
BACK BAY WL REF	3.44	.77			.18				.80		.05															.19		1.45				
BOHANNON 1 NE	4.47	.17	.38		.19			T	1.26																.03	.22	1.02	1.16	.04			
BOYKINS	3.58	.50	.10		.27				1.28																	.23	.07	1.01				
BURGESS 1 ESE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CHERITON	3.59	*	1.00	T	.24			*	.81		.18														T	.26	.22	.82				
CHINCOTEAGUE WL REF	3.53		.41		.19				1.50		.45															.14	.79		.05			
COLONIAL BEACH	3.95	.32	.09		.33				1.09		.38		.11														.78	.82	.03			
DIAMOND SPRINGS	4.42	.92	.37			.20			1.06		.22														T		.55	.67	.43			
DRIVER 4 NE	3.66	.37	.10		.52			.10	.80		.20															.64	.21	.72				
EMPORIA 1 WNW	4.27	.55	.35	T	.02	.10			1.42	T																	.81	.91	.11			
FORT LEE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
FREDERICKSBURG NATL PK	4.96	.18	.05		.58			T	1.06		.30		.17													.36	.42	1.84	T		T	
HOLLAND 1 E	4.43	.82	.55		.05	.44			.89																		.62	.81	.25			
HOPEWELL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
LANGLEY AIR FORCE BASE	3.37	.30	T		.66			.63	.25		.38		T													.19	.27	.69				
NASSAWADOX	4.15	.16	.32	.02	.40			.04	1.08		.28		T												.12	.30	.40	.98	.05			
NELSONIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
NEWPORT NEWS PRESS BLD.	-	.26	.10		.50			.18	.60		.30															.36	.18	-				
NORFOLK WSO AP	3.44	.31			.22			.47	.41	T	.14														T	.36	.16	1.37				
PAINTER 2 W	4.59	.40	.02		.45				1.32		.20														.04	.15	.77	1.19	.05			
PARRAMORE BEACH L B S	-	.25	.15		.15				-		.20															.15	-	-	-			
QUANTICO 1 S	4.58	.26			.70			.46	.58		.26	T	.16						.01					T	T	.68	.11	1.34	T		T	
SMITHFIELD 3 NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
STONY CREEK 4 SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SUFFOLK LAKE KILBY	3.34	.42			.36			.60	.23		.28															.39	.25	.81			T	
TANGIER ISLAND	3.89	.28	.40		.06				1.72	T	.02		T												.12	.19	.34	.72	.04			
URBANNA	3.94	.08	.09		.12			.07	1.40		.07		T													.40	.62	1.07	.02			
WAKEFIELD 1 NW	3.43	.10			.17				1.28																	.70	.18	1.00				
WALKERTON 2 NW	4.74	.12	.10		.17	T		.27	1.04	T	.07	T	T												.18	.65	1.07	1.04	.03			
WALLACETON LK DRUMMOND	5.50	1.62	.40			.80			1.08		.20																.42	.64	.24			
WALLOPS ISLAND WSO	4.41	.24	.03		.13			.69	.93		.38	T	T												.05	.66	.40	.87	.03			
WARSAW 2 NW	4.44	.10	.25		.35			.03	1.20		.24		.02												.03	.41	.68	1.01	.12		T	
WEST POINT 2 SW	3.89	.05	.08		.09			.11	1.45		.24		T												T	.40	.60	.86	.01			
WILLIAMSBURG 2 N	3.42	.15	.10		.23			.06	1.17		.10		T												T	.32	.41	.88			T	
EASTERN PIEDMONT 02																																
AMELIA COURT HOUSE	6.66	.54	.41						1.37		.35																1.99	1.87	.13			
ASHLAND	4.41	.02	.10		.37	.02		.10	.98		.28		T												.03	.73	.45	1.31			T	
BREMO BLUFF	5.31		.10			.36			1.08		.66													.01		.68	.74	1.44	.24			
BUCKINGHAM	5.71	.45	.26		T	.43			1.09	T	.57			T											.01	.20	.95	1.33	.42			
CAMP PICKETT	5.39	.35	.09			.17			1.21	.02	.08																1.50	1.67	.30			
CHASE CITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLARKSVILLE	5.28	.67			.04	.02			1.15		.37																.76	2.00	.27			
COLUMBIA	6.38	.66	.24		.11	.32			1.13	T	.55			.01												.40	1.18	1.46	.32			
CORBIN	5.04	.38	.37			.62			1.20	.02	.37	T		.15					T							.05	.67	1.11	.10			
FARMVILLE 2 N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GORDONSVILLE 3 S	6.35	.53	.14						.94	.02	.63			.16										T		.63	1.55	1.44	.31			
JOHN H KERR DAM	4.90	.82	.01		.01	.02			1.18	.01																	.89	1.79	.23			
LAWRENCEVILLE 5 W	5.80	.17	.48		.04			.29	1.09		.30															.73	.63	1.87				
LOUISA	6.10	.33	T		.64	T		.08	.97		.81		.11	-											T	1.13	.28	1.75	T		T	
NEW CANTON	4.23	.30			.38				1.05		.09															.63	1.58					
PALMYRA 1 E	5.79	.50	.02			.62			1.01	.03	.44	T		.15											.02	.59	.77	1.33	.31			
PARTLOW 3 WNW	6.80	.80	.15		.60				1.30		*	*	.65													.90	.40	2.00				
RICHMOND WSO AP R	4.58	.32			.18			.96	.31		.19		T											T	T	1.20	.21	1.21			T	
STATE FARM	5.55	.37	.22			.24			1.20	.02	.39														.02	.22	.93	1.81	.13			
WESTERN PIEDMONT 03																																
ALTAVISTA	5.83	.58	.32		.20	.22			.85	T	.53			T												.44	1.28	1.38	.03			
APPOMATTOX 3 W	6.32	.65	.52		.11	.28			.92		.76			T											T	T	1.68	1.25	.15			
BEDFORD	4.37	.65	.24	.03	.15	.34			.67	T	.33																.62	1.34				
BROOKNEAL	6.21	.48	.67		.03	.51			1.27		.20			T				T	T						.08	.01	1.44	1.33	.21			
CHARLOTTE COURT HOUSE	4.76	.48	.30		.04	.12			1.06		.06														.01	.03	.93	1.61	.10			
CHARLOTTESVILLE 2 W	5.41	.52	.42		.09	.54	T		.92	T	.43	T	.01	.18			T	T	T						T	.44	.62	1.13	.11			
CHATHAM 2 NE	5.02	.47	.09		.16	.30			1.02	.04	.31										.03					.19	.89	1.47	.05			
CONCORD 5 S	6.17	.78	.17		T	.57			.92	T	.83								T								1.64	1.33	.13			
DANVILLE-BRIDGE ST	4.26	.70	.03		.01	.06			.97	.08	.10															.12	.24	1.78	.17			
FREE UNION	5.52	.56	.24			.76			.91		.46			.16				.10								.20	.87	.92	.34			
HALIFAX 2 SSE	4.46	*	.81			.16			1.13		.09																.84	1.52	.21			
HOLCOMBS ROCK	4.83	*	1.15		T	.53			.24	.05	.41	.02		.05												T	.79	1.34	.25			
HUDDLESTON 2 SW	6.18	.57	.59		.04	.30			.82	.03	.61			.02					.01	T							1.42	1.55	.22		.08	
LYNCHBURG WSO AP R	4.57	.21			.38			.74	.05	.64	T		.02					T	T							.78	.91	.76				
MARTINSVILLE FILT PL	5.43	.67	.23		.09	.33		*	.82	.06	.55															*	.79	1.66	.23			
MEADOWS OF DAN 5 SW	4.97	1.24	.16		.17	.31			.83	.02	.33								.14	.03							.50	.99	.25			
MONTEBELLO 3 NE	5.50	.51	.65			.52			.94	.06	.46			.16													.70	.97	.53			
PEDLAR DAM	5.54	.52	.80		T	.62			1.08	.05	.32			.08					T	T					T	T	.80	.96	.31			
PHILPOT DAM 2	5.35	.57	.24		.22	.18			.80	.06	.46								.01	.02	T					.03	.64	2.00	.12			
RANDOLPH 5 NNE	5.17	.62	.47		.08				1.10		.09																.90	1.77	.14			
ROCKFISH	6.61	.99	.39			.76			1.08	T	.59			.10												.35	1.20	1.19	.38			
ROCKY MOUNT	6.23	.35	.35		T	.63			.94	.07	.27						T	T	.04	.03					.08	T	1.67	1.60	.20			
STUART 1 SSE	4.33	.04	T		.48			.53	.36		.39						.02	.03	.02							.29	.33	1.67	.01			
TYE RIVER 1 SE	5.68	.42	.35		.04	.75			.97	.06	.35			.05												.18	.91	1.05	.35			
WOOLWINE 4 S	5.84	.68	.44		.40	.24				.10	.42						T	.07	.04	T							1.12	2.05	.28			
NORTHERN 04																																
ALEXANDRIA CITY GARAGE	5.59	.55	.70			.85			.67	.12	.25	T		.10				.03			.04				T	T	1.07	.68	.53			
AMISSVILLE	5.18	.46	.31			.66			.48	.14	.48			.15				T									1.23	1.10	.15			
BERRYVILLE	6.46	.68	.75		.67				.83		.23		.15				.15	.12						.27	.22	.87	.61	.87	.04			
BIG MEADOWS	4.92		.61		T	.42			.85	.13	.32	.05		.35			.01								.15	.13	.95	.83	.10			
CULPEPER	6.56	1.34	.01		.61	T		T	.94		.45	T	.21				T	.09							.02	1.00	.45	1.47	.01		T	
ELKWOOD 6 SE	5.58	.31	.02		.67			T	1.11	.01	.31		.16				T	.01							.03	.65	.37	1.72	.01			
GROVETON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
LINCOLN	-	-	-		-				.76		.36		.18											*	*	1.87	.77	.28				
LURAY 3 E	4.14	.11	.56		.01	.52			.75	.01	.28	T		.18			.07	.08							.05	.05	.79	.30	.18			
MANASSAS	-	1.64	.10		-			.13	.61		-		T				T									.73	.86	1.85			.05	
MOUNT WEATHER	7.29	.84	1.40		T	.60			.80	.07	.38			.16			.02	.19							.22	.10	1.36	.85	.30			
PIEDMONT RESEARCH STA	6.22	.50	.12			.76			1.01	.02	.50	.01		.18												.47	1.10	1.27	.28			
RAPIDAN	6.64	.62	.24			.72			1.00	.02	.42			.17				T							T	.03	1.72	1.37	.31			
RIVERTON	5.43	.41	1.20		*	*	*	*	1.24		.22			.30			.09	.45							.11	*	.57	.62	.26			
SOMERSET	6.43	.58	.48			.61			.95	.03	.54	T		.15				.14		T					T	.22	1.20	1.23	.28			
THE PLAINS 2 NNE	5.85	.46	.64		.01	.76			.57	.15	.58			.11											.05	T	1.32	.73	.47			
VIENNA DUNN LORING	6.47	.77	.18		.98				.80		.39		.12					.02							.08	.76	.88	1.40	.05			
WARRENTON 3 SE	6.12	.50	.87			.63			.58	.01	.64			.17				.05			.02			T	.03	.14	1.12	1.02	.36		.02	
WASHINGTON	4.53		.68			.60			.29	T	*	*	*	.44				.06							.03	T	1.15	.95	.33			
WASH. DULLES WSO AP	7.35	1.64	.09		.75			.16	.53	.32	.48	T	.13				T	.01		T				.32	.02	1.34	.20	1.69	.01		T	
WASH. NATIONAL WSO AP R	4.19	.30	T	T	.88			.20	.39		.20		.11					.02		T				T	T	.68	.44	.77	T		T	
WINCHESTER 1 N	6.94	.33	1.37		.05	.57			.70		.46	T		.24			.21	.29							.25	.29	1.23	.67	.28			

See reference notes following Station Index.

HOURLY PRECIPITATION

HOURLY AMOUNTS

VIRGINIA APRIL 1973

STATION	DATE	A.M. Hour Ending 1	2	3	4	5	6	7	8	9	10	11	12	P.M. Hour Ending 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL

MONTHLY MAXIMUM AMOUNTS

HOURS	1	2	3	6	12	24	ACCUMULATION
MINUTES	15	30	45	60	120	180	

(Apply heading as appropriate)

CHATHAM 2 NE

	1 / 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
AMOUNT DATE/TIME OF ENDING	-	-	-	-	-	-	

COLUMBIA

STATION	DATE	AM 1	2	3	4	5	6	7	8	9	10	11	12	PM 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
COLUMBIA	1											.1							.1							.2
	4								.1	.1	.2	.1														.5
	7																.1		.1	.1		.1	.2	.1	.2	.9
	8	.2					.1																			.3
	9																								.3	.3
	10	.2																								.2
	12												.1													.1
	25				.3					.1	.1	.2	.1	.1		.1				.1			.1	.3		1.5
	26				.1																					.1
	27	.2	.2	.2	.2	.4	.2			.2	.1															1.7
	30																	.1								.1

	1 / 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
AMOUNT	.4	.6	.8	1.4	1.7	1.7	
DATE/TIME OF ENDING	27/5:00A	27/6:00A+	27/6:00A+	27/6:00A	27/10:00A	27/10:00A	
AMOUNT	.3	.5	.5	.5	.7	.8	
DATE/TIME OF ENDING	9/12:00P	10/0:15A	10/0:15A	10/0:15A	27/5:30A	27/6:00A+	

COVINGTON FILTER PLT

STATION	DATE	AM 1	2	3	4	5	6	7	8	9	10	11	12	PM 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
COVINGTON FILTER PLT	1								-	-	-	-	-	-	-	-	-									-
	4										.2															.2
	7															.1	.1	.1			.1		.1	.2	.1	.8
	8		.1							.1																.2
	9																					.1	.2			.3
	10										.1															.1
	12													.1												.1
	17			.1		.1	.1		.1	.1		.1														.6
	18												.1													.1
	25												.1			.1		.1		.2	.1			.2		.8
	26																							.1	.1	.2
	27	.1	.1				.1		.1		.1		.1													.6
	30																.2	.1	.1	.1	.1					.6

	1 / 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
AMOUNT DATE/TIME OF ENDING	-	-	-	-	-	-	
AMOUNT DATE/TIME OF ENDING	-	-	-	-	-	-	

DAVENPORT 2 NE

STATION	DATE	AM 1	2	3	4	5	6	7	8	9	10	11	12	PM 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
DAVENPORT 2 NE	1		.10	.21	.01				.01		.01	.01			.03	.01										.39
	4				.01	.09	.07	.08	.02	.02	.01	.03														.33
	5							.01	.04																	.05
	7										.01	.03	.01	.04	.09	.01					.08	.01	.02			.30
	8		.01			.01	.01	.01																		.04
	9										.01	.01	.01	.01	.01				.11	.02	.01		.01			.20
	10								.01	.04	.01	.02	.02													.10
	16													.01	.01	.01	.01	.01								.05
	17	.02	.01	.01	.01	.05	.05	.04	.06	.03	.02	.01	.02	.02			.01	.01								.37
	18								.07	.06	.01	.02														.16
	23																						.17	.03	.02	.22
	24		.02					.01	.01	.01																.05
	25				.02			.01	.06	.01	.01	.01				.04	.02						.03	.01	.01	.28
	26	.01	.01					.01												.12	.03	.12	.12	.24	.14	.80
	27	.14	.05	.13	.03	.07	.02	.11	.02	.02	.01	.05	.03	.06	.08	.08	.06	.04	.01	.04		.01	.03	.04	.03	1.16
	28	.04	.05		.01		.01																			.11

	1 / 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
AMOUNT	.24	.38	.52	.82	1.21	1.78	
DATE/TIME OF ENDING	26/11:00P	26/12:00P	27/1:00A	27/3:00A	27/6:00A	27/6:00P	

ELKWOOD 6 SE

STATION	DATE	AM 1	2	3	4	5	6	7	8	9	10	11	12	PM 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
ELKWOOD 6 SE	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	1 / 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
AMOUNT DATE/TIME OF ENDING	-	-	-	-	-	-	
AMOUNT DATE/TIME OF ENDING	-	-	-	-	-	-	

FREDERICKSBURG NATL PK

STATION	DATE	AM 1	2	3	4	5	6	7	8	9	10	11	12	PM 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
FREDERICKSBURG NATL PK	1	.1																								.1
	2							.3			.1															.4
	4									.1		.1	.3													.5
	7																			.1	.1	.1	.1	.1	.1	.6
	8	.1	.2	.1					.1																	.5
	10		.2	.1																						.3
	12													.1												.1
	25							.1				.1	.1				.1							.1	.2	.7
	26		.1																							.1
	27			.2	.2	.2	.4	.5	.1	.1			.1													1.8

HOURLY PRECIPITATION

HOURLY AMOUNTS

VIRGINIA
APRIL 1973

STATION	DATE	A.M. 1	2	3	4	5	6	7	8	9	10	11	12	P.M. 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
PAINTER 2 W	8	.1	.2	.1	.1	.1																				.6
	10				.1	.1																				.2
	24		.1																							.1
	25														.1											.1
	26	.3							.1		.3															.7
	27				.2	.1	.1	.1						.6	.1											1.2
PHILPOT DAM 2	1								.3																	.3
	4								.1	.2	.1				.1											.5
	7																.1	.1	.1	.1		.1	.1	.1	.1	.8
	8													.1												.1
	9																						.3	.1	.1	.5
	19																			.1						.1
	25																				.1	.2				.3
	26		.1			.2																.2	.1	.1	.4	1.1
	27	.2	.2	.1	.1	.2	.2	.2		.1	.1															1.4
PIEDMONT RESEARCH STA	1		.1																							.1
	4								.1		.3	.3		.1												.8
	7																			.1	.2	.1	.1	.2	.2	.9
	8		.1																							.1
	9																							.1	.3	.4
	10	.1																								.1
	12												.1	.1												.2
	25						.2		.3	.3	.2	.1	.1			.1						.1	.1	.1		1.6
	26												.1													.1
	27		.3	.1	.2	.3	.3		.1	.1	.1															1.5
PULASKI 2 E	1							.3	.1																	.4
	4								.1																	.1
	7														.1	.1	.1			.1		.1	.2	.1	.1	.9
	8		.1																							.1
	9																				.1	.2				.3
	12									.1																.1
	17			.1			.1			.1					.1											.4
	19												.1													.1
	25									.4								.1	.4	.1			.1			1.1
	26																	.3				.2	.2	.2	.2	1.1
	27	.1	.1	.1	.1	.1			.1	.3	.1															1.0
	30																							.1		.1
RANDOLPH 5 NNE	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-															-
	7																.1	.1	.1	.1			.1	.2	.1	.8
	8	.2																								.2
	25									.2	.1	.1								.1						.5
	26		.1				.2	.1																	.3	.7
	27	.4	.1	.1	.4	.2			.1						.1											1.4

MONTHLY MAXIMUM AMOUNTS

(Apply heading as appropriate)

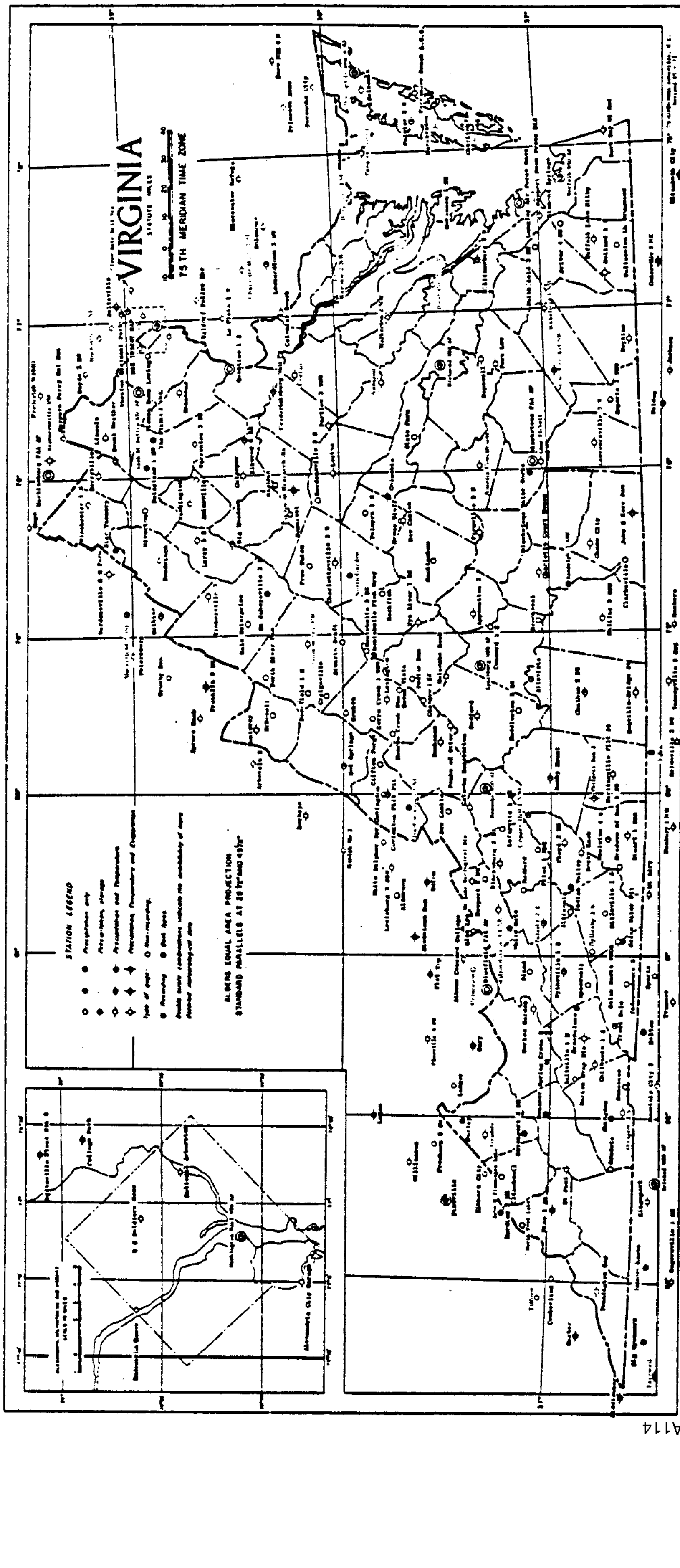
STATION		HOURS 1 / MINUTES 15	HOURS 2 / MINUTES 30	HOURS 3 / MINUTES 45	HOURS 6 / MINUTES 60	HOURS 12 / MINUTES 120	HOURS 24 / MINUTES 180	ACCUMULATION
PAINTER 2 W	AMOUNT	.6	.7	.7	1.0	1.3	1.3	
	DATE/TIME OF ENDING	27/1:00P	27/2:00P	27/2:00P	8/3:00A	8/5:00A	8/5:00A	
	AMOUNT	.4	.6	.6	.6	.7	.7	
	DATE/TIME OF ENDING	27/0:30P	27/0:45P	27/0:45P	27/0:45P	27/1:45P	27/1:45P	
PHILPOT DAM 2	AMOUNT	.4	.6	.8	1.2	2.0	2.2	
	DATE/TIME OF ENDING	26/12:00P	27/1:00A	27/2:00A	27/5:00A+	27/7:00A	27/10:00A	
	AMOUNT	.2	.3	.3	.4	.7	.9	
	DATE/TIME OF ENDING	26/9:00P+	9/9:45P	27/0:15A+	27/0:15A+	27/0:45A	27/1:45A	
PIEDMONT RESEARCH STA	AMOUNT	.3	.6	.8	1.2	1.5	1.6	
	DATE/TIME OF ENDING	27/6:00A+	27/6:00A+	27/6:00A+	27/6:00A	27/10:00A	27/10:00A+	
	AMOUNT	.2	.3	.3	.4	.6	.8	ACC. .1
	DATE/TIME OF ENDING	9/11:15P	9/11:30P	27/5:45A+	27/5:45A+	27/5:45A+	27/5:45A+	1/2:00A
PULASKI 2 E	AMOUNT	.4	.5	.6	1.0	1.5	2.1	
	DATE/TIME OF ENDING	25/6:00P+	25/7:00P+	26/12:00P+	27/2:00A	27/9:00A+	27/10:00A	
	AMOUNT	.3	.3	.4	.5	.6	.7	
	DATE/TIME OF ENDING	25/8:15A	26/4:45P+	25/6:15P+	25/6:15P	25/6:15P	26/11:45P+	
RANDOLPH 5 NNE	AMOUNT	-	-	-	-	-	-	
	DATE/TIME OF ENDING							

HOURLY PRECIPITATION

HOURLY AMOUNTS

VIRGINIA
APRIL 1975

STATION	DATE	A. M. Hour Ending												P. M. Hour Ending												
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
		MONTHLY MAXIMUM AMOUNTS																								
		HOURS			1			2			3			6			12			24			ACCUMULATION			
		MINUTES			15			30			45			60			120			180						
		(Apply heading as appropriate)																								
RANDOLPH 5 NNE		AMOUNT DATE/TIME OF ENDING			-			-			-			-			-			-						
RICHMOND WSO AP	1																	.22			.04	.03		.01	.02	.32
	4										.04	.01	.04	.07	.02											.18
	7																.03	.06	.03	.07	.17	.09	.17	.14	.20	.96
	8	.06	.23	.01				.01																		.31
	10		.19																							.19
	25				.05							.22	.25	.07	.10	.06						.24	.18		.03	1.20
	26	.08	.03	.01					.09																	.21
	27	.01	.30	.28	.19	.11	.03	.01	.10	.06	.01		.01			.03	.07									1.21
		AMOUNT			.30			.58			.77			.92			1.26			1.36						
		DATE/TIME OF ENDING			27/2:00A			27/3:00A			27/4:00A			27/7:00A+			8/3:00A			26/8:00A						
ROANOKE WSO AP	1									.01	.01						.82									.86
	4								.02	.06	.10	.02														.20
	7														.02	.13	.05	.03	.07	.06	.03	.07	.12	.12	.04	.74
	8	.14	.05		.02	.01		.02		.03	.02	.01			.01											.31
	9																					.02	.06	.02		.10
	12								.02																	.02
	17						.03	.03	.05	.07	.01				.01	.01										.21
	19						.04																			.04
	25							.14	.01	.02	.01				.10	.03	.05	.07	.12	.21	.09	.04	.03	.11	.12	1.15
	26	.01	.02	.01	.02																		.03	.11	.30	.50
	27	.28	.11	.08	.14	.13	.12	.20		.04	.11	.05	.01			.01										1.28
		AMOUNT			.82			.82			.82			1.04			1.62			1.72						
		DATE/TIME OF ENDING			1/4:00P			1/4:00P			1/4:00P			27/5:00A			27/10:00A			27/3:00P						
ROCKY MOUNT	1								.1	.1			.1					.2								.5
	4							.1	.3	.2								.1								.7
	7														.1	.1		.1		.2	.1	.1	.1		.1	.9
	8														.1											.1
	9																					.1	.1			.2
	19										.1															.1
	25									.1										.3	.6					1.0
	26	.1	.1		.4						.1												.1	.2	.4	1.4
	27	.2		.1	.1	.2	.1	.1		.1																.9
	28												.1													.1
		AMOUNT			.6			.9			.9			1.0			1.6			1.7						
		DATE/TIME OF ENDING			25/8:00P			25/8:00P			25/8:00P			27/5:00A+			27/9:00A			27/9:00A						
		AMOUNT			.2			.4			.5			.7			.9			.9						
		DATE/TIME OF ENDING			26/11:45P+			25/7:45P			25/8:00P+			25/7:45P			25/8:00P			25/8:00P						
SPRING CREEK 2	1				.04																					.04
	2			.05	.01		.01		.01																	.08
	4			.02		.03	.15	.09					.01			.02	.04									.36
	5	.01		.01					.02																	.04
	7												.17	.20	.01					.19	.14	.02				.73
	8	.02					.03																			.05
	9																		.13	.04	.04	.01				.22
	10			.01				.01																		.02
	17		.02	.02	.03	.03	.03	.08	.02				.03	.01	.02		.01									.30
	18					.02	.01	.05	.01																	.09
	23																						.02	.01	.01	.04
	25													.01	.06	.04			.07	.02					.10	.30
	26					.01	.01											.25	.09	.11	.15	.20	.14	.11	.05	1.12
	27	.10			.13	.12	.13	.02	.03	.02			.01	.05	.05	.03	.03	.01	.01	.01	.01	.02	.02	.02	.03	.85
	28	.01																								.01
		AMOUNT			.25			.37			.49			.94			1.33			1.82						
		DATE/TIME OF ENDING			26/5:00P			7/1:00P			26/10:00P			26/10:00P			27/4:00A			27/4:00P						
STAR TANNERY	1									.1			.2		.1								.2	.2	.2	1.0
	4									.2		.1	.2			.1										.6
	7																						.2		.1	.3
	8	.2	.1			.1		.1																		.5
	9																							.2	.3	.5
	10	.2																								.2
	11									.1																.1
	12											.1														.1
	17						.1			.1			.1													.3
	18		.1																							.1
	23															.1					.1					.2
	25								.1	.4	.1	.1	.1	.1	.1				.1	.1			.1	.1		1.4
	26																			.1						.1
	27			.1	.1	.1	.1	.1	.1			.2				.1										.9



Data for non-recording stations shown on this map may be found in the publication Climatological Data.

N02FA114

DAILY PRECIPITATION

VIRGINIA
MARCH 1975

STATION	TOTAL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
* * * TIDEWATER 01																																
BACK BAY WL REF	5.46										.40	.14		.31	.89			1.77		1.39	.18										.30	
BOHANNON 1 NE	6.34		.31					.09			.21	.15	.31	.20	1.25	T		1.10		1.10	.22		.10		.18						1.12	
BOYKINS	6.93		.39	.03							.31	.10	.02	.68	2.30			.81		1.12	.14		.09			.22					.72	.03
CHERITON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COLONIAL BEACH	7.80		.18					.08			.10	.10	.40	.50	1.26	.02		1.72	.01	.51	1.86		.02		.26	.34					.64	
DIAMOND SPRINGS	6.23		.40	.05								.27		.22	.78	.43		1.28	.02	.37	1.33			.01		.21					.14	.72
DRIVER 4 NE	6.82		.37								.31		.05	.57	1.31			1.25		1.82			.09		.33						.76	
EMPORIA 1 WNW	8.34		.24								.02	.35		.76	1.40	.52		1.13		.34	.18			.14	.02	.31					.28	.65
FREDERICKSBURG NATL PK	6.89		.05	T				.10	T		.12	.01	.60	.15	1.39	.02		1.32	T	.84	1.10	T	T	.01	.54	.01				T	.62	.01
HOLLAND 1 E	6.74		.43					.03	.03			.34	.01	.31	1.04	1.22		1.45		.41	.78	.02		.04		.08					.09	.48
HOPEWELL	8.27		.19					.15			.20	.0[illegible]	.39	.33	2.00			1.88	T	.80	.02		.11	.12	.32	.16					1.57	
LANGLEY AIR FORCE BASE	10.94	.02	.33					T	T		.09	T	.09	1.26	2.73		.55	1.93		1.68	.04		.08		.34						1.80	
MOLLUSK 1 SW	9.65	T	.50					.09			.50		.70	.35	1.40		.30	1.30		1.50			.20		1.05				T		1.60	
MASSAWADOX	8.80		.15					.08			.15	.19	.30	.17	3.35			1.46		1.60	.01		.09	T	.15	.25					.81	
MELSONIA	7.54		.19					.05	.05		.24	.18	.49	.14	1.50			1.03		1.41				.07	.13	.64					1.52	
NEWPORT NEWS PRESS BLD	9.46	.57	.25	.52				T					.05	.88	2.40		.03	1.10	.02	1.56	.04		.08		.47	.45					1.25	T
NORFOLK WSO AP	5.72	.07	.41					T	T		.25		.02	.66	.57		.28	.98		1.41	.03		.01		.28						.74	
PAINTER 2 W	8.32		.10						.14		.13	.20	.45	.15	1.82			1.37		2.07	.05		.02	.09	.17	.48					1.18	
PARRAMORE BEACH L B S	-		.10								.18		-	-	.15			.24		.11		-	-	-							-	
QUANTICO 1 S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
STONY CREEK 5 SSW	8.23		.17									.54		.64	1.76	.75		1.31	.07	.28	.27			.18	T	.41						1.89
SUFFOLK LAKE KILBY	6.66		.43								.30		T	.85	1.02		.22	1.04		2.18			.01		.02						.59	
TANGIER ISLAND	7.24		.25					.02			.11		.54	.10	1.14			.98		1.67			T	.08	.44	.17					1.77	
WAKEFIELD 1 NW	8.26		.20								.50		.23	1.20	1.02		.08	1.52		1.07			.11		.28						2.05	
WALKERTON 2 NW	7.92		.20					.13			.19	.04	.45	.25	1.43			1.70		1.10	.18		.18		.69						1.38	
WALLACETON LK DRUMMOND	6.10											.43	.23	.94	.43			1.28	.12	.10	2.05					.14						.41
WALLOPS ISLAND WSO	6.47		.15					.04	.04		.37	.01	.43	.47	1.08	.01	.16	.82		1.28	T		.04		.34						1.23	
WARSAW 2 NW	5.98		.17	T				.05			.12		.30	.13	1.18		T	1.58		.81	.09		.05		.10	.08					1.31	
WEST POINT 2 SW	8.13		.26					.10			.21	.03	.43	.24	1.56		T	1.60		1.20	.04		.11	.04	.30	.01					2.01	
WILLIAMSBURG 2 N	8.04		.22					.11			.33	.04	.26	.30	1.33		T	1.51	T	2.17	.10		.11	T	.28	T					1.28	
* * * EASTERN PIEDMONT 02																																
AMELIA COURT HOUSE	9.88		.07								.27	.20	.26	.63	1.49	.57	.10	1.51		.37	.68			.03	.57					.17	2.94	
ASHLAND	8.13		.21					.10	T		.21		.35	.51	1.01		T	1.94	T	1.22	.19		.10		.84					T	1.65	
BREMO BLUFF	6.85								.35			.19		.31	1.35	.43		1.38		.78	.69					.79					.62	
BUCKINGHAM	8.40		.15						.21		.07	.22	T	.30	1.40	.42		1.22		1.48	1.26			.06	.39	.42				T	.84	
CAMP PICKETT	8.70		.21						.25		.12	.31		.96	1.35	.56		1.75	.02	.24	.55			.21	.05	.26					1.80	.08
CHASE CITY	8.92											.80	.40		1.92			1.20		.80					.60						3.20	
CLARKSVILLE	7.11		.38						.08		.22	.15	.20	.92	1.76	.69		1.22		.80	.08			.10	.01	.36					.15	
COLUMBIA	7.21		.20						.14		.06	.16		.36	1.42	.43		1.50	T	.57	.92			.05	.32	.43					.65	
CORBIN	7.85		.17						.12		.01	.13		.59	.92	.47		1.50		.27	2.46			.05	.04	.40			T	T	.69	.01
FARMVILLE 2 N	8.31		T	T						T	.40	T	T	.77	1.52	.37		1.38		.72	.40			.06		.67				.03	2.10	
GORDONSVILLE 3 S	7.21		.12						.10	T	T	.14		.58	1.10	.67		1.01	.09	.91	1.11			T		.63				.01	.74	
JOHN H KERR DAM	7.52		.11	.02					.04		.10	.23	.20	1.22	1.67	.63		1.08	.02	.40	.31	T		.13	.01	.19					.51	.69
LAWRENCEVILLE 5 W	8.52		.25					.07			.44		.25	.97	1.94		.01	1.33	.03	1.29			.22		.42					.10	1.20	
LOUISA	8.45		.11					.04			.08	.01	.38	.06	1.49	T	.04	1.33	T	1.19	.62		.03		.31					.04	.72	
NEW CANTON	6.96					.17	.08	.26			.22				1.80	.06		1.36			1.51		.07	.08	.70					.70		
PALMYRA 1 E	4.92		T						.06		T	.14		.29	.85	.22		.98	T	.74	.51				T	.45				.25	.40	.03
PARTLOW 3 WNW	9.95		.10					.30			.20			.55	1.80		.40	1.70		.85	1.80			.20	1.80					.25		
RICHMOND WSO AP R	8.04	.10	.04					.11			.14		.30	1.16	.87		.57	1.14	.01	.91	T		.12		.60				T	.03	1.94	
STATE FARM	7.52		.24						.16		T	.26		.57	1.40	.56		1.62	.03	.24	.33			.09	.26	.38					1.32	.06
* * * WESTERN PIEDMONT 03																																
ALTAVISTA	9.26		.08						.28		.17	.27	.03	.39	1.78	.39		1.22		2.38	.27			T		.35					1.65	
APPOMATTOX 3 W	010.90		T	T					.45		.080	.10	.13	.42	1.64	2.02		1.24		2.06	.88			.07	.28	.46				.05	1.03	T
BEDFORD	6.96								.57		.20	.15	.20	.25	2.10	.30		1.08		2.05	.18					.73				.05	1.10	
BROOKNEAL	11.72		.53	T					.33	T	.10	.39	T	1.36	1.68	.37		.94		1.63	.96			.05	.01	.48				T	2.90	.01
CHARLOTTE COURT HOUSE	10.67		.18						.24		.15	.29	.12	1.03	1.59	.34		1.19		.77	.78			.11	.11	.37					3.30	
CHARLOTTESVILLE 2 W	7.81		.03						.09		.02	.12	.10	.39	1.85	.22		.85	T	2.48	.89			T		.33			T	.09	.46	
CHATHAM	11.76		.02					.30	.30		*	.38		1.28	1.77	.43		.94		1.47	.38	T			.03	.90	T				3.58	T
CONCORD 5 S	9.79		.21						.24		.15	.27	T	.45	1.89	.44		1.33		2.15	.90			T	.13	.46				T	1.14	T
DANVILLE-BRIDGE ST	10.44								.12		.12	.12	.15	.91	1.84	.38		.94		1.41	.94			.05	.03	.53					2.87	.06
FREE UNION	6.96		.04						.12			.14	.03	.40		.44		.80	.04	2.06	2.04					.40				.03	.42	
HALIFAX 2 SSE	10.23		.16						.18		.13	.20		.94	1.31	.41		1.09		1.10	.91					.89					3.15	
HOLCOMBS ROCK	8.13		.02						.30		.12	.39	.03	.20	1.75	.48		.98		1.98					T	.86				.60	.74	
HUDDLESTON 2 SW	9.76		.02	.01					.35		.14	.34	.02	.37	1.83	.40		1.39		2.02	.95			.04		.74					1.54	
LYNCHBURG WSO AP R	9.24	.08	T					.38	T		.51		.10	1.39	.89		.80	.35	.74	1.74			.03		1.09				.03	.78	.43	T
MARTINSVILLE FILT PL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MEADOWS OF DAN 5 SW	11.27		.04						.41		.31	.16	.03	.66	2.59	.23		1.01		1.09	.03			.03		1.32					2.56	
MONTEBELLO 2 NE	9.12		.10								.23	.11		.43	1.33	.59		.74		3.39	.83				.01	.79				.04	.51	.02
PEDLAR DAM	8.08		.08						.28		.10	.33	.03	.31	1.65	.64		.70		1.98	.63					.60			T	.16	.69	
PHILPOTT DAM 2	10.71		.03						.27		.10	.10	.06	.60	3.00	.38		.97		2.09	.05				.05	.85					2.10	.05
RANDOLPH 5 NNE	11.87								.22		.27	.68	.09	1.10	1.75	.45		1.20		1.03	.90			.20	.10	.37					3.51	
ROCKFISH	8.28		.09						.17		.03	.27	.02	.25	1.42	.63		.90		2.03	1.40			T		.48					.41	T
ROCKY MOUNT	8.86		T						.30		.20	.17	.02	.41	1.95	.45		.96		1.89	.18			T		.82					1.49	
STUART 1 SSE	D11.09	.01	T	T				.34	T	.01	D .30	T	.24	.87	2.35	.01	.21	.83	.21	1.49			T		1.29					.47	2.50	
TYE RIVER 1 SE	8.37		.05						.21		.02	.37	.03	.25	1.52	.72		.91	.03	1.85	1.15				.02	.82					.47	.15
WOOLWINE 4 S	10.99		T						.42		.25	.08	.05	.59	3.15	.13		.96		2.20	T				.08	.90					2.23	
* * * NORTHERN 04																																
ALEXANDRIA CITY GARAGE	6.41			T					.05			.18		.63	.63	.63		.53	.04	.13	1.53		.02	.05	.04	1.52				.04	.39	T
AMISSVILLE	6.43									T		.10	T	.20	.79	1.06		.75		.75	1.60					.05				.09	1.08	
BERRYVILLE	-			T					.01					.39	.39	.67	.18			.49	1.24			.07	.09	.09				-	-	
BIG MEADOWS	9.09		T						.13		.02	.05	T	.33	.89	.64		.77	.13	2.96	2.12			.09	T	.21				.15	.61	
CULPEPER	7.14							.10			.11		.40		2.00	.03		.82		2.19	.28		T		.73					.05	.46	
ELKWOOD 6 SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LINCOLN	4.18										.14		.52		1.17				1.77		.08	.07		.22					.21			
LURAY 5 E	7.38			T					.07	T	T	.03		.31	.53	1.13	T	.68		2.10	1.86			.05	T	.13				.09	.60	
MANASSAS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOUNT WEATHER	9.07								.14			.10		.49	.98	.87		.41		.88	1.07		T	.09	.02	.06				.02	.71	
PIEDMONT RESEARCH STA	6.79		.04						.06			.14		.68	1.04	.66		.90		1.09	.79			.02	.02	.70		.01		.02	.84	.02
RAPIDAN	7.27		T						.10			.12		.59	1.13	.82		.97	T	1.27	1.12			T	T	.49					.68	
RIVERTON	5.56								.05					.41	.35	.51		.53		1.72	1.06					.10				.30	.56	
SOMERSET	6.82												.13	.55	1.10	.81	.30	.59	1.30	.95						.35				.06	.61	
THE PLAINS 2 NNE	5.11								.07	T		.05	T	.42	.74	.72	T	.43	T	.66	1.12			.03	.02	.12				T	.73	T
VIENNA DUNN LORING	4.86		T					.12	.01		.13	.01	.44	.03	1.30	.01		.48	T	1.20			.03		.63					.08	.40	
WARRENTON 3 SE	5.28								.15			.09	.01	.42	.64	.75		.74		.79	.75			.02	.05	.44				.02	.38	.03
WASHINGTON	5.87								.10			.05		.36	.59	.82				2.10	1.27				.05	T				.15	.38	
WASH. DULLES WSO AP	4.38	T	T					.11	T		.12		.41	.33	.34		.14	.31	.04	1.07			.01		.58				T	.28	.34	
WASH. NATIONAL WSO AP T	5.33	T	T					.06	T		.16		.57	.28	.79		.14	.38	T	1.23	T		.03		1.35				T	.02	.38	
WINCHESTER 1 N	4.94								.25			.06		.49	.54	.72		.22		.95	.75			.01	.09	.09				.26	.59	
WOODSTOCK	6.35								.16			.04		.30	.40	.80		.36	.02	.76	1.54			.03	.02	.11				.04	.73	

SEE REFERENCE NOTES FOLLOWING STATION INDEX

HOURLY PRECIPITATION

HOURLY AMOUNTS

VIRGINIA
MARCH 1975

MONTHLY MAXIMUM AMOUNTS

HOURS	1	2	3	6	12	24	ACCUMULATION
MINUTES	15	30	45	60	120	180	

(Apply heading as appropriate)

STATION	DATE	A.M. Hour Ending 1	2	3	4	5	6	7	8	9	10	11	12	P.M. Hour Ending 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
CHATHAM																										

CHATHAM	1 / 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
AMOUNT	.5	.6	.7	1.0	1.5	2.1	
DATE/TIME OF ENDING	24/0:30P	30/1:45A+	30/1:45A+	30/1:45A	30/1:45A	30/1:45A	

STATION	DATE	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	TOTAL
COLUMBIA	1																					.1		.1		.2
	7												.1													.1
	10							.1							.1											.2
	12								.1		.2															.3
	13					.1																.1	.3	.2	.1	.8
	14	.2		.2	.2			.1	.1	.1	.1		.1													1.1
	16																	.1		.1		.1	.1	.1	.2	.7
	17	.2	.2	.2	.1		.1																			.8
	18																		.1			.1				.2
	19	.1			.1	.2			.1		.2	.1					.2	.3								1.3
	22												.1													.1
	24					.3	.1								.3		.1									.8
	29																							.2		.2
	30	.1	.1	.1	.1					.1																.5

COLUMBIA	1 / 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
AMOUNT	.3	.5	.6	1.0	1.5	1.8	
DATE/TIME OF ENDING	24/2:00P+	19/5:00P+	17/3:00A+	17/4:00A+	14/9:00A+	14/12:00A	
AMOUNT	.3	.3	.4	.4	.6	.7	
DATE/TIME OF ENDING	13/10:00P	24/1:30P+	13/10:30P	24/5:15A+	13/11:45P	14/0:30A	

STATION	DATE	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	TOTAL
COVINGTON FILTER PLT	7								.1		.1	.1	.1													.4
	10						.1		.1					.1												.3
	12												.1												.1	.2
	13	.1	.1														.1	.1		.1		.1	.1	.1		.8
	14	.2	.2					.1	.1	.1											.1					.8
	16																		.1		.1		.1		.2	.5
	17		.1																							.1
	18																					.1		.1		.2
	19	.1	.1		.2	.2		.1																		.7
	20								.1																	.1
	22																.1									.1
	24							.1					.1													.2
	28																.1			.1						.2
	29							.1	.2														.1			.4
	30		.1																							.1

COVINGTON FILTER PLT	1 / 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
AMOUNT	.2	.4	.4	.7	1.0	1.3	
DATE/TIME OF ENDING	29/8:00A+	19/5:00A+	19/5:00A+	14/2:00A	14/2:00A	14/9:00A	
AMOUNT	.2	.2	.2	.2	.4	.5	
DATE/TIME OF ENDING	14/1:45A	19/5:00A+	29/7:45A+	29/7:45A+	19/5:00A+	19/6:15A	

STATION	DATE	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	TOTAL
DAVENPORT 2 NE	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	8	-	-	-	-	-		-	-	-	-	-	-	-				.02	.01							-
	10		.02	.05		.01				.01	.11	.07	.02	.03	.01	.02	.01							.02		.38
	12									.02	.29	.13	.05	.05	.03	.13	.04	.02		.01		.02		.05	.08	.92
	13	.11	.01	.03	.05	.05	.03						.02	.12	.04	.11	.03	.02			.05	.05	.08	.22	.17	1.19
	14	.01			.02	.03	.12		.12	.05		.04	.01													.40
	16														.02	.03	.06	.09	.03		.02	.05				.30
	17		.01	.01																						.02
	18													.01									*	*	*	*
	20	*	*	*	*	*	*	*	*	*	*	*	.87													.88
	22									*	*	*	*	*	*	*	.43									.43
	24			.01	.16			.19	.08	.23	.06	.07	.03		.03	.01	.03									.90
	27																							.08	.15	.23
	28	.12	.17	.02		.02	.01	.01															.25	.13	.18	.91
	29	.12	.03	.05	.02	.01										.01		.03	.05	.07	.15	.13	.27	.22	.27	1.43
	30	.16	.09	.06	.12	.04							.01			.03										.51

DAVENPORT 2 NE	1 / 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
AMOUNT	-	-	-	-	-	-	
DATE/TIME OF ENDING							

STATION	DATE	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	TOTAL
ELKWOOD 6 SE	7												.1													.1
	10													.1												.1
	12										.2		.1	.2	.1											.6
	13			.1				.1												.1			.2	.1		.6
	14	.1	.2		.1				.1	.2	.2	.1		.1												1.1
	15									.1																.1
	16																					.1		.1	.1	.3
	17	.1	.1	.1	.1		.1			.1																.6
	19	.1		.1			.2	.1		.1	.1	.3	.4								.3	.2				1.9
	20	.1																								.1
	24														.2	.6	.1									.9
	29																								.1	.1
	30		.1	.1	.1	.1																				.4

ELKWOOD 6 SE	1 / 15	2 / 30	3 / 45	6 / 60	12 / 120	24 / 180	ACCUMULATION
AMOUNT	.6	.8	.9	1.0	1.4	1.9	
DATE/TIME OF ENDING	24/3:00P	24/3:00P	24/4:00P	19/12:00A	19/12:00A	20/1:00A+	

HOURLY PRECIPITATION

HOURLY AMOUNTS

VIRGINIA
MARCH 1979

STATION	DATE	A. M. Hour Ending												P. M. Hour Ending												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
		MONTHLY MAXIMUM AMOUNTS																								
		HOURS			1			2			3			6			12			24			ACCUMULATION			
		MINUTES			15			30			45			60			120			180						
		(Apply heading as appropriate)																								
ELKWOOD 6 SE		AMOUNT			.3			.5			.6			.7			.8			.9						
		DATE/TIME OF ENDING			24/2:30P			24/2:30P			24/2:45P+			24/2:45P			24/2:45P			24/4:00P						
FREDERICKSBURG NATL PK	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	17	-	-	-	-	-	-	-	-	-	-	-	-													-
	19				.1		.1					.1	.2	.1	.1					.1	.2	.8	.1			1.9
	24																.5									.5
	30	.1		.1	.2	.1		.1																		.6
		AMOUNT			-			-			-			-			-			-						
		DATE/TIME OF ENDING																								
		AMOUNT			-			-			-			-			-			-						
		DATE/TIME OF ENDING																								
GALAX WATER PLANT	7								.1			.1	.1	.1												.5
	10																.1									.1
	11										.1															.1
	12												.1					.2								.3
	13	.2		.1					.1										.1	.2	.3	.1		.2	.3	1.6
	14	.4	.1			.1	.3	.4	.2																	1.5
	16																		.1		.1	.1	.2	.1	.1	.7
	18																			.1				.1	.2	.4
	19	.2	.4	.2	.1	.2											.1									1.2
	24									.1	.1	.1	.1	.2	.1											.7
	29								.1	.1	.1											.1	.2	.1	.3	1.0
	30	.1	.1		.1																					.3
		AMOUNT			.4			.7			.9			1.3			2.2			2.7						
		DATE/TIME OF ENDING			19/2:00A+			14/7:00A+			14/8:00A+			19/5:00A+			14/7:00A			14/8:00A						
		AMOUNT			.2			.3			.4			.5			.8			1.0						
		DATE/TIME OF ENDING			19/1:15A+			19/1:30A+			19/1:45A+			19/1:45A+			14/7:15A+			14/7:45A+						
GROSECLOSE	1																.12	.10	.05	.03	.01			.01		.32
	2																	.01	.01		.01		.01	.01		.05
	3	.01	.01		.01	.01		.01																		.05
	7						.10	.11	.02	.13	.11	.13	.13	.05	.01											.79
	10		.08	.09	.09	.08	.03	.01			.01	.09	.16	.04	.02											.70
	12										.04	.14	.02	.01	.01	.01	.12	.01						.07	.32	.75
	13	.06		.02		.01		.03	.03							.02	.02	.03	.12	.05	.09	.11	.01	.22	.25	1.07
	14	.12			.01	.06	.04	.06	.02	.01			.01													.33
	16											.08				.01	.02	.05	.04	.09	.04	.05	.01	.11	.02	.52
	17	.01	.01																							.02
	18																		.01	.02	.04	.01			.10	.18
	19	.10	.20	.13	.04	.01	.02	.02				.04	.04	.01	.10	.09	.04	.04	.01		.01	.01	.01			.92
	22															.10	.11	.01	.01	.07	.04					.34
	24									.07	.16	.04	.07	.01												.35
	28								.06	.07	.04	.01														.18
	29						.13	.15	.12	.12	.02								.05	.27	.42	.31	.10	.02	.06	1.77
	30	.12	.03	.12	.05																					.32
		AMOUNT			.42			.73			1.00			1.18			1.55			2.09						
		DATE/TIME OF ENDING			29/8:00P			29/9:00P			29/9:00P			29/12:00P			30/4:00A			30/4:00A						
HONAKER	1									.01					.01	.08	.03	.05	.01		.02					.21
	7					.16	.19	.02	.16	.18	.25	.03	.06											.01	.01	1.03
	8	.01											.01	.01	.02	.01	.01	.01								.08
	10	.03	.08	.03	.03	.02			.01	.01	.11	.10	.02	.05	.02											.51
	12										.25	.10	.04		.01	.20	.03	.02		.01	.02	.02	.03	.15	.10	.98
	13	.04	.02	.05	.03	.02	.05	.01					.10	.04	.12	.01		.01	.02	.03	.07	.20	.50	.21	.01	1.54
	14			.03	.08			.02	.12	.02																.27
	16																.06	.07	.02		.01	.04	.01			.21
	18																							.02	.01	.03
	19			.01	.14	.02	.01	.02	.02	.08	.09	.08	.16	.12	.07	.06	.02	.10	.03							1.03
	22									.10	.10	.12		.08	.19	.01	.06									.66
	24							.20	.10	.14	.04	.04														.52
	28						.05	.20	.37																	.62
	29				.07	.20	.21	.17	.13	.02		.01					.01	.16	.12	.27	.13	.25	.25	.25	.30	2.35
	30	.10	.05	.17	.03																					.35
		AMOUNT			.50			.71			.91			1.45			2.08			2.87						
		DATE/TIME OF ENDING			13/10:00P			13/11:00P			13/11:00P			29/12:00P			30/4:00A			30/3:00A						
HOT SPRINGS	7									.1		.3														.4
	8																.1									.1
	10								.1					.1												.2
	12								.1				.1												.1	.3
	13	.1	.1	.1													.1	.1			.1			.1		.7
	14	.1	.1	.1				.1		.1						.1										.6
	16																		.1		.1		.1		.1	.4
	17	.1																								.1
	18																			.1	.1	.1	.1	.1	.1	.6

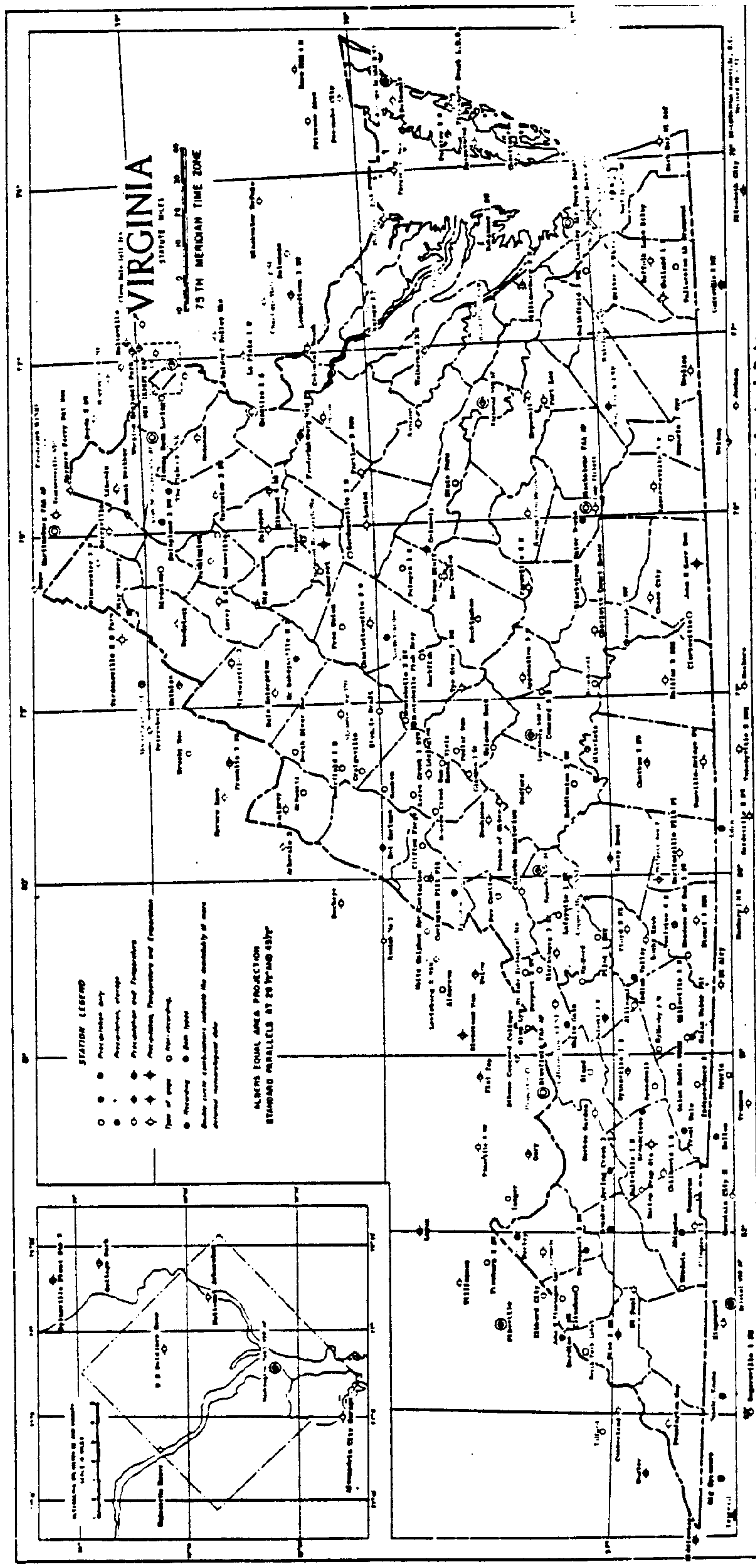
HOURLY PRECIPITATION

HOURLY AMOUNTS

VIRGINIA
MARCH [illegible]

STATION	DATE	A. M. Hour Ending												P. M. Hour Ending												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
		MONTHLY MAXIMUM AMOUNTS																								
		HOURS			1			2			3			6			12			24			ACCUMULATION			
		MINUTES			15			30			45			60			120			180						
		(Apply heading as appropriate)																								
PHILPOTT DAM 2		AMOUNT			.3			.4			.5			.6			.9			1.1						
		DATE/TIME OF ENDING			24/11:45A			24/12:00A+			29/10:15P+			29/10:15P			30/1:15A			30/1:00A+						
PIEDMONT RESEARCH STA	7												.1													.1
	10											.1														.1
	12									.1	.1		.2	.2	.1											.7
	13					.1													.1		.1		.2	.1	.1	.7
	14	.2		.1		.1			.2	.2	.1	.1														1.0
	15																	.1								.1
	16																					.1	.1		.2	.4
	17	.1	.1	.1	.1			.1																		.5
	18																					.1				.1
	19	.1	.1		.1	.3	.3	.1			.4	.3														1.7
	24													.1	.6											.7
	29									.1														.1		.2
	30	.1	.2	.1			.1																			.5
		AMOUNT			.6			.7			.7			1.1			1.7			1.8						
		DATE/TIME OF ENDING			24/2:00P			24/2:00P+			24/2:00P+			19/11:00A+			19/11:00A			19/11:00A						
		AMOUNT			.3			.5			.5			.6			.7			.8						
		DATE/TIME OF ENDING			24/1:30P			24/1:30P			24/1:30P+			24/2:00P+			24/2:00P+			19/6:30A						
PULASKI 2 E	1																			.1						.1
	7								.1	.1	.1	.1	.1													.5
	10			.1	.1	.1							.2						.1							.6
	12												.1												.1	.2
	13	.2				.1											.1		.1	.1	.2	.2	.1		.3	1.4
	14	.2	.1			.1	.2	.1	.1						.1											.9
	16																		.1			.1	.1		.1	.4
	18																				.1			.1	.1	.3
	19	.1	.3	.2	.2	.1		.1							.1		.1									1.2
	24										.2	.5														.7
	29							.1	.1	.2	.1										.2	.2	.2	.1		1.2
	30			.1																						.1
		AMOUNT			.5			.7			.7			1.0			1.5			2.0						
		DATE/TIME OF ENDING			24/11:00A			24/11:00A			24/11:00A+			19/5:00A+			14/7:00A+			14/2:00P						
		AMOUNT			.5			.5			.5			.5			.7			.7						
		DATE/TIME OF ENDING			24/11:00A			24/11:00A			24/11:00A			24/11:00A			24/11:00A			29/10:30P+						
RANDOLPH 5 NNE	1 31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		AMOUNT			-			-			-			-			-			-						
		DATE/TIME OF ENDING																								
		AMOUNT			-			-			-			-			-			-						
		DATE/TIME OF ENDING																								
RICHMOND WSO AP	1																							.06	.04	.1
	2	.02	.01		.01																					.0
	7													.03	.07	.01										.1
	10								.01	.01	.01			.01	.03	.03	.02	.01	.01							.1
	12								.01	.12	.12	.02	.02	.01												.3
	13					.12	.08	.07											.02	.10	.02	.12	.21	.27	.15	1.1
	14	.03	.07	.08	.08	.04		.03		.10	.19	.04	.16	.05												.8
	16																		.02	.04	.07	.03	.08	.12	.21	.5
	17	.25	.25	.29	.15	.02	.11	.04	.02	.01																1.1
	18																		.01							.0
	19		.01	.05		.03	.19			.01	.04	.08	.47											.02	.01	.9
	22													.03	.04	.01	.02	.01	.01							.1
	24						.08	.19								.22	.04	.07								.0
	29																								.03	.0
	30	.51	.28	.26	.11	.56	.11	.08	.02	.01																1.9
		AMOUNT			.56			.79			1.05			1.83			1.97			1.97						
		DATE/TIME OF ENDING			30/5:00A			30/2:00A			30/3:00A			30/6:00A			30/9:00A			30/9:00A						
ROANOKE WSO AP	1																			.03		.01				.0
	7								.01	.07	.07	.08	.04													.2
	8																.01									.0
	10				.07	.09	.04	.03	.03	.01		.03	.06	.10	.02		.02									.5
	12						.02		.01	.02	.02		.02					.01						.01		.1
	13	.05	.04	.02	.01	.07	.01	.01									.04	.08		.14	.23	.35	.20	.20	.08	1.5
	14	.17	.21	.07			.22	.33	.39	.03	.03															1.4
	16																	.01	.02	.05	.03	.10	.05	.20	.15	.6
	17	.03																								.0
	18																	.02	.04	.05	.08	.10	.12	.12	.06	.5
	19	.22	.21	.25	.22	.15	.19	.04	.01						.02											1.2

Best Copy Available



N02FA120

Appendix 2A
Attachment 2[1]
Historical Inflows and Unit Hydrograph Optimization

1. Attachment 2 to Appendix 2A was submitted as Appendix J, Section 7.2 in the original FSAR.

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A. Inflows to WHTF, HEC-1 Summary Printouts

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
31	4	0	7	0	0	0

SUM OF 4 HYDROGRAPHS AT 31

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	2.	1.
1.	0.	0.	1.	1.	1.	0.	0.	0.	0.
0.	2.	3.	16.	30.	70.	295.	663.	836.	792.
698.	538.	395.	316.	243.	191.	167.	140.	91.	49.
28.	17.	9.	4.	2.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	10.	17.	11.
5.	12.	29.	31.	18.	8.	4.	13.	21.	13.
6.	3.	1.	1.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	10.	17.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	836.	654.	233.	81.	5835.
INCHES		3.68	5.25	5.45	5.48
AC-FT		324.	463.	480.	482.

REACH 1
WHTF Inflows
June 1972

N02FA203

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
27	19	0	7	0	0	0

SUM OF19 HYDROGRAPHS AT 27

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	10.	19.	14.
9.	5.	3.	8.	12.	9.	5.	3.	2.	1.
1.	16.	28.	129.	242.	576.	2387.	5401.	7129.	7298.
6883.	5717.	4566.	3779.	3028.	2467.	2121.	1777.	1294.	862.
589.	406.	266.	174.	113.	73.	47.	31.	20.	12.
8.	5.	3.	2.	1.	0.	0.	75.	136.	100.
64.	114.	249.	275.	191.	119.	72.	134.	189.	137.
87.	53.	33.	21.	14.	9.	6.	4.	3.	2.
1.	1.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	77.	138.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7298.	6166.	2388.	828.	59855.
INCHES		3.38	5.24	5.45	5.47
AC-FT		3059.	4740.	4931.	4949.

REACH 2
WHTF Inflows
June 1972

N02FA204

Best Copy Available

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
8	8	0	7	0	0	0

SUM OF 8 HYDROGRAPHS AT 8

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	5.	9.	7.
3.	2.	1.	3.	5.	4.	2.	1.	0.	0.
0.	7.	14.	61.	117.	272.	1129.	2603.	3418.	3336.
2986.	2365.	1767.	1410.	1100.	868.	750.	630.	428.	242.
142.	89.	49.	24.	12.	5.	3.	1.	0.	0.
0.	0.	0.	0.	0.	0.	0.	35.	67.	48.
24.	48.	115.	130.	82.	41.	20.	52.	85.	59.
29.	15.	7.	4.	2.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	36.	69.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3418.	2746.	993.	344.	24846.
INCHES		3.63	5.25	5.45	5.48
AC-FT		1363.	1970.	2046.	2054.

REACH 3
WHTF Inflows
June 1972

N02FA205

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
32	3	0	7	0	0	0

SUM OF 3 HYDROGRAPHS AT 32

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	17.	30.	22.
13.	7.	4.	12.	19.	13.	8.	4.	3.	2.
1.	25.	45.	206.	389.	917.	3811.	8667.	11383.	11429.
10567.	8619.	6728.	5505.	4371.	3526.	3038.	2547.	1814.	1152.
759.	512.	324.	202.	126.	79.	50.	32.	20.	13.
8.	5.	3.	2.	1.	0.	0.	120.	220.	159.
93.	174.	393.	437.	291.	168.	97.	199.	295.	209.
122.	70.	42.	25.	16.	10.	6.	4.	3.	2.
1.	1.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	123.	224.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11429.	9566.	3613.	1253.	90534.
INCHES		3.47	5.24	5.45	5.47
AC-FT		4746.	7171.	7457.	7486.

Combined
WHTF Inflows
June 1972

N02FA206

Best Copy Available

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
31	4	0	7	0	0	0

SUM OF 4 HYDROGRAPHS AT 31

0.	0.	0.	0.	0.	2.	3.	23.	66.	91.
82.	63.	43.	23.	19.	19.	11.	5.	2.	1.
9.	25.	37.	35.	20.	9.	4.	2.	1.	0.
0.	0.	0.	0.	0.	10.	18.	12.	5.	3.
1.	1.	0.	0.	0.	0.	0.	0.	0.	43.
91.	106.	144.	194.	180.	121.	89.	75.	54.	29.
13.	6.	2.	1.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	194.	139.	49.	25.	1794.
INCHES		0.79	1.09	1.68	1.68
AC-FT		69.	96.	148.	148.

REACH 1
WHTF Inflows
April 1973

N02FA207

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COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
27	19	0	7	0	0	0

SUM OF19 HYDROGRAPHS AT 27

0.	0.	0.	0.	0.	13.	23.	183.	531.	766.
753.	639.	488.	316.	259.	234.	160.	102.	64.	41.
95.	213.	322.	322.	220.	137.	83.	52.	33.	21.
13.	9.	6.	4.	3.	83.	146.	108.	69.	41.
25.	16.	10.	6.	4.	3.	2.	1.	1.	344.
734.	911.	1275.	1717.	1688.	1295.	1045.	880.	678.	445.
280.	176.	113.	75.	49.	33.	23.	15.	10.	7.
4.	3.	1.	1.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1717.	1322.	492.	256.	18421.
INCHES		0.73	1.08	1.68	1.68
AC-FT		656.	976.	1523.	1523.

REACH 2
WHTF Inflows
April 1973

N02FA208

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COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
8	8	0	7	0	0	0

SUM OF 8 HYDROGRAPHS AT 8

0.	0.	0.	0.	0.	6.	11.	86.	256.	371.
349.	273.	193.	110.	85.	83.	53.	26.	13.	7.
35.	96.	150.	148.	91.	45.	23.	12.	6.	3.
1.	1.	0.	0.	0.	38.	72.	51.	26.	13.
6.	3.	2.	1.	0.	0.	0.	0.	0.	161.
361.	437.	584.	791.	766.	540.	398.	331.	247.	141.
70.	34.	17.	9.	4.	2.	1.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	791.	586.	205.	106.	7642.
INCHES		0.78	1.09	1.68	1.68
AC-FT		291.	408.	632.	632.

REACH 3
WHTF Inflow
April 1973

N02FA209

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
32	3	0	7	0	0	0

SUM OF 3 HYDROGRAPHS AT 32

0.	0.	0.	0.	0.	20.	37.	292.	853.	1229.
1184.	975.	725.	448.	362.	336.	224.	133.	80.	49.
139.	333.	509.	505.	330.	192.	110.	65.	40.	24.
15.	10.	7.	4.	3.	131.	236.	170.	99.	56.
33.	20.	12.	7.	4.	3.	2.	1.	1.	549.
1186.	1455.	2004.	2702.	2634.	1957.	1532.	1286.	979.	615.
364.	216.	133.	84.	54.	35.	23.	16.	10.	7.
4.	3.	1.	1.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2702.	2047.	744.	387.	27857.
INCHES		0.74	1.08	1.68	1.68
AC-FT		1016.	1476.	2303.	2303.

Combined
WHTF Inflows
April 1973

N02FA210

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
31	4	0	7	0	0	0

SUM OF 4 HYDROGRAPHS AT 31

0.	0.	0.	0.	0.	0.	0.	0.	1.	2.
1.	7.	12.	21.	43.	66.	85.	127.	192.	237.
263.	277.	256.	207.	146.	104.	83.	47.	22.	10.
5.	2.	1.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	277.	239.	92.	31.	2216.
INCHES		1.34	2.08	2.08	2.08
AC-FT		118.	183.	183.	183.

REACH 1
WHTF Inflows
September 1974

N02FA211

Best Copy Available

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
27	19	0	7	0	0	0

SUM OF19 HYDROGRAPHS AT 27

0.	0.	0.	0.	0.	0.	0.	0.	8.	15.
11.	59.	99.	175.	356.	564.	743.	1115.	1674.	2110.
2416.	2622.	2521.	2184.	1692.	1314.	1070.	711.	455.	289.
186.	122.	81.	54.	36.	25.	16.	11.	7.	4.
2.	1.	1.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2622.	2258.	944.	316.	22750.
INCHES		1.24	2.07	2.08	2.08
AC-FT		1120.	1873.	1881.	1881.

REACH 2

WHTF Inflows
September 1974

N02FA212

Best Copy Available

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
8	8	0	7	0	0	0

SUM OF 8 HYDROGRAPHS AT 8

0.	0.	0.	0.	0.	0.	0.	0.	4.	7.
5.	27.	48.	82.	168.	268.	347.	512.	775.	975.
1092.	1162.	1092.	904.	656.	474.	377.	229.	116.	59.
30.	15.	7.	3.	1.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1162.	1000.	393.	131.	9438.
INCHES		1.32	2.08	2.08	2.08
AC-FT		496.	780.	780.	780.

REACH 3
WHTF Inflows
September 1974

N02FA213

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
32	3	0	7	0	0	0

SUM OF 3 HYDROGRAPHS AT 32

0.	0.	0.	0.	0.	0.	0.	0.	13.	24.
17.	94.	159.	277.	569.	898.	1174.	1754.	2641.	3323.
3771.	4061.	3669.	3295.	2493.	1693.	1531.	987.	593.	359.
220.	136.	89.	57.	37.	25.	16.	11.	7.	4.
2.	1.	1.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4061.	3493.	1428.	478.	34403.
INCHES		1.27	2.07	2.08	2.08
AC-FT		1733.	2835.	2845.	2845.

Combined
WHTF Inflows
September 1974

N02FA214

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
31	4	0	7	0	0	0

SUM OF 4 HYDROGRAPHS AT 31

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	3.	6.	12.	66.	156.	177.	118.	60.	113.
229.	219.	124.	58.	27.	13.	6.	2.	0.	2.
19.	31.	19.	9.	4.	2.	1.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	229.	152.	61.	21.	1477.
INCHES		0.86	1.38	1.39	1.39
AC-FT		76.	122.	122.	122.

REACH 1
WHTF Inflows
March 1975

N02FA215

Best Copy Available

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
27	19	0	7	0	0	0

SUM OF19 HYDROGRAPHS AT 27

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	27.	49.	102.	533.	1264.	1515.	1171.	751.	1127.
2004.	2010.	1385.	863.	526.	328.	210.	137.	88.	70.
190.	275.	200.	128.	77.	47.	30.	20.	12.	7.
5.	3.	2.	2.	1.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2010.	1430.	627.	211.	15162.
INCHES		0.78	1.38	1.39	1.39
AC-FT		709.	1245.	1254.	1254.

REACH 2
WHTF Inflows
March 1975

N02FA216

HYDROGRAPH ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
8	1	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	1	0	0.0	0.0	0.0	0.

ROUTED FLOWS AT 8

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	1.	2.	4.	23.	51.	51.	30.	15.	38.
74.	61.	31.	15.	7.	4.	2.	1.	0.	1.
7.	9.	5.	2.	1.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	74.	45.	18.	6.	437.
INCHES		0.86	1.38	1.39	1.39
AC-FT		22.	36.	36.	36.

REACH 3
WHTF Inflow
March 1975

N02FA217

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
32	3	0	7	0	0	0

SUM OF 3 HYDROGRAPHS AT 32

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	44.	80.	162.	851.	2031.	2423.	1811.	1092.	1695.
3145.	3158.	2078.	1206.	696.	414.	254.	157.	96.	81.
282.	429.	305.	180.	102.	60.	37.	23.	13.	8.
5.	3.	2.	2.	1.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3158.	2221.	950.	318.	22928.
INCHES		0.81	1.38	1.39	1.39
AC-FT		1102.	1884.	1896.	1896.

Combined
WHTF Inflows
March 1975

N02FA218

B. Printout from Inflow Analysis Program

** LAKE INFLOW COMPUTATION **

CASE 4

** JUNE 72 STORM, UNSMOOTHED STAGE DATA **

** NORMAL DIKE DISCHARGE, NORMAL LAKE $ WHTF AREA **

DT(HR.)	HI(FT)	QC(CFS)	N	HSADDLE(FT)	TW(STEP)
1.00	232.50	0.0	0.03	253.50	60.00

	DIKE ELE (FT)	DIKE WIDTH (FT)	DIKE LENGTH (FT)
1	260.00	20.00	3890.00
2	260.00	20.00	3740.00
3	260.00	32.00	2340.00
4	260.00	25.00	400.00

	CANAL ELE 1 (FT)	CANAL ELE 2 (FT)	CANAL LENGTH (FT)
1	227.00	255.00	3910.00
2	227.00	255.00	3000.00
3	227.00	255.00	4310.00

	Q1(CFS)	Q2(CFS)	Q3(CFS)	Q4(CFS)	HR(FT)	QS(CFS)	QPR(IN/HR)	QP(IN/HR)
1	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
2	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
3	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
4	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
5	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
6	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
7	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
8	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
9	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
10	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
11	0.0	0.0	0.0	0.0	232.50	247.00	0.0	0.0
12	0.0	0.0	0.0	0.0	232.50	247.00	0.0	0.0
13	0.0	0.0	0.0	0.0	232.50	232.00	0.0300	0.0100
14	0.0	0.0	0.0	0.0	232.50	227.00	0.0	0.0
15	0.0	0.0	0.0	0.0	232.50	228.00	0.0	0.0
16	0.0	0.0	0.0	0.0	232.50	225.00	0.0700	0.0800
17	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
18	1.00	10.00	5.00	0.0	232.50	225.00	0.1300	0.1600
19	2.00	19.00	9.00	0.0	232.50	225.00	0.0700	0.0800
20	1.00	14.00	7.00	0.0	232.50	225.00	0.0900	0.0900
21	1.00	9.00	3.00	0.0	232.50	225.00	0.0	0.0
22	0.0	5.00	2.00	0.0	232.50	225.00	0.0300	0.0100
23	0.0	3.00	1.00	0.0	232.50	225.00	0.0	0.0
24	1.00	8.00	3.00	0.0	232.50	225.00	0.0700	0.0800
25	1.00	12.00	5.00	0.0	232.50	225.00	0.0	0.0
26	1.00	9.00	4.00	0.0	232.50	227.00	0.0	0.0
27	0.0	5.00	2.00	0.0	232.50	227.00	0.0	0.0
28	0.0	3.00	1.00	0.0	232.50	225.00	0.0	0.0
29	0.0	2.00	0.0	0.0	232.50	225.00	0.0	0.0
30	0.0	1.00	0.0	0.0	232.50	225.00	0.0	0.0
31	0.0	1.00	0.0	0.0	232.50	227.00	0.0	0.0
32	2.00	16.00	7.00	0.0	232.50	227.00	0.0700	0.0800
33	3.00	28.00	14.00	0.0	232.50	227.00	0.0	0.0

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34	16.00	129.00	61.00	0.0	232.50	228.00	0.1300	0.1600
35	30.00	242.00	117.00	0.0	232.52	227.00	0.0700	0.0800
36	70.00	576.00	272.00	0.0	232.55	227.00	0.3100	0.3300
37	295.00	2387.00	1129.00	0.0	232.60	227.00	1.0200	1.1300
38	663.00	5401.00	2603.00	0.0	232.65	227.00	1.1400	1.3400
39	836.00	7129.00	3418.00	0.0	233.08	227.00	0.6600	0.7800
40	792.00	7298.00	3338.00	0.0	233.50	227.00	0.6600	0.7800
41	698.00	6883.00	2986.00	0.0	234.00	227.00	0.5100	0.5700
42	538.00	5717.00	2365.00	0.0	234.50	227.00	0.3600	0.2400
43	395.00	4566.00	1767.00	0.0	234.98	225.00	0.5800	0.3800
44	316.00	3779.00	1410.00	0.0	235.45	227.00	0.3400	0.2300
45	243.00	3028.00	1100.00	0.0	235.92	228.00	0.2300	0.1900
46	191.00	2467.00	868.00	0.0	236.40	228.00	0.2300	0.1900
47	167.00	2121.00	750.00	0.0	236.88	230.00	0.2600	0.2000
48	140.00	1777.00	630.00	0.0	237.35	230.00	0.1200	0.1000
49	91.00	1294.00	428.00	0.0	237.72	1744.00	0.0500	0.0200
50	49.00	862.00	242.00	0.0	238.10	7433.00	0.0800	0.0300
51	28.00	589.00	142.00	0.0	236.50	22654.00	0.1000	0.0400
52	17.00	406.00	69.00	0.0	238.90	29973.00	0.0	0.0
53	9.00	266.00	49.00	0.0	239.00	31334.00	0.0	0.0
54	4.00	174.00	24.00	0.0	239.00	31334.00	0.0	0.0
55	2.00	113.00	12.00	0.0	239.00	31334.00	0.0	0.0
56	1.00	73.00	5.00	0.0	239.00	31334.00	0.0	0.0
57	0.0	47.00	3.00	0.0	239.00	31334.00	0.0	0.0
58	0.0	31.00	1.00	0.0	239.00	23125.00	0.0	0.0
59	0.0	20.00	0.0	0.0	238.94	23125.00	0.0	0.0
60	0.0	12.00	0.0	0.0	238.87	22940.00	0.0	0.0
61	0.0	8.00	0.0	0.0	238.80	19143.00	0.0	0.0
62	0.0	5.00	0.0	0.0	238.75	16590.00	0.0	0.0
63	0.0	3.00	0.0	0.0	238.75	12850.00	0.0	0.0
64	0.0	2.00	0.0	0.0	238.75	10578.00	0.0	0.0
65	0.0	1.00	0.0	0.0	238.75	9317.00	0.0	0.0
66	0.0	0.0	0.0	0.0	238.75	7634.00	0.0	0.0
67	0.0	0.0	0.0	0.0	238.75	6860.00	0.0	0.0
68	10.00	75.00	35.00	0.0	238.75	4135.00	0.0700	0.0800
69	17.00	136.00	67.00	0.0	238.75	4135.00	0.0	0.0
70	11.00	100.00	48.00	0.0	233.75	230.00	0.0300	0.0100
71	5.00	64.00	24.00	0.0	238.75	230.00	0.0300	0.0100
72	12.00	114.00	48.00	0.0	238.75	230.00	0.0700	0.0800
73	29.00	249.00	115.00	0.0	238.78	230.00	0.0900	0.0900
74	31.00	275.00	130.00	0.0	238.81	230.00	0.0	0.0
75	18.00	191.00	82.00	0.0	238.84	230.00	0.0300	0.0100
76	8.00	119.00	41.00	0.0	238.87	230.00	0.0	0.0
77	4.00	72.00	20.00	0.0	238.90	230.00	0.0	0.0
78	13.00	134.00	52.00	0.0	238.90	230.00	0.0900	0.0900
79	21.00	189.00	85.00	0.0	238.90	230.00	0.0	0.0
80	13.00	137.00	59.00	0.0	238.90	230.00	0.0	0.0
81	6.00	87.00	29.00	0.0	238.90	230.00	0.0	0.0
82	3.00	53.00	15.00	0.0	238.90	230.00	0.0	0.0
83	1.00	33.00	7.00	0.0	238.90	230.00	0.0	0.0
84	1.00	21.00	4.00	0.0	238.90	230.00	0.0	0.0
85	0.0	14.00	2.00	0.0	239.00	230.00	0.0	0.0
86	0.0	9.00	1.00	0.0	239.00	230.00	0.0	0.0
87	0.0	6.00	0.0	0.0	239.00	230.00	0.0	0.0
88	0.0	4.00	0.0	0.0	239.10	230.00	0.0	0.0
89	0.0	3.00	0.0	0.0	239.20	230.00	0.0	0.0
90	0.0	2.00	0.0	0.0	239.40	230.00	0.0	0.0
91	0.0	1.00	0.0	0.0	239.40	230.00	0.0	0.0
92	0.0	1.00	0.0	0.0	239.40	230.00	0.0	0.0
93	0.0	0.0	0.0	0.0	239.50	230.00	0.0	0.0
94	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
95	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
96	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0

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97	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
98	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
99	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
100	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
101	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
102	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
103	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
104	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
105	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
106	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
107	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
108	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
109	0.0	0.0	0.0	0.0	239.35	230.00	0.0	0.0
110	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
111	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
112	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
113	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
114	0.0	0.0	0.0	0.0	239.45	230.00	0.0	0.0
115	0.0	0.0	0.0	0.0	239.45	230.00	0.0	0.0
116	0.0	0.0	0.0	0.0	239.45	230.00	0.0	0.0
117	0.0	0.0	0.0	0.0	239.45	230.00	0.0	0.0
118	0.0	0.0	0.0	0.0	239.45	230.00	0.0	0.0
119	10.00	77.00	36.00	0.0	239.45	230.00	0.0700	0.0800
120	17.00	138.00	69.00	0.0	239.45	230.00	0.0	0.0

ELEV VS AREA FOR AREA 1

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	6.10	210.00	20.40	220.00	44.20
230.00	85.00	240.00	142.80	250.00	231.20	255.00	318.20
260.00	374.00	270.00	573.90				

ELEV VS AREA FOR AREA 2

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	55.30	210.00	184.20	220.00	399.10
230.00	767.50	240.00	1289.40	250.00	2087.60	255.00	2873.50
260.00	3377.00	270.00	5182.20				

ELEV VS AREA FOR AREA 3

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	28.10	210.00	93.60	220.00	202.80
230.00	390.00	240.00	655.20	250.00	1060.80	255.00	1460.20
260.00	1716.00	270.00	2633.30				

ELEV VS AREA FOR AREA 4

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	0.50	210.00	1.80	220.00	3.90
230.00	7.50	240.00	12.60	250.00	20.40	255.00	28.10
260.00	33.00	270.00	50.60				

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ELEV VS AREA FOR AREA 5

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
180.00	0.0	190.00	280.00	200.00	960.00	210.00	2100.00
220.00	3500.00	230.00	5010.00	240.00	6950.00	250.00	9540.00
260.00	12150.00	270.00	15310.00				

FLOW FACTOR FOR FLOW OVER THE DIKES

HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR
0.0	0.0	0.20	0.0	0.50	0.84	1.00	0.94
1.50	0.96	2.00	0.97	3.00	0.98	4.00	0.98
5.00	0.98	6.00	0.98	7.00	0.97	8.00	0.97
9.00	0.96	10.00	0.95	15.00	0.90		

FLOW THROUGH THE DIKES AND CANALS

	DIKE 1 (CFS)	DIKE 2 (CFS)	DIKE 3 (CFS)	DIKE 4 (CFS)	CANAL A (CFS)	CANAL B (CFS)	CANAL C (CFS)
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	-96.09	0.0	87.53	-21.88	61.66
18	0.0	0.0	-71.62	0.0	86.76	-31.56	11.78
19	0.0	0.0	-192.19	0.0	87.86	-8.95	114.07
20	0.0	0.0	-150.24	0.0	87.82	-12.65	105.17
21	0.0	0.0	-143.25	0.0	87.81	-10.95	100.98
22	0.0	0.0	-55.48	0.0	87.13	-28.23	32.47
23	0.0	0.0	-71.62	0.0	86.76	-31.56	11.78
24	0.0	0.0	-64.06	0.0	86.76	-32.80	5.27
25	0.0	0.0	-106.24	0.0	87.54	-22.78	70.09
26	0.0	0.0	-71.62	0.0	86.94	-30.27	10.53
27	0.0	0.0	-64.06	0.0	86.76	-33.40	0.0
28	0.0	0.0	-64.06	0.0	86.76	-33.40	-5.27
29	0.0	0.0	-55.48	0.0	86.76	-33.40	-5.27
30	0.0	0.0	-55.48	0.0	86.76	-33.40	-7.45
31	0.0	0.0	-55.48	0.0	86.76	-33.40	-7.45
32	0.0	0.0	-78.46	0.0	86.59	-30.92	10.53
33	0.0	0.0	-128.13	0.0	87.22	-19.98	80.09
34	0.0	0.0	-175.44	0.0	85.16	-6.32	104.91
35	0.0	0.0	-783.29	0.0	85.00	-11.05	106.38
36	0.0	0.0	-1000.18	0.0	80.59	15.85	168.85
37	0.0	0.0	-1866.35	0.0	44.13	54.84	494.47
38	0.0	0.0	-3569.29	0.0	-180.27	128.23	1002.75
39	0.0	0.0	-4270.26	0.0	-234.91	145.07	1311.73
40	0.0	0.0	-4271.56	0.0	-282.65	141.45	1676.34

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41	0.0	0.0	-4228.73	0.0	-327.17	150.55	1883.67
42	0.0	0.0	-4068.10	0.0	-354.49	165.19	1893.37
43	0.0	0.0	-3818.71	0.0	-375.35	172.19	1635.49
44	0.0	0.0	-3471.81	0.0	-402.10	147.23	1116.50
45	0.0	0.0	-2317.35	0.0	-430.23	-163.28	-364.53
46	0.0	0.0	1271.60	0.0	-469.75	-214.65	-1222.64
47	0.0	0.0	2411.72	0.0	-514.85	-250.30	-1868.96
48	0.0	0.0	3221.81	0.0	-561.04	-287.51	-2369.24
49	0.0	0.0	3597.64	0.0	-602.84	-312.30	-2689.00
50	0.0	0.0	4190.10	0.0	-644.60	-335.26	-3009.31
51	0.0	0.0	4790.04	0.0	-691.56	-360.59	-3368.50
52	0.0	0.0	5299.31	0.0	-743.24	-386.73	-3729.85
53	0.0	0.0	4646.63	0.0	-792.76	-386.59	-3697.09
54	0.0	0.0	3881.47	0.0	-835.67	-397.29	-3341.55
55	0.0	0.0	3286.91	0.0	-873.29	-368.65	-2871.02
56	0.0	0.0	2715.87	0.0	-905.58	-299.94	-2364.08
57	0.0	0.0	2130.02	0.0	-931.61	-194.69	-1843.98
58	0.0	0.0	1527.46	0.0	-955.15	48.64	-1314.97
59	0.0	0.0	817.27	0.0	-950.93	403.06	274.17
60	0.0	0.0	-594.09	0.0	-935.97	460.09	792.85
61	0.0	0.0	-873.70	0.0	-920.93	469.04	954.55
62	0.0	0.0	-822.90	0.0	-908.26	460.19	893.95
63	0.0	0.0	-365.21	0.0	-906.57	398.88	313.69
64	0.0	0.0	-78.46	0.0	-909.44	355.00	-59.49
65	0.0	0.0	-78.46	0.0	-909.44	355.00	-62.70
66	0.0	0.0	-78.46	0.0	-909.44	355.00	-62.70
67	0.0	0.0	-78.46	0.0	-909.44	355.00	-62.70
68	0.0	0.0	-146.79	0.0	-910.05	368.33	90.87
69	0.0	0.0	-358.12	0.0	-909.86	386.52	237.22
70	0.0	0.0	-163.33	0.0	-909.13	368.33	106.79
71	0.0	0.0	-124.06	0.0	-909.28	360.55	71.50
72	0.0	0.0	-202.58	0.0	-909.91	370.65	134.50
73	0.0	0.0	-677.22	0.0	-923.98	330.30	-191.23
74	0.0	0.0	-776.06	0.0	-930.72	343.05	-155.19
75	0.0	0.0	-526.33	0.0	-935.91	318.87	-243.81
76	0.0	0.0	-313.84	0.0	-941.86	307.03	-325.55
77	0.0	0.0	132.07	0.0	-948.43	297.53	-396.24
78	0.0	0.0	-192.19	0.0	-946.62	386.11	134.56
79	0.0	0.0	-433.31	0.0	-946.64	406.58	293.42
80	0.0	0.0	-219.60	0.0	-945.50	388.43	161.02
81	0.0	0.0	-115.49	0.0	-945.53	374.39	75.90
82	0.0	0.0	-78.46	0.0	-945.48	372.00	49.68
83	0.0	0.0	-32.03	0.0	-945.22	369.60	0.0
84	0.0	0.0	-32.03	0.0	-945.46	370.40	-28.68
85	0.0	0.0	993.49	0.0	-965.70	169.62	-1033.39
86	0.0	0.0	502.39	0.0	-972.16	301.82	-433.37
87	0.0	0.0	-64.06	0.0	-970.04	377.59	-79.74
88	0.0	0.0	1014.44	0.0	-990.43	180.91	-1045.10
89	0.0	0.0	1382.18	0.0	-1009.24	120.41	-1272.08
90	0.0	0.0	2305.58	0.0	-1031.74	-134.68	-1832.95
91	0.0	0.0	1580.93	0.0	-1058.05	115.42	-1344.04
92	0.0	0.0	937.70	0.0	-1071.80	270.70	-794.82
93	0.0	0.0	1297.56	0.0	-1090.96	182.07	-1216.28
94	0.0	0.0	-564.88	0.0	-1070.73	509.37	752.50
95	0.0	0.0	-101.29	0.0	-1072.13	432.57	75.64
96	0.0	0.0	32.03	0.0	-1073.24	419.67	-65.50
97	0.0	0.0	32.03	0.0	-1073.24	419.67	-65.50
98	0.0	0.0	32.03	0.0	-1073.24	419.67	-65.50
99	0.0	0.0	-1049.73	0.0	-1048.14	533.61	1062.92
100	0.0	0.0	720.53	0.0	-1072.61	268.27	-855.82
101	0.0	0.0	-866.03	0.0	-1046.19	521.76	949.72
102	0.0	0.0	814.12	0.0	-1071.49	253.75	-915.00
103	0.0	0.0	323.50	0.0	-1074.93	373.67	-276.08

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104	0.0	0.0	-1030.99	0.0	-1047.90	531.59	1049.26
105	0.0	0.0	-495.19	0.0	-1043.94	467.25	422.11
106	0.0	0.0	-55.48	0.0	-1046.67	409.58	-68.05
107	0.0	0.0	-55.48	0.0	-1046.67	409.58	-68.05
108	0.0	0.0	-55.48	0.0	-1046.67	409.58	-68.05
109	0.0	0.0	507.47	0.0	-1061.27	296.60	-684.70
110	0.0	0.0	664.99	0.0	-1073.48	280.85	-775.38
111	0.0	0.0	160.16	0.0	-1074.45	396.07	-164.83
112	0.0	0.0	64.06	0.0	-1073.22	418.03	-78.73
113	0.0	0.0	64.06	0.0	-1073.22	418.03	-78.73
114	0.0	0.0	520.45	0.0	-1087.72	305.49	-689.44
115	0.0	0.0	55.48	0.0	-1087.30	416.90	-100.78
116	0.0	0.0	-32.03	0.0	-1086.61	424.35	-90.68
117	0.0	0.0	-32.03	0.0	-1086.61	424.35	-90.68
118	0.0	0.0	-32.03	0.0	-1086.61	424.35	-90.68
119	0.0	0.0	-146.79	0.0	-1087.29	439.70	95.87
120	0.0	0.0	-366.61	0.0	-1087.36	459.27	242.03

	H1	H2	H3	H4	HR	QR
	FT	FT	FT	FT	FT	CFS
1	232.50	232.50	232.50	232.50	232.50	0.0
2	232.50	232.50	232.50	232.50	232.50	225.00
3	232.50	232.50	232.50	232.50	232.50	225.00
4	232.50	232.50	232.50	232.50	232.50	225.00
5	232.50	232.50	232.50	232.50	232.50	225.00
6	232.50	232.50	232.50	232.50	232.50	225.00
7	232.50	232.50	232.50	232.50	232.50	225.00
8	232.50	232.50	232.50	232.50	232.50	225.00
9	232.50	232.50	232.50	232.50	232.50	225.00
10	232.50	232.50	232.50	232.50	232.50	225.00
11	232.50	232.50	232.50	232.50	232.50	247.00
12	232.50	232.50	232.50	232.50	232.50	247.00
13	232.50	232.50	232.50	232.50	232.50	65.78
14	232.50	232.50	232.50	232.50	232.50	227.00
15	232.50	232.50	232.50	232.50	232.50	228.00
16	232.50	232.50	232.50	232.50	232.50	-162.85
17	232.50	232.50	232.50	232.51	232.50	128.91
18	232.50	232.50	232.50	232.50	232.50	-566.93
19	232.51	232.51	232.50	232.51	232.50	-355.04
20	232.51	232.51	232.50	232.51	232.50	-423.91
21	232.51	232.51	232.50	232.51	232.50	81.75
22	232.50	232.50	232.50	232.50	232.50	3.30
23	232.50	232.50	232.50	232.50	232.50	153.38
24	232.50	232.50	232.50	232.50	232.50	-226.92
25	232.50	232.50	232.50	232.51	232.50	118.76
26	232.50	232.50	232.50	232.50	232.50	155.38
27	232.50	232.50	232.50	232.50	232.50	162.94
28	232.50	232.50	232.50	232.50	232.50	160.94
29	232.50	232.50	232.50	232.50	232.50	169.52
30	232.50	232.50	232.50	232.50	232.50	169.52
31	232.50	232.50	232.50	232.50	232.50	171.52
32	232.50	232.50	232.50	232.50	232.50	-239.32
33	232.50	232.50	232.50	232.51	232.50	98.88
34	232.51	232.51	232.50	232.51	232.50	-667.74
35	232.54	232.54	232.53	232.54	232.52	385.57
36	232.58	232.58	232.56	232.58	232.55	-495.73
37	232.77	232.77	232.65	232.77	232.60	-3974.49
38	233.24	233.24	232.84	233.23	232.65	-6349.95
39	233.86	233.86	233.35	233.85	233.08	21400.33

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40	234.42	234.41	233.77	234.40	233.50	21081.80
41	234.91	234.91	234.27	234.90	234.00	28028.10
42	235.29	235.28	234.75	235.27	234.50	29615.50
43	235.54	235.54	235.20	235.53	234.98	27620.21
44	235.77	235.77	235.63	235.75	235.45	29179.90
45	235.98	235.99	236.00	235.97	235.92	31505.73
46	236.24	236.24	236.38	236.22	236.40	36358.69
47	236.52	236.52	236.79	236.50	236.88	37828.10
48	236.81	236.81	237.20	236.78	237.35	39274.07
49	237.08	237.08	237.53	237.05	237.72	34148.00
50	237.32	237.33	237.84	237.30	238.10	41353.82
51	237.57	237.58	238.16	237.55	238.50	59002.87
52	237.83	237.83	238.48	237.80	238.90	67876.88
53	238.08	238.08	238.68	238.05	239.00	44155.88
54	238.31	238.31	238.78	238.28	239.00	35215.47
55	238.51	238.51	238.84	238.48	239.00	34620.91
56	238.67	238.68	238.89	238.64	239.00	34049.86
57	238.80	238.81	238.93	238.77	239.00	33464.02
58	238.90	238.90	238.97	238.87	239.00	24652.46
59	238.94	238.93	238.93	238.91	238.94	19044.82
60	238.90	238.90	238.88	238.87	238.87	16645.59
61	238.85	238.85	238.81	238.82	238.80	12579.25
62	238.80	238.79	238.76	238.77	238.75	11710.05
63	238.76	238.76	238.75	238.73	238.75	12484.79
64	238.75	238.75	238.75	238.72	238.75	10499.54
65	238.75	238.75	238.75	238.72	238.75	9238.54
66	238.75	238.75	238.75	238.72	238.75	7555.54
67	238.75	238.75	238.75	238.72	238.75	6781.54
68	238.75	238.75	238.75	238.73	238.75	3514.78
69	238.76	238.75	238.75	238.73	238.75	3776.88
70	238.75	238.75	238.75	238.73	238.75	-136.23
71	238.75	238.75	238.75	238.72	238.75	-96.96
72	238.76	238.75	238.75	238.73	238.75	-446.02
73	238.79	238.79	238.79	238.76	238.78	1380.38
74	238.82	238.82	238.82	238.79	238.81	1892.89
75	238.84	238.84	238.84	238.81	238.84	1941.30
76	238.87	238.87	238.87	238.84	238.87	2359.33
77	238.90	238.89	238.90	238.87	238.90	2807.35
78	238.91	238.90	238.90	238.87	238.90	-573.53
79	238.91	238.91	238.90	238.88	238.90	-203.31
80	238.91	238.90	238.90	238.88	238.90	10.40
81	238.90	238.90	238.90	238.87	238.90	114.51
82	238.90	238.90	238.90	238.87	238.90	151.54
83	238.90	238.90	238.90	238.87	238.90	197.97
84	238.90	238.90	238.90	238.87	238.90	197.97
85	238.95	238.95	238.99	238.92	239.00	9398.73
86	238.99	238.99	239.00	238.96	239.00	732.39
87	239.00	239.00	239.00	238.97	239.00	165.94
88	239.05	239.05	239.08	239.02	239.10	9441.90
89	239.12	239.12	239.17	239.08	239.20	9834.38
90	239.21	239.21	239.32	239.18	239.40	19072.62
91	239.30	239.30	239.36	239.27	239.40	1810.93
92	239.37	239.37	239.39	239.33	239.40	1167.70
93	239.43	239.43	239.47	239.39	239.50	9820.19
94	239.43	239.42	239.40	239.40	239.40	-8604.03
95	239.40	239.40	239.40	239.37	239.40	128.71
96	239.40	239.40	239.40	239.37	239.40	262.03
97	239.40	239.40	239.40	239.37	239.40	262.03
98	239.40	239.40	239.40	239.37	239.40	262.03
99	239.36	239.35	239.32	239.33	239.30	-9065.39
100	239.37	239.37	239.39	239.34	239.40	9219.68
101	239.35	239.34	239.31	239.31	239.30	-8681.70
102	239.36	239.36	239.39	239.33	239.40	9313.27

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103	239.40	239.40	239.40	239.37	239.40	553.50
104	239.36	239.35	239.32	239.33	239.30	-9046.66
105	239.31	239.31	239.30	239.28	239.30	-265.19
106	239.30	239.30	239.30	239.27	239.30	174.52
107	239.30	239.30	239.30	239.27	239.30	174.52
108	239.30	239.30	239.30	239.27	239.30	174.52
109	239.33	239.33	239.35	239.30	239.35	4866.17
110	239.38	239.37	239.39	239.34	239.40	5029.56
111	239.40	239.40	239.40	239.37	239.40	390.16
112	239.40	239.40	239.40	239.37	239.40	294.06
113	239.40	239.40	239.40	239.37	239.40	294.06
114	239.43	239.43	239.45	239.40	239.45	4890.89
115	239.45	239.45	239.45	239.42	239.45	285.48
116	239.45	239.45	239.45	239.42	239.45	197.97
117	239.45	239.45	239.45	239.42	239.45	197.97
118	239.45	239.45	239.45	239.42	239.45	197.97
119	239.45	239.45	239.45	239.42	239.45	-399.81
120	239.46	239.45	239.45	239.42	239.45	-136.61

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** LAKE INFLOW COMPUTATION **

[illegible]

** APRIL 73 STORM, UNSMOOTHED STAGE DATA **

** NORMAL DIKE DISCHARGE, NORMAL LAKE $ WHTF AREA **

DT(HR.)	HI(FT)	QC(CFS)	N	HSADDLE(FT)	TW(STEP)
1.00	250.00	0.0	0.03	253.50	60.00

	DIKE ELE (FT)	DIKE WIDTH (FT)	DIKE LENGTH (FT)
1	260.00	20.00	3890.00
2	260.00	20.00	3740.00
3	260.00	32.00	2340.00
4	260.00	25.00	400.00

	CANAL ELE 1 (FT)	CANAL ELE 2 (FT)	CANAL LENGTH (FT)
1	227.00	255.00	3910.00
2	227.00	255.00	2000.00
3	227.00	255.00	4310.00

	Q1(CFS)	Q2(CFS)	Q3(CFS)	Q4(CFS)	HR(FT)	QS(CFS)	QPR(IN/HR)	QP(IN/HR)
1	0.0	0.0	0.0	0.0	250.00	60.86	0.0	0.0
2	0.0	0.0	0.0	0.0	250.00	60.86	0.0	0.0
3	0.0	0.0	0.0	0.0	250.00	60.86	0.0	0.0
4	0.0	0.0	0.0	0.0	250.00	60.86	0.0	0.0
5	0.0	0.0	0.0	0.0	250.00	60.86	0.0	0.0
6	1.00	12.00	5.00	0.0	250.00	60.86	0.1600	0.1900
7	2.00	22.00	11.00	0.0	250.00	60.86	0.0300	0.0100
8	22.00	182.00	86.00	0.0	250.00	60.86	0.2300	0.2800
9	66.00	530.00	256.00	0.0	250.00	60.86	0.2300	0.2600
10	91.00	766.00	371.00	0.0	250.00	60.86	0.1600	0.1900
11	82.00	752.00	348.00	0.0	250.00	60.86	0.1100	0.1100
12	62.00	638.00	273.00	0.0	250.00	60.86	0.1100	0.1100
13	43.00	480.00	193.00	0.0	250.01	30.92	0.0	0.0
14	22.00	315.00	110.00	0.0	250.02	62.70	0.0	0.0
15	18.00	258.00	84.00	0.0	250.03	63.62	0.0800	0.0900
16	18.00	234.00	83.00	0.0	250.05	65.48	0.0300	0.0100
17	10.00	159.00	53.00	0.0	250.07	499.72	0.0	0.0
18	4.00	102.00	26.00	0.0	250.09	503.40	0.0	0.0
19	2.00	64.00	13.00	0.0	250.10	505.25	0.0	0.0
20	0.0	41.00	6.00	0.0	250.10	505.25	0.0	0.0
21	9.00	94.00	35.00	0.0	250.10	505.25	0.0800	0.0900
22	24.00	212.00	96.00	0.0	250.10	505.25	0.0800	0.0900
23	37.00	321.00	150.00	0.0	250.10	505.25	0.1100	0.1100
24	34.00	322.00	147.00	0.0	250.10	505.25	0.0600	0.0200
25	19.00	219.00	90.00	0.0	250.20	3125.26	0.0	0.0
26	9.00	136.00	45.00	0.0	250.20	3125.26	0.0300	0.0100
27	4.00	83.00	22.00	0.0	250.20	3125.26	0.0	0.0
28	2.00	51.00	11.00	0.0	250.20	3125.26	0.0	0.0
29	0.0	32.00	5.00	0.0	250.20	3125.26	0.0	0.0
30	0.0	20.00	2.00	0.0	250.20	3125.26	0.0	0.0
31	0.0	13.00	1.00	0.0	250.20	3125.26	0.0	0.0
32	0.0	8.00	0.0	0.0	250.20	3125.26	0.0	0.0
33	0.0	6.00	0.0	0.0	250.20	3125.26	0.0	0.0

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34	0.0	4.00	0.0	0.0	250.20	3125.26	0.0	0.0
35	0.0	2.00	0.0	0.0	250.20	3125.26	0.0	0.0
36	10.00	82.00	37.00	0.0	250.20	3125.26	0.0800	0.0900
37	18.00	146.00	71.00	0.0	250.20	3125.26	0.0	0.0
38	11.00	107.00	51.00	0.0	250.20	3125.26	0.0	0.0
39	5.00	68.00	25.00	0.0	250.20	3125.26	0.0	0.0
40	2.00	41.00	12.00	0.0	250.20	3125.26	0.0	0.0
41	1.00	25.00	6.00	0.0	250.20	3125.26	0.0	0.0
42	0.0	15.00	3.00	0.0	250.20	3125.26	0.0	0.0
43	0.0	10.00	1.00	0.0	250.17	3118.41	0.0	0.0
44	0.0	6.00	0.0	0.0	250.15	3113.66	0.0	0.0
45	0.0	4.00	0.0	0.0	250.12	3107.05	0.0	0.0
46	0.0	2.00	0.0	0.0	250.10	3102.52	0.0	0.0
47	0.0	1.00	0.0	0.0	250.10	3102.52	0.0	0.0
48	0.0	1.00	0.0	0.0	250.10	3102.52	0.0	0.0
49	0.0	0.0	0.0	0.0	250.10	3102.52	0.0	0.0
50	43.00	343.00	161.00	0.0	250.13	3109.32	0.2300	0.2800
51	91.00	733.00	360.00	0.0	250.16	3116.14	0.1400	0.1200
52	106.00	911.00	437.00	0.0	250.20	3125.26	0.2200	0.2100
53	143.00	1275.00	584.00	0.0	250.20	5726.66	0.2900	0.3000
54	193.00	1717.00	790.00	0.0	250.20	5726.66	0.3500	0.3300
55	180.00	1688.00	765.00	0.0	250.20	5726.66	0.1500	0.0600
56	121.00	1295.00	540.00	0.0	250.20	5726.66	0.1100	0.1100
57	89.00	1045.00	397.00	0.0	250.23	5734.78	0.1100	0.1100
58	74.00	880.00	331.00	0.0	250.26	5742.91	0.0800	0.0900
59	53.00	678.00	246.00	0.0	250.30	5753.77	0.0	0.0
60	28.00	445.00	141.00	0.0	250.33	5761.94	0.0300	0.0100
61	13.00	280.00	70.00	0.0	250.36	5770.13	0.0	0.0
62	5.00	175.00	34.00	0.0	250.39	5778.34	0.0	0.0
63	2.00	112.00	17.00	0.0	250.44	5792.06	0.0	0.0
64	1.00	74.00	8.00	0.0	250.50	5808.59	0.0	0.0
65	0.0	49.00	4.00	0.0	250.58	5830.75	0.0	0.0
66	0.0	33.00	1.00	0.0	250.72	5869.83	0.0	0.0
67	0.0	22.00	0.0	0.0	250.80	5892.33	0.0	0.0
68	0.0	15.00	0.0	0.0	250.80	5892.33	0.0	0.0
69	0.0	9.00	0.0	0.0	250.80	5892.33	0.0	0.0
70	0.0	6.00	0.0	0.0	250.80	5892.33	0.0	0.0
71	0.0	4.00	0.0	0.0	250.80	5892.33	0.0	0.0
72	0.0	2.00	0.0	0.0	250.80	5892.33	0.0	0.0
73	0.0	1.00	0.0	0.0	250.80	5892.33	0.0	0.0
74	0.0	0.0	0.0	0.0	250.80	5892.33	0.0	0.0
75	0.0	0.0	0.0	0.0	250.80	5892.33	0.0	0.0
76	0.0	0.0	0.0	0.0	250.80	5892.33	0.0	0.0
77	0.0	0.0	0.0	0.0	250.70	5864.22	0.0	0.0
78	0.0	0.0	0.0	0.0	250.70	5864.22	0.0	0.0
79	0.0	0.0	0.0	0.0	250.70	5864.22	0.0	0.0
80	0.0	0.0	0.0	0.0	250.70	5864.22	0.0	0.0
81	0.0	0.0	0.0	0.0	250.70	5864.22	0.0	0.0
82	0.0	0.0	0.0	0.0	250.70	5864.22	0.0	0.0
83	0.0	0.0	0.0	0.0	250.70	5864.22	0.0	0.0
84	0.0	0.0	0.0	0.0	250.70	5864.22	0.0	0.0
85	0.0	0.0	0.0	0.0	250.70	5864.22	0.0	0.0
86	0.0	0.0	0.0	0.0	250.70	5864.22	0.0	0.0
87	0.0	0.0	0.0	0.0	250.68	5858.62	0.0	0.0
88	0.0	0.0	0.0	0.0	250.65	5850.24	0.0	0.0
89	0.0	0.0	0.0	0.0	250.62	5841.88	0.0	0.0
90	0.0	0.0	0.0	0.0	250.60	5836.31	0.0	0.0
91	0.0	0.0	0.0	0.0	250.60	5836.31	0.0	0.0
92	0.0	0.0	0.0	0.0	250.55	5822.43	0.0	0.0
93	0.0	0.0	0.0	0.0	250.50	5808.59	0.0	0.0
94	0.0	0.0	0.0	0.0	250.50	5808.59	0.0	0.0
95	0.0	0.0	0.0	0.0	250.40	5781.08	0.0	0.0
96	0.0	0.0	0.0	0.0	250.38	5775.60	0.0	0.0

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ELEV VS AREA FOR AREA 1

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	6.10	210.00	20.40	220.00	44.20
230.00	85.00	240.00	142.80	250.00	231.20	255.00	318.20
260.00	374.00	270.00	573.90				

ELEV VS AREA FOR AREA 2

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	55.30	210.00	184.20	220.00	399.10
230.00	767.50	240.00	1289.40	250.00	2087.60	255.00	2873.50
260.00	3377.00	270.00	5182.20				

ELEV VS AREA FOR AREA 3

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	28.10	210.00	93.60	220.00	202.80
230.00	390.00	240.00	655.20	250.00	1060.80	255.00	1460.20
260.00	1716.00	270.00	2633.30				

ELEV VS AREA FOR AREA 4

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	0.50	210.00	1.80	220.00	3.90
230.00	7.50	240.00	12.60	250.00	20.40	255.00	28.10
260.00	33.00	270.00	50.60				

ELEV VS AREA FOR AREA 5

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
180.00	0.0	190.00	280.00	200.00	960.00	210.00	2100.00
220.00	3500.00	230.00	5010.00	240.00	6950.00	250.00	9540.00
260.00	12150.00	270.00	15310.00				

FLOW FACTOR FOR FLOW OVER THE DIKES

HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR
0.0	0.0	0.20	0.0	0.50	0.84	1.00	0.94
1.50	0.96	2.00	0.97	3.00	0.98	4.00	0.98
5.00	0.98	6.00	0.98	7.00	0.97	8.00	0.97
9.00	0.96	10.00	0.95	15.00	0.90		

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FLOW THROUGH THE DIKES AND CANALS

	DIKE 1 (CFS)	DIKE 2 (CFS)	DIKE 3 (CFS)	DIKE 4 (CFS)	CANAL A (CFS)	CANAL B (CFS)	CANAL C (CFS)
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	-686.99	0.0	6404.17	-2039.32	811.62
8	0.0	0.0	-545.47	0.0	6396.75	-2055.18	739.16
9	0.0	0.0	-1299.54	0.0	6418.35	-1948.29	1078.08
10	0.0	0.0	-1710.00	0.0	6438.71	-1900.75	1313.56
11	0.0	0.0	-1824.38	0.0	6448.57	-1889.36	1409.30
12	0.0	0.0	-1738.56	0.0	6445.90	-1904.61	1371.54
13	0.0	0.0	-1458.04	0.0	6440.55	-1949.32	1161.36
14	0.0	0.0	-933.31	0.0	6428.56	-2023.95	929.17
15	0.0	0.0	-576.56	0.0	6424.37	-2086.26	589.31
16	0.0	0.0	-709.04	0.0	6443.22	-2125.30	428.61
17	0.0	0.0	-451.54	0.0	6457.98	-2147.06	217.32
18	0.0	0.0	-217.25	0.0	6474.34	-2161.11	-182.08
19	0.0	0.0	-370.79	0.0	6488.65	-2129.93	357.94
20	0.0	0.0	-243.94	0.0	6491.96	-2081.38	600.49
21	0.0	0.0	-329.78	0.0	6492.08	-2070.04	631.34
22	0.0	0.0	-691.46	0.0	6498.24	-2027.93	835.60
23	0.0	0.0	-883.04	0.0	6502.27	-2003.40	940.30
24	0.0	0.0	-994.52	0.0	6506.67	-1992.02	1001.77
25	0.0	0.0	1406.46	0.0	6525.39	-2333.24	-1203.63
26	0.0	0.0	277.40	0.0	6568.04	-2161.40	250.36
27	0.0	0.0	-312.20	0.0	6577.41	-2080.50	636.56
28	0.0	0.0	-267.99	0.0	6576.33	-2082.08	617.30
29	0.0	0.0	-241.83	0.0	6576.60	-2087.02	605.46
30	0.0	0.0	-230.98	0.0	6576.54	-2087.00	601.45
31	0.0	0.0	-219.60	0.0	6576.54	-2087.00	601.45
32	0.0	0.0	-212.47	0.0	6576.47	-2086.98	601.45
33	0.0	0.0	-212.47	0.0	6576.47	-2086.98	601.45
34	0.0	0.0	-212.47	0.0	6576.47	-2086.98	601.45
35	0.0	0.0	-212.47	0.0	6576.47	-2086.98	601.45
36	0.0	0.0	-317.09	0.0	6576.25	-2072.18	628.93
37	0.0	0.0	-639.82	0.0	6582.60	-2037.71	801.31
38	0.0	0.0	-454.12	0.0	6579.41	-2057.40	698.10
39	0.0	0.0	-331.33	0.0	6577.54	-2077.21	640.35
40	0.0	0.0	-258.24	0.0	6576.26	-2083.74	613.38
41	0.0	0.0	-237.55	0.0	6576.60	-2085.36	605.46
42	0.0	0.0	-221.92	0.0	6576.54	-2087.00	601.45
43	0.0	0.0	-857.70	0.0	6568.39	-1971.70	1026.18
44	0.0	0.0	-851.09	0.0	6550.48	-1978.87	1019.79
45	0.0	0.0	-1033.47	0.0	6532.14	-1946.95	1083.59
46	0.0	0.0	-935.51	0.0	6511.30	-1965.90	1016.12
47	0.0	0.0	-443.84	0.0	6496.31	-2048.83	692.37
48	0.0	0.0	-207.59	0.0	6491.83	-2079.70	600.48
49	0.0	0.0	-189.50	0.0	6491.77	-2081.32	596.51
50	0.0	0.0	-279.24	0.0	6503.32	-2161.99	-300.98
51	0.0	0.0	-1139.70	0.0	6549.84	-2021.38	860.37
52	0.0	0.0	-1153.13	0.0	6580.41	-2073.65	667.19
53	0.0	0.0	-1812.81	0.0	6613.25	-1904.19	1413.84
54	0.0	0.0	-2420.35	0.0	6646.05	-1829.99	1811.14
55	0.0	0.0	-2818.02	0.0	6681.88	-1790.27	2090.65
56	0.0	0.0	-2744.61	0.0	6685.93	-1807.06	2090.78
57	0.0	0.0	-2325.74	0.0	6679.65	-1877.11	1748.34
58	0.0	0.0	-1886.31	0.0	6676.08	-1930.73	1414.34
59	0.0	0.0	-1256.18	0.0	6679.86	-2050.70	967.05
60	0.0	0.0	-784.60	0.0	6686.52	-2163.69	384.73
61	0.0	0.0	-410.20	0.0	6705.15	-2193.79	-99.52
62	0.0	0.0	328.22	0.0	6725.92	-2225.76	-451.56
63	0.0	0.0	944.79	0.0	6752.66	-2292.77	-751.96
64	0.0	0.0	1341.11	0.0	6789.42	-2332.43	-1016.62

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65	0.0	0.0	1827.47	0.0	6832.26	-2389.03	-1366.42
66	0.0	0.0	2733.38	0.0	6887.68	-2491.94	-2032.30
67	0.0	0.0	2770.84	0.0	6945.95	-2494.24	-1967.08
68	0.0	0.0	1965.69	0.0	6992.76	-2402.54	-1239.99
69	0.0	0.0	1100.78	0.0	7025.84	-2311.02	-630.52
70	0.0	0.0	55.48	0.0	7046.29	-2189.46	583.34
71	0.0	0.0	-228.75	0.0	7049.15	-2150.97	635.72
72	0.0	0.0	-228.75	0.0	7049.15	-2150.97	635.72
73	0.0	0.0	-228.75	0.0	7049.15	-2150.97	635.72
74	0.0	0.0	-228.75	0.0	7049.15	-2150.97	635.72
75	0.0	0.0	-228.75	0.0	7049.15	-2150.97	635.72
76	0.0	0.0	-228.75	0.0	7049.15	-2150.97	635.72
77	0.0	0.0	-1953.91	0.0	7040.97	-1864.69	1762.59
78	0.0	0.0	-1371.00	0.0	7014.63	-1979.51	1173.59
79	0.0	0.0	-822.27	0.0	6999.59	-2052.98	954.97
80	0.0	0.0	-436.85	0.0	6991.72	-2102.22	719.88
81	0.0	0.0	-277.40	0.0	6989.24	-2123.21	642.97
82	0.0	0.0	-266.07	0.0	6989.18	-2126.73	638.88
83	0.0	0.0	-266.07	0.0	6989.18	-2126.73	638.88
84	0.0	0.0	-266.07	0.0	6989.18	-2126.73	638.88
85	0.0	0.0	-266.07	0.0	6989.18	-2126.73	638.88
86	0.0	0.0	-266.07	0.0	6989.18	-2126.73	638.88
87	0.0	0.0	-695.90	0.0	6986.53	-2040.06	998.70
88	0.0	0.0	-1026.00	0.0	6975.82	-1986.51	1108.23
89	0.0	0.0	-1165.52	0.0	6961.81	-1965.53	1165.30
90	0.0	0.0	-1067.65	0.0	6943.84	-1980.55	1094.48
91	0.0	0.0	-589.76	0.0	6927.55	-2064.38	812.13
92	0.0	0.0	-1326.88	0.0	6911.62	-1927.08	1301.10
93	0.0	0.0	-1025.73	0.0	6883.60	-1890.82	1463.54
94	0.0	0.0	-1040.69	0.0	6654.70	-1999.33	1049.87
95	0.0	0.0	-2116.00	0.0	6828.16	-1807.62	1844.73
96	0.0	0.0	-1772.17	0.0	6786.25	-1877.42	1465.66

	H1	H2	H3	H4	HR	QR
	FT	FT	FT	FT	FT	CFS
1	250.00	250.00	250.00	250.00	250.00	0.0
2	250.00	250.00	250.00	250.00	250.00	60.86
3	250.00	250.00	250.00	250.00	250.00	60.86
4	250.00	250.00	250.00	250.00	250.00	60.86
5	250.00	250.00	250.00	250.00	250.00	60.86
6	250.00	250.00	250.00	250.00	250.00	-1470.26
7	250.00	250.01	250.01	250.12	250.00	-914.72
8	250.00	250.01	250.00	250.12	250.00	-2697.10
9	250.02	250.03	250.03	250.14	250.00	-3451.16
10	250.04	250.05	250.04	250.16	250.00	-3188.26
11	250.05	250.06	250.05	250.17	250.00	-2821.66
12	250.04	250.05	250.04	250.16	250.00	-2735.85
13	250.04	250.05	250.04	250.16	250.01	-273.10
14	250.03	250.04	250.03	250.15	250.02	283.72
15	250.03	250.04	250.03	250.15	250.03	-126.72
16	250.05	250.06	250.06	250.17	250.05	1376.02
17	250.06	250.07	250.07	250.18	250.07	2331.78
18	250.08	250.09	250.09	250.20	250.09	2601.01
19	250.09	250.10	250.10	250.21	250.10	1291.32
20	250.09	250.10	250.10	250.21	250.10	261.31
21	250.09	250.10	250.10	250.22	250.10	-596.20
22	250.10	250.11	250.11	250.22	250.10	-957.87
23	250.11	250.11	250.11	250.23	250.10	-1438.83
24	250.11	250.12	250.11	250.23	250.10	-1068.02

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25	250.15	250.17	250.17	250.28	250.20	16138.97
26	250.19	250.20	250.20	250.31	250.20	3112.49
27	250.19	250.20	250.20	250.32	250.20	2813.06
28	250.19	250.20	250.20	250.32	250.20	2857.27
29	250.19	250.20	250.20	250.32	250.20	2883.43
30	250.19	250.20	250.20	250.32	250.20	2894.28
31	250.19	250.20	250.20	250.32	250.20	2905.66
32	250.19	250.20	250.20	250.32	250.20	2912.79
33	250.19	250.20	250.20	250.32	250.20	2912.79
34	250.19	250.20	250.20	250.32	250.20	2912.79
35	250.19	250.20	250.20	250.32	250.20	2912.79
36	250.19	250.20	250.20	250.32	250.20	2034.40
37	250.20	250.21	250.21	250.32	250.20	2485.44
38	250.20	250.20	250.20	250.32	250.20	2671.14
39	250.19	250.20	250.20	250.32	250.20	2793.93
40	250.19	250.20	250.20	250.32	250.20	2867.02
41	250.19	250.20	250.20	250.32	250.20	2887.71
42	250.19	250.20	250.20	250.32	250.20	2903.34
43	250.18	250.18	250.18	250.30	250.17	-1218.27
44	250.16	250.16	250.16	250.28	250.15	-55.88
45	250.13	250.14	250.14	250.25	250.12	-1400.67
46	250.11	250.12	250.11	250.23	250.10	-148.48
47	250.10	250.10	250.10	250.22	250.10	2658.68
48	250.09	250.10	250.10	250.21	250.10	2894.93
49	250.09	250.10	250.10	250.21	250.10	2913.02
50	250.12	250.13	250.13	250.24	250.13	4084.91
51	250.17	250.18	250.18	250.30	250.16	4101.85
52	250.21	250.22	250.22	250.33	250.20	4487.87
53	250.25	250.26	250.25	250.37	250.20	1108.93
54	250.29	250.30	250.29	250.41	250.20	-79.44
55	250.32	250.33	250.32	250.45	250.20	1457.82
56	250.32	250.33	250.31	250.44	250.20	1918.11
57	250.31	250.32	250.31	250.44	250.23	5828.89
58	250.31	250.32	250.31	250.44	250.26	6564.06
59	250.32	250.33	250.32	250.44	250.30	9152.05
60	250.33	250.34	250.34	250.45	250.33	6180.28
61	250.35	250.36	250.36	250.46	250.36	8856.90
62	250.38	250.39	250.39	250.50	250.39	9608.16
63	250.41	250.42	250.43	250.54	250.44	12576.59
64	250.46	250.47	250.47	250.58	250.50	14171.97
65	250.51	250.52	250.53	250.64	250.58	17037.88
66	250.58	250.60	250.61	250.71	250.72	25082.21
67	250.66	250.67	250.69	250.79	250.80	18100.20
68	250.73	250.74	250.74	250.85	250.80	7858.01
69	250.77	250.78	250.78	250.90	250.80	6993.10
70	250.79	250.80	250.80	250.92	250.80	5947.80
71	250.79	250.80	250.80	250.92	250.80	5663.58
72	250.79	250.80	250.80	250.92	250.80	5663.58
73	250.79	250.80	250.80	250.92	250.80	5663.58
74	250.79	250.80	250.80	250.92	250.80	5663.58
75	250.79	250.80	250.80	250.92	250.80	5663.58
76	250.79	250.80	250.80	250.92	250.80	5663.58
77	250.76	250.77	250.76	250.89	250.70	-7853.06
78	250.72	250.73	250.73	250.85	250.70	4493.22
79	250.70	250.71	250.71	250.83	250.70	5041.94
80	250.70	250.70	250.70	250.82	250.70	5427.37
81	250.69	250.70	250.70	250.82	250.70	5586.82
82	250.69	250.70	250.70	250.82	250.70	5598.14
83	250.69	250.70	250.70	250.82	250.70	5598.14
84	250.69	250.70	250.70	250.82	250.70	5598.14
85	250.69	250.70	250.70	250.82	250.70	5598.14
86	250.69	250.70	250.70	250.82	250.70	5598.14
87	250.68	250.69	250.69	250.81	250.68	2810.59

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87	250.68	250.69	250.69	250.81	250.68	2810.59
88	250.66	250.67	250.67	250.79	250.65	1299.78
89	250.64	250.64	250.64	250.76	250.62	1154.75
90	250.61	250.62	250.62	250.74	250.60	2421.58
91	250.60	250.61	250.61	250.73	250.60	5246.55
92	250.57	250.58	250.58	250.70	250.55	-1363.35
93	250.54	250.55	250.54	250.67	250.50	-1666.36
94	250.51	250.52	250.52	250.64	250.50	4767.70
95	250.47	250.48	250.47	250.60	250.40	-8005.34
96	250.43	250.43	250.43	250.55	250.38	1670.25

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CASE 2

** SEPT. 74 STORM, UNSMOOTHED STAGE DATA **

** NORMAL DIKE DISCHARGE, NORMAL LAKE $ WHTF AREA **

DT(HR.)	HI(FT)	QC(CFS)	N	HSADDLE(FT)	TW(STEP)
1.00	249.98	0.0	0.03	255.50	60.00

	DIKE ELE (FT)	DIKE WIDTH (FT)	DIKE LENGTH (FT)
1	260.00	20.00	3890.00
2	260.00	20.00	3740.00
3	260.00	32.00	2340.00
4	260.00	25.00	400.00

	CANAL ELE 1 (FT)	CANAL ELE 2 (FT)	CANAL LENGTH (FT)
1	227.00	255.00	5910.00
2	227.00	255.00	5000.00
3	227.00	255.00	4310.00

	Q1(CFS)	Q2(CFS)	Q3(CFS)	Q4(CFS)	HR(FT)	QS(CFS)	QPR(IN/HR)	QP(IN/HR)
1	0.0	0.0	0.0	0.0	249.98	54.79	0.0	0.0
2	0.0	0.0	0.0	0.0	249.96	54.79	0.0	0.0
3	0.0	0.0	0.0	0.0	249.98	54.79	0.0	0.0
4	0.0	0.0	0.0	0.0	249.98	54.79	0.0	0.0
5	0.0	0.0	0.0	0.0	249.98	54.79	0.0500	0.0200
6	0.0	0.0	0.0	0.0	249.98	54.79	0.0500	0.0200
7	0.0	0.0	0.0	0.0	249.99	55.35	0.0	0.0
8	0.0	0.0	0.0	0.0	250.01	341.27	0.0500	0.0200
9	1.00	8.00	4.00	0.0	250.01	341.27	0.1200	0.1600
10	2.00	15.00	7.00	0.0	250.02	342.35	0.0500	0.0200
11	1.00	11.00	5.00	0.0	250.02	752.71	0.0	0.0
12	7.00	59.00	27.00	0.0	250.02	752.71	0.1200	0.1600
13	12.00	99.00	46.00	0.0	250.04	752.82	0.0	0.0
14	21.00	175.00	82.00	0.0	250.04	752.82	0.1600	0.1800
15	43.00	358.00	168.00	0.0	250.04	752.62	0.1600	0.1800
16	66.00	564.00	268.00	0.0	250.06	752.92	0.2100	0.2000
17	85.00	743.00	347.00	0.0	250.06	752.92	0.1600	0.1800
18	127.00	1115.00	512.00	0.0	250.08	2724.67	0.3300	0.3600
19	192.00	1674.00	775.00	0.0	250.10	2725.40	0.3300	0.3600
20	237.00	2110.00	975.00	0.0	250.11	2725.77	0.3300	0.3600
21	263.00	2416.00	1092.00	0.0	250.14	4700.37	0.3300	0.3600
22	277.00	2622.00	1162.00	0.0	250.14	4700.37	0.3300	0.3600
23	256.00	2571.00	1092.00	0.0	250.18	4703.08	0.2100	0.2000
24	207.00	2164.00	904.00	0.0	250.20	6041.76	0.2100	0.2000
25	146.00	1692.00	856.00	0.0	250.19	6040.88	0.0500	0.0200

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26	104.00	1314.00	474.00	0.0	250.21	6042.66	0.1600	0.1800
27	83.00	1070.00	377.00	0.0	250.20	6041.76	0.0	0.0
28	47.00	711.00	229.00	0.0	250.20	6041.76	0.0	0.0
29	22.00	455.00	116.00	0.0	250.20	6041.76	0.0500	0.0200
30	10.00	289.00	59.00	0.0	250.18	6039.99	0.0	0.0
31	5.00	186.00	30.00	0.0	250.18	5721.07	0.0	0.0
32	2.00	122.00	15.00	0.0	250.18	5721.07	0.0	0.0
33	1.00	81.00	7.00	0.0	250.17	5720.23	0.0	0.0
34	0.0	54.00	3.00	0.0	250.17	5720.23	0.0	0.0
35	0.0	36.00	1.00	0.0	250.17	5720.23	0.0	0.0
36	0.0	25.00	1.00	0.0	250.17	5720.23	0.0	0.0
37	0.0	16.00	0.0	0.0	250.17	5720.23	0.0	0.0
38	0.0	11.00	0.0	0.0	250.16	5719.39	0.0	0.0
39	0.0	7.00	0.0	0.0	250.15	5716.55	0.0	0.0
40	0.0	4.00	0.0	0.0	250.14	5717.71	0.0	0.0
41	0.0	2.00	0.0	0.0	250.12	5716.05	0.0	0.0
42	0.0	1.00	0.0	0.0	250.12	5716.05	0.0	0.0
43	0.0	1.00	0.0	0.0	250.10	5714.38	0.0	0.0
44	0.0	0.0	0.0	0.0	250.08	5712.70	0.0	0.0
45	0.0	0.0	0.0	0.0	250.06	4058.33	0.0	0.0
46	0.0	0.0	0.0	0.0	250.05	4057.75	0.0	0.0
47	0.0	0.0	0.0	0.0	250.04	2405.00	0.0	0.0
48	0.0	0.0	0.0	0.0	250.04	2405.00	0.0	0.0
49	0.0	0.0	0.0	0.0	250.03	2404.69	0.0	0.0
50	0.0	0.0	0.0	0.0	250.02	2404.37	0.0	0.0
51	0.0	0.0	0.0	0.0	250.02	2404.37	0.0	0.0
52	0.0	0.0	0.0	0.0	250.02	2404.37	0.0	0.0
53	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
54	0.0	0.0	0.0	0.0	250.01	752.66	0.0	0.0
55	0.0	0.0	0.0	0.0	250.01	752.66	0.0	0.0
56	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
57	0.0	0.0	0.0	0.0	250.01	752.66	0.0	0.0
58	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
59	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
60	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
61	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
62	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
63	0.0	0.0	0.0	0.0	250.01	752.66	0.0	0.0
64	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
65	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
66	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
67	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
68	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
69	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
70	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
71	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
72	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
73	0.0	0.0	0.0	0.0	249.99	533.60	0.0	0.0
74	0.0	0.0	0.0	0.0	249.99	533.60	0.0	0.0
75	0.0	0.0	0.0	0.0	249.99	533.60	0.0	0.0
76	0.0	0.0	0.0	0.0	249.99	376.28	0.0	0.0
77	0.0	0.0	0.0	0.0	249.99	242.53	0.0	0.0
78	0.0	0.0	0.0	0.0	249.99	242.53	0.0	0.0
79	0.0	0.0	0.0	0.0	249.99	242.53	0.0	0.0
80	0.0	0.0	0.0	0.0	249.98	84.78	0.0	0.0
81	0.0	0.0	0.0	0.0	249.98	84.78	0.0	0.0
82	0.0	0.0	0.0	0.0	249.98	84.78	0.0	0.0
83	0.0	0.0	0.0	0.0	249.98	84.78	0.0	0.0
84	0.0	0.0	0.0	0.0	249.98	84.78	0.0	0.0
85	0.0	0.0	0.0	0.0	249.98	84.78	0.0	0.0
86	0.0	0.0	0.0	0.0	249.98	84.78	0.0	0.0
87	0.0	0.0	0.0	0.0	249.99	85.42	0.0	0.0
88	0.0	0.0	0.0	0.0	249.99	85.42	0.0	0.0

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89	0.0	0.0	0.0	0.0	249.99	85.42	0.0	0.0
90	0.0	0.0	0.0	0.0	249.99	85.42	0.0	0.0
91	0.0	0.0	0.0	0.0	249.99	85.42	0.0	0.0
92	0.0	0.0	0.0	0.0	249.99	85.42	0.0	0.0
93	0.0	0.0	0.0	0.0	249.99	85.42	0.0	0.0
94	0.0	0.0	0.0	0.0	249.99	85.42	0.0	0.0
95	0.0	0.0	0.0	0.0	250.00	86.07	0.0	0.0
96	0.0	0.0	0.0	0.0	250.00	86.07	0.0	0.0

ELEV VS AREA FOR AREA 1

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	6.10	210.00	20.40	220.00	44.20
230.00	65.00	240.00	142.80	250.00	231.20	255.00	318.20
260.00	374.00	270.00	573.90				

ELEV VS AREA FOR AREA 2

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	55.30	210.00	184.20	220.00	399.10
230.00	767.50	240.00	1269.40	250.00	2067.60	255.00	2673.50
260.00	3377.00	270.00	5182.20				

ELEV VS AREA FOR AREA 3

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	28.10	210.00	93.60	220.00	202.80
230.00	390.00	240.00	655.20	250.00	1060.80	255.00	1460.20
260.00	1716.00	270.00	2633.30				

ELEV VS AREA FOR AREA 4

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	0.50	210.00	1.80	220.00	3.90
230.00	7.50	240.00	12.60	250.00	20.40	255.00	28.10
260.00	33.00	270.00	50.60				

ELEV VS AREA FOR AREA 5

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
180.00	0.0	190.00	280.00	200.00	960.00	210.00	2100.00
220.00	3500.00	230.00	5010.00	240.00	6950.00	250.00	9540.00
260.00	12150.00	270.00	15310.00				

FLOW FACTOR FOR FLOW OVER THE DIKES

HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR
0.0	0.0	0.20	0.0	0.50	0.84	1.00	0.94
1.50	0.96	2.00	0.97	3.00	0.98	4.00	0.98
5.00	0.98	6.00	0.98	7.00	0.97	8.00	0.97

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FLOW THROUGH THE DIKES AND CANALS

	DIKE 1	DIKE 2	DIKE 3	DIKE 4	CANAL A	CANAL B	CANAL C
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
2	0.0	0.0	-135.90	0.0	6373.13	-2111.85	586.65
3	0.0	0.0	-135.90	0.0	6373.13	-2111.85	586.65
4	0.0	0.0	-135.90	0.0	6373.13	-2111.85	586.65
5	0.0	0.0	-135.90	0.0	6373.13	-2111.85	586.65
6	0.0	0.0	-219.60	0.0	6373.79	-2102.43	586.67
7	0.0	0.0	-340.50	0.0	6380.16	-2146.66	289.60
8	0.0	0.0	260.22	0.0	6392.66	-2185.15	-586.67
9	0.0	0.0	-228.75	0.0	6405.30	-2088.52	592.09
10	0.0	0.0	-598.39	0.0	6417.63	-2076.51	592.61
11	0.0	0.0	-321.91	0.0	6414.87	-2072.64	619.66
12	0.0	0.0	-262.19	0.0	6412.92	-2092.24	604.34
13	0.0	0.0	-693.68	0.0	6434.05	-2117.14	399.65
14	0.0	0.0	-516.49	0.0	6435.84	-2047.15	728.79
15	0.0	0.0	-1016.46	0.0	6446.73	-1987.39	1005.94
16	0.0	0.0	-1075.32	0.0	6465.27	-2011.23	912.08
17	0.0	0.0	-1494.87	0.0	6485.18	-1924.40	1260.38
18	0.0	0.0	-1629.51	0.0	6502.54	-1928.59	1212.85
19	0.0	0.0	-2161.81	0.0	6541.67	-1862.66	1566.33
20	0.0	0.0	-2728.68	0.0	6587.79	-1793.42	1991.72
21	0.0	0.0	-3031.82	0.0	6636.51	-1778.51	2190.09
22	0.0	0.0	-3528.97	0.0	6665.56	-1711.49	2603.82
23	0.0	0.0	-3591.65	0.0	6728.88	-1722.16	2609.94
24	0.0	0.0	-3580.06	0.0	6752.96	-1726.98	2664.07
25	0.0	0.0	-3646.50	0.0	6760.64	-1703.85	2761.01
26	0.0	0.0	-3237.22	0.0	6739.45	-1757.68	2451.48
27	0.0	0.0	-3152.92	0.0	6725.98	-1749.13	2413.23
28	0.0	0.0	-2743.49	0.0	6694.44	-1795.34	2119.99
29	0.0	0.0	-2265.40	0.0	6660.54	-1855.00	1789.14
30	0.0	0.0	-2015.17	0.0	6628.65	-1862.48	1649.35
31	0.0	0.0	-1476.57	0.0	6597.94	-1936.29	1241.80
32	0.0	0.0	-952.36	0.0	6577.02	-2003.28	1008.30
33	0.0	0.0	-744.34	0.0	6563.63	-2009.31	955.60
34	0.0	0.0	-397.50	0.0	6554.06	-2067.25	682.41
35	0.0	0.0	-250.17	0.0	6551.45	-2080.24	607.93
36	0.0	0.0	-228.75	0.0	6550.91	-2085.16	599.97
37	0.0	0.0	-217.25	0.0	6550.85	-2085.16	599.97
38	0.0	0.0	-385.71	0.0	6547.72	-2040.47	780.20
39	0.0	0.0	-418.86	0.0	6540.15	-2035.50	794.79
40	0.0	0.0	-415.17	0.0	6531.45	-2033.82	791.12
41	0.0	0.0	-661.89	0.0	6521.07	-1997.33	956.53
42	0.0	0.0	-360.48	0.0	6510.04	-2068.45	617.13
43	0.0	0.0	-630.13	0.0	6503.39	-1999.06	942.39
44	0.0	0.0	-731.85	0.0	6487.36	-1989.32	978.01
45	0.0	0.0	-770.08	0.0	6468.59	-1984.48	988.48
46	0.0	0.0	-564.88	0.0	6451.47	-2019.20	854.34
47	0.0	0.0	-460.85	0.0	6439.77	-2030.54	811.16
48	0.0	0.0	-202.58	0.0	6432.69	-2082.38	585.59
49	0.0	0.0	-349.42	0.0	6427.39	-2041.82	750.50
50	0.0	0.0	-373.55	0.0	6418.55	-2043.47	765.13
51	0.0	0.0	-166.44	0.0	6412.47	-2090.17	588.60
52	0.0	0.0	-156.92	0.0	6412.47	-2093.38	596.50
53	0.0	0.0	-589.76	0.0	6404.81	-2015.98	916.90
54	0.0	0.0	-350.88	0.0	6400.34	-2136.18	527.91
55	0.0	0.0	-156.92	0.0	6402.64	-2096.45	596.01
56	0.0	0.0	-331.33	0.0	6397.35	-2054.71	745.27

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57	0.0	0.0	-266.50	0.0	6399.48	-2142.32	264.79
58	0.0	0.0	-340.50	0.0	6397.82	-2054.73	748.40
59	0.0	0.0	-169.49	0.0	6392.88	-2099.51	595.52
60	0.0	0.0	-169.49	0.0	6392.88	-2099.51	595.52
61	0.0	0.0	-169.49	0.0	6392.88	-2099.51	595.52
62	0.0	0.0	-169.49	0.0	6392.88	-2099.51	595.52
63	0.0	0.0	-266.07	0.0	6399.01	-2146.97	255.81
64	0.0	0.0	-337.47	0.0	6397.82	-2054.73	745.28
65	0.0	0.0	-169.49	0.0	6392.88	-2099.51	595.52
66	0.0	0.0	-169.49	0.0	6392.88	-2099.51	595.52
67	0.0	0.0	-169.49	0.0	6392.88	-2099.51	595.52
68	0.0	0.0	-169.49	0.0	6392.88	-2099.51	595.52
69	0.0	0.0	-169.49	0.0	6392.88	-2099.51	595.52
70	0.0	0.0	-169.49	0.0	6392.88	-2099.51	595.52
71	0.0	0.0	-169.49	0.0	6392.88	-2099.51	595.52
72	0.0	0.0	-169.49	0.0	6392.88	-2099.51	595.52
73	0.0	0.0	-334.42	0.0	6387.94	-2059.51	741.53
74	0.0	0.0	-169.49	0.0	6383.00	-2105.72	595.03
75	0.0	0.0	-169.49	0.0	6383.00	-2105.72	595.03
76	0.0	0.0	-169.49	0.0	6383.00	-2105.72	595.03
77	0.0	0.0	-169.49	0.0	6383.00	-2105.72	595.03
78	0.0	0.0	-169.49	0.0	6383.00	-2105.72	595.03
79	0.0	0.0	-169.49	0.0	6383.00	-2105.72	595.03
80	0.0	0.0	-331.33	0.0	6378.13	-2064.28	737.76
81	0.0	0.0	-169.49	0.0	6373.19	-2108.73	594.53
82	0.0	0.0	-169.49	0.0	6373.19	-2108.73	594.53
83	0.0	0.0	-169.49	0.0	6373.19	-2108.73	594.53
84	0.0	0.0	-169.49	0.0	6373.19	-2108.73	594.53
85	0.0	0.0	-169.49	0.0	6373.19	-2108.73	594.53
86	0.0	0.0	-169.49	0.0	6373.19	-2108.73	594.53
87	0.0	0.0	-246.04	0.0	6378.84	-2155.81	236.44
88	0.0	0.0	-169.49	0.0	6382.59	-2107.31	595.03
89	0.0	0.0	-169.49	0.0	6382.59	-2107.31	595.03
90	0.0	0.0	-169.49	0.0	6382.59	-2107.31	595.03
91	0.0	0.0	-169.49	0.0	6382.59	-2107.31	595.03
92	0.0	0.0	-169.49	0.0	6382.59	-2107.31	595.03
93	0.0	0.0	-169.49	0.0	6382.59	-2107.31	595.03
94	0.0	0.0	-169.49	0.0	6382.59	-2107.31	595.03
95	0.0	0.0	-243.94	0.0	6386.64	-2151.38	236.64
96	0.0	0.0	-169.49	0.0	6392.82	-2104.29	595.52

	H1	H2	H3	H4	HR	QR
	FT	FT	FT	FT	FT	CFS
1	249.98	249.98	249.98	249.98	249.98	0.0
2	249.97	249.98	249.98	250.09	249.98	-81.11
3	249.97	249.98	249.98	250.09	249.98	-81.11
4	249.97	249.98	249.98	250.09	249.98	-81.11
5	249.97	249.98	249.98	250.09	249.98	-561.82
6	249.97	249.98	249.98	250.09	249.98	-645.52
7	249.98	249.99	249.99	250.10	249.99	868.24
8	250.00	250.01	250.01	250.12	250.01	2430.19
9	250.00	250.01	250.01	250.12	250.01	-1042.13
10	250.02	250.03	250.03	250.14	250.02	417.06
11	250.01	250.02	250.02	250.13	250.02	430.00
12	250.01	250.02	250.02	250.13	250.02	-664.45
13	250.04	250.05	250.05	250.16	250.04	2370.84
14	250.04	250.05	250.04	250.16	250.04	-1304.47
15	250.05	250.06	250.06	250.17	250.04	-1804.44
16	250.07	250.08	250.06	250.19	250.06	-32.84

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17	250.09	250.10	250.09	250.21	250.06	-2283.59
18	250.12	250.12	250.12	250.24	250.06	226.24
19	250.17	250.18	250.17	250.29	250.10	-304.04
20	250.23	250.25	250.22	250.35	250.11	-2029.72
21	250.28	250.29	250.28	250.41	250.14	1959.66
22	250.34	250.35	250.35	250.46	250.14	-2015.19
23	250.39	250.39	250.37	250.51	250.18	3720.70
24	250.41	250.41	250.39	250.53	250.20	2752.36
25	250.40	250.41	250.39	250.53	250.19	745.43
26	250.38	250.38	250.37	250.50	250.21	3579.91
27	250.36	250.37	250.35	250.48	250.20	1726.82
28	250.32	250.33	250.31	250.44	250.20	3298.27
29	250.28	250.29	250.28	250.40	250.20	3292.75
30	250.24	250.25	250.24	250.37	250.16	1704.27
31	250.21	250.22	250.21	250.33	250.18	4244.50
32	250.19	250.20	250.19	250.31	250.18	4768.71
33	250.17	250.18	250.18	250.30	250.17	3816.82
34	250.16	250.17	250.17	250.29	250.17	5322.73
35	250.16	250.17	250.17	250.29	250.17	5470.05
36	250.16	250.17	250.17	250.29	250.17	5491.48
37	250.16	250.17	250.17	250.28	250.17	5502.98
38	250.15	250.16	250.16	250.28	250.16	4173.15
39	250.15	250.15	250.15	250.27	250.15	4141.24
40	250.14	250.14	250.14	250.26	250.14	4144.41
41	250.12	250.13	250.13	250.24	250.12	2737.40
42	250.11	250.12	250.12	250.24	250.12	5415.57
43	250.10	250.11	250.11	250.22	250.10	2768.76
44	250.08	250.09	250.09	250.20	250.08	2606.65
45	250.06	250.07	250.07	250.18	250.06	977.05
46	250.05	250.06	250.05	250.17	250.05	2335.83
47	250.04	250.05	250.04	250.16	250.04	789.18
48	250.03	250.04	250.04	250.15	250.04	2202.42
49	250.02	250.03	250.03	250.15	250.03	900.62
50	250.01	250.02	250.02	250.14	250.02	674.73
51	250.01	250.02	250.02	250.13	250.02	2237.93
52	250.01	250.02	250.02	250.13	250.02	2247.45
53	250.00	250.01	250.01	250.12	250.00	-2144.57
54	250.00	250.01	250.01	250.12	250.01	1555.60
55	250.00	250.01	250.01	250.12	250.01	595.74
56	249.99	250.00	250.00	250.11	250.00	-732.44
57	250.00	250.01	250.01	250.12	250.01	1620.18
58	249.99	250.00	250.00	250.11	250.00	-741.60
59	249.99	250.00	250.00	250.11	250.00	583.11
60	249.99	250.00	250.00	250.11	250.00	583.11
61	249.99	250.00	250.00	250.11	250.00	583.11
62	249.99	250.00	250.00	250.11	250.00	583.11
63	250.00	250.01	250.01	250.12	250.01	1640.61
64	249.99	250.00	250.00	250.11	250.00	-758.58
65	249.99	250.00	250.00	250.11	250.00	583.11
66	249.99	250.00	250.00	250.11	250.00	583.11
67	249.99	250.00	250.00	250.11	250.00	583.11
68	249.99	250.00	250.00	250.11	250.00	583.11
69	249.99	250.00	250.00	250.11	250.00	583.11
70	249.99	250.00	250.00	250.11	250.00	583.11
71	249.99	250.00	250.00	250.11	250.00	583.11
72	249.99	250.00	250.00	250.11	250.00	583.11
73	249.98	249.99	249.99	250.10	249.99	-955.97
74	249.98	249.99	249.99	250.10	249.99	364.11
75	249.98	249.99	249.99	250.10	249.99	364.11
76	249.98	249.99	249.99	250.10	249.99	206.79
77	249.98	249.99	249.99	250.10	249.99	73.04
78	249.98	249.99	249.99	250.10	249.99	73.04
79	249.98	249.99	249.99	250.10	249.99	73.04

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80	249.97	249.98	249.98	250.09	249.98	-1399.63
81	249.97	249.98	249.98	250.09	249.98	-84.71
82	249.97	249.98	249.98	250.09	249.98	-84.71
83	249.97	249.98	249.98	250.09	249.98	-84.71
84	249.97	249.98	249.98	250.09	249.98	-84.71
85	249.97	249.98	249.98	250.09	249.98	-84.71
86	249.97	249.98	249.98	250.09	249.98	-84.71
87	249.98	249.99	249.99	250.10	249.99	992.77
88	249.98	249.99	249.99	250.10	249.99	-84.07
89	249.98	249.99	249.99	250.10	249.99	-84.07
90	249.98	249.99	249.99	250.10	249.99	-84.07
91	249.98	249.99	249.99	250.10	249.99	-84.07
92	249.98	249.99	249.99	250.10	249.99	-84.07
93	249.98	249.99	249.99	250.10	249.99	-84.07
94	249.98	249.99	249.99	250.10	249.99	-84.07
95	249.99	250.00	250.00	250.11	250.00	997.59
96	249.99	250.00	250.00	250.11	250.00	-83.42

CASE 3

** MARCH 75 STORM, UNSMOOTHED STAGE DATA **

** NORMAL DIKE DISCHARGE, NORMAL LAKE $ WHTF AREA **

DT(HR.)	HI(FT)	QC(CFS)	N	HSADDLE(FT)	TW(STEP)
1.00	250.02	0.0	0.03	253.50	60.00

	DIKE ELE (FT)	DIKE WIDTH (FT)	DIKE LENGTH (FT)
1	260.00	20.00	3890.00
2	260.00	20.00	3740.00
3	260.00	32.00	2340.00
4	260.00	25.00	400.00

	CANAL ELE 1 (FT)	CANAL ELE 2 (FT)	CANAL LENGTH (FT)
1	227.00	255.00	3910.00
2	227.00	255.00	3000.00
3	227.00	255.00	4310.00

	Q1(CFS)	Q2(CFS)	Q3(CFS)	Q4(CFS)	HR(FT)	QS(CFS)	QPR(IN/HR)	QP(IN/HR)
1	0.0	0.0	0.0	0.0	250.02	752.71	0.1000	0.1300
2	3.00	27.00	13.00	0.0	250.02	752.71	0.1000	0.1300
3	6.00	49.00	24.00	0.0	250.02	752.71	0.0	0.0
4	12.00	102.00	48.00	0.0	250.03	752.76	0.1400	0.1500
5	66.00	533.00	251.00	0.0	250.03	752.76	0.2900	0.3900
6	156.00	1264.00	611.00	0.0	250.03	752.76	0.3300	0.4100
7	177.00	1515.00	730.00	0.0	250.01	752.66	0.1000	0.1300
8	118.00	1171.00	522.00	0.0	250.02	752.71	0.0	0.0
9	60.00	751.00	281.00	0.0	250.03	4056.60	0.0	0.0
10	113.00	1127.00	455.00	0.0	250.04	4057.16	0.3900	0.5200
11	229.00	2004.00	912.00	0.0	250.06	4058.33	0.3300	0.4100
12	219.00	2010.00	929.00	0.0	250.12	4061.79	0.0800	0.0300
13	124.00	1355.00	569.00	0.0	250.14	4062.93	0.0400	0.0200
14	58.00	863.00	285.00	0.0	250.14	4062.93	0.0400	0.0200
15	27.00	526.00	143.00	0.0	250.16	4064.08	0.0	0.0
16	13.00	376.00	73.00	0.0	250.20	4066.38	0.0	0.0
17	6.00	210.00	38.00	0.0	250.20	4066.38	0.0	0.0

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18	2.00	137.00	18.00	0.0	250.35	4074.98	0.0	0.0
19	0.0	88.00	8.00	0.0	250.36	4075.56	0.0400	0.0200
20	2.00	70.00	9.00	0.0	250.44	5742.73	0.0800	0.0300
21	19.00	190.00	73.00	0.0	250.62	5757.70	0.3000	0.1300
22	31.00	275.00	123.00	0.0	250.70	5764.33	0.0400	0.0200
23	19.00	200.00	85.00	0.0	250.75	5768.47	0.0	0.0
24	9.00	128.00	43.00	0.0	250.82	5774.27	0.0	0.0
25	4.00	77.00	21.00	0.0	250.85	5776.75	0.0	0.0
26	2.00	47.00	11.00	0.0	250.90	5780.68	0.0	0.0
27	1.00	30.00	6.00	0.0	250.92	5782.54	0.0	0.0
28	0.0	20.00	3.00	0.0	250.92	5782.54	0.0	0.0
29	0.0	12.00	1.00	0.0	250.92	5782.54	0.0	0.0
30	0.0	7.00	1.00	0.0	250.92	5782.54	0.0	0.0
31	0.0	5.00	0.0	0.0	250.90	5780.68	0.0	0.0
32	0.0	3.00	0.0	0.0	250.89	5780.66	0.0	0.0
33	0.0	2.00	0.0	0.0	250.87	5778.40	0.0	0.0
34	0.0	2.00	0.0	0.0	250.86	5777.57	0.0	0.0
35	0.0	1.00	0.0	0.0	250.84	5775.93	0.0	0.0
36	0.0	1.00	0.0	0.0	250.84	5775.93	0.0	0.0
37	0.0	0.0	0.0	0.0	250.82	5774.27	0.0	0.0
38	0.0	0.0	0.0	0.0	250.78	5770.96	0.0	0.0
39	0.0	0.0	0.0	0.0	250.78	5770.96	0.0	0.0
40	0.0	0.0	0.0	0.0	250.76	5769.30	0.0	0.0
41	0.0	0.0	0.0	0.0	250.74	5767.65	0.0	0.0
42	0.0	0.0	0.0	0.0	250.66	5761.02	0.0	0.0
43	0.0	0.0	0.0	0.0	250.64	5759.36	0.0	0.0
44	0.0	0.0	0.0	0.0	250.62	5757.70	0.0	0.0
45	0.0	0.0	0.0	0.0	250.60	5756.04	0.0	0.0
46	0.0	0.0	0.0	0.0	250.57	5753.55	0.0	0.0
47	0.0	0.0	0.0	0.0	250.55	5751.88	0.0	0.0
48	0.0	0.0	0.0	0.0	250.53	5750.23	0.0	0.0
49	0.0	0.0	0.0	0.0	250.50	5747.73	0.0	0.0
50	0.0	0.0	0.0	0.0	250.48	5746.07	0.0	0.0
51	0.0	0.0	0.0	0.0	250.46	5744.40	0.0	0.0
52	0.0	0.0	0.0	0.0	250.42	5741.07	0.0	0.0
53	0.0	0.0	0.0	0.0	250.40	5739.41	0.0	0.0
54	0.0	0.0	0.0	0.0	250.38	5737.73	0.0	0.0
55	0.0	0.0	0.0	0.0	250.36	5736.08	0.0	0.0
56	0.0	0.0	0.0	0.0	250.32	5732.75	0.0	0.0
57	0.0	0.0	0.0	0.0	250.30	5731.08	0.0	0.0
58	0.0	0.0	0.0	0.0	250.28	5729.41	0.0	0.0
59	0.0	0.0	0.0	0.0	250.25	5726.91	0.0	0.0
60	0.0	0.0	0.0	0.0	250.22	5724.40	0.0	0.0
61	0.0	0.0	0.0	0.0	250.18	5721.07	0.0	0.0
62	0.0	0.0	0.0	0.0	250.16	5719.39	0.0	0.0
63	0.0	0.0	0.0	0.0	250.14	4062.93	0.0	0.0
64	0.0	0.0	0.0	0.0	250.12	4061.79	0.0	0.0
65	0.0	0.0	0.0	0.0	250.10	4060.63	0.0	0.0
66	0.0	0.0	0.0	0.0	250.10	2406.68	0.0	0.0
67	0.0	0.0	0.0	0.0	250.07	2405.94	0.0	0.0
68	0.0	0.0	0.0	0.0	250.07	2405.94	0.0	0.0
69	0.0	0.0	0.0	0.0	250.07	2405.94	0.0	0.0
70	0.0	0.0	0.0	0.0	250.05	2405.31	0.0	0.0
71	0.0	0.0	0.0	0.0	250.05	2405.31	0.0	0.0
72	0.0	0.0	0.0	0.0	250.05	2405.31	0.0	0.0
73	0.0	0.0	0.0	0.0	250.05	2405.31	0.0	0.0
74	0.0	0.0	0.0	0.0	250.05	2405.31	0.0	0.0
75	0.0	0.0	0.0	0.0	250.04	2405.00	0.0	0.0
76	0.0	0.0	0.0	0.0	250.04	2405.00	0.0	0.0
77	0.0	0.0	0.0	0.0	250.02	2404.37	0.0	0.0
78	0.0	0.0	0.0	0.0	250.00	2403.74	0.0	0.0
79	0.0	0.0	0.0	0.0	250.00	2403.74	0.0	0.0
80	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0

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81	0.0	0.0	0.0	0.0	249.99	752.55	0.0	0.0
82	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
83	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
84	0.0	0.0	0.0	0.0	250.00	752.60	0.0	0.0
85	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
87	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ELEV VS AREA FOR AREA 1

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	6.10	210.00	20.40	220.00	44.20
230.00	85.00	240.00	142.80	250.00	231.20	255.00	318.20
260.00	374.00	270.00	573.90				

ELEV VS AREA FOR AREA 2

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	55.30	210.00	184.20	220.00	399.10
230.00	767.50	240.00	1289.40	250.00	2067.60	255.00	2873.50
260.00	3377.00	270.00	5182.20				

ELEV VS AREA FOR AREA 3

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	28.10	210.00	93.60	220.00	202.80
230.00	390.00	240.00	655.20	250.00	1060.80	255.00	1460.20
260.00	1716.00	270.00	2653.30				

ELEV VS AREA FOR AREA 4

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	0.50	210.00	1.80	220.00	3.90
230.00	7.50	240.00	12.60	250.00	20.40	255.00	28.10
260.00	35.00	270.00	50.60				

ELEV VS AREA FOR AREA 5

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
180.00	0.0	190.00	280.00	200.00	960.00	210.00	2100.00
220.00	3500.00	230.00	5010.00	240.00	6950.00	250.00	9540.00
260.00	12150.00	270.00	15310.00				

FLOW FACTOR FOR FLOW OVER THE DIKES

HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR
0.0	0.0	0.20	0.0	0.50	0.84	1.00	0.94
1.50	0.96	2.00	0.97	3.00	0.98	4.00	0.98
5.00	0.98	6.00	0.98	7.00	0.97	8.00	0.97

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9.00 0.96 10.00 0.95 15.00 0.90

FLOW THROUGH THE DIKES AND CANALS

	DIKE 1	DIKE 2	DIKE 3	DIKE 4	CANAL A	CANAL B	CANAL C
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
2	0.0	0.0	-586.27	0.0	-6100.35	2733.00	525.77
3	0.0	0.0	-688.49	0.0	-6100.62	2744.55	556.18
4	0.0	0.0	-507.47	0.0	-6109.71	2692.35	-335.56
5	0.0	0.0	-1098.44	0.0	-6115.24	2794.74	760.61
6	0.0	0.0	-1992.39	0.0	-6137.55	2869.19	1376.27
7	0.0	0.0	-2736.75	0.0	-6143.14	2955.58	1957.30
8	0.0	0.0	-2606.76	0.0	-6134.18	2925.15	1864.92
9	0.0	0.0	-2185.38	0.0	-6122.60	2885.45	1598.16
10	0.0	0.0	-1971.42	0.0	-6134.56	2875.95	1428.30
11	0.0	0.0	-2603.81	0.0	-6170.02	2948.64	1789.76
12	0.0	0.0	-2612.27	0.0	-6184.99	2947.75	1697.50
13	0.0	0.0	-2405.12	0.0	-6171.19	2929.93	1737.66
14	0.0	0.0	-2168.00	0.0	-6159.34	2917.81	1658.57
15	0.0	0.0	-1599.32	0.0	-6156.80	2866.65	1124.02
16	0.0	0.0	-777.38	0.0	-6172.57	2731.37	-568.80
17	0.0	0.0	-574.78	0.0	-6163.01	2801.30	551.42
18	0.0	0.0	2221.04	0.0	-6210.30	2525.96	-1653.50
19	0.0	0.0	1497.61	0.0	-6222.32	2655.08	-1118.10
20	0.0	0.0	1654.50	0.0	-6261.69	2615.10	-1510.52
21	0.0	0.0	3016.72	0.0	-6324.26	2516.62	-2347.23
22	0.0	0.0	2861.96	0.0	-6383.42	2576.55	-2693.96
23	0.0	0.0	2436.90	0.0	-6426.66	2653.74	-1801.96
24	0.0	0.0	2394.00	0.0	-6469.23	2652.18	-1608.27
25	0.0	0.0	1937.62	0.0	-6502.89	2722.38	-1444.45
26	0.0	0.0	1624.10	0.0	-6536.13	2741.80	-1434.30
27	0.0	0.0	1309.76	0.0	-6560.02	2812.08	-1089.58
28	0.0	0.0	300.48	0.0	-6567.39	2924.06	-620.24
29	0.0	0.0	-279.24	0.0	-6563.89	2976.54	255.05
30	0.0	0.0	-279.24	0.0	-6563.89	2976.54	255.05
31	0.0	0.0	-711.93	0.0	-6550.42	3030.67	666.03
32	0.0	0.0	-613.63	0.0	-6544.65	3013.54	573.89
33	0.0	0.0	-794.35	0.0	-6532.65	3030.29	707.70
34	0.0	0.0	-656.45	0.0	-6526.83	3009.07	591.02
35	0.0	0.0	-809.07	0.0	-6514.91	3023.09	713.57
36	0.0	0.0	-432.13	0.0	-6515.00	2972.30	456.93
37	0.0	0.0	-738.80	0.0	-6502.57	3014.00	677.75
38	0.0	0.0	-1209.58	0.0	-6482.94	3048.57	1049.34
39	0.0	0.0	-703.96	0.0	-6479.22	2982.35	582.75
40	0.0	0.0	-822.90	0.0	-6466.20	3005.12	727.44
41	0.0	0.0	-876.04	0.0	-6454.60	3004.43	754.85
42	0.0	0.0	-1826.91	0.0	-6423.48	3078.97	1544.47
43	0.0	0.0	-1549.46	0.0	-6405.58	3034.17	1195.12
44	0.0	0.0	-1324.95	0.0	-6389.65	3010.57	1041.24
45	0.0	0.0	-1166.83	0.0	-6375.00	2991.72	942.59
46	0.0	0.0	-1232.27	0.0	-6357.08	2993.83	1026.78
47	0.0	0.0	-1105.43	0.0	-6344.50	2975.38	905.29
48	0.0	0.0	-1023.00	0.0	-6331.35	2963.65	854.27
49	0.0	0.0	-1150.45	0.0	-6314.57	2971.18	972.25
50	0.0	0.0	-1051.68	0.0	-6301.79	2954.36	865.62
51	0.0	0.0	-987.79	0.0	-6289.13	2944.10	825.24
52	0.0	0.0	-1295.58	0.0	-6269.80	2966.84	1104.59
53	0.0	0.0	-1142.85	0.0	-6255.63	2940.88	927.34
54	0.0	0.0	-1039.91	0.0	-6243.04	2929.06	858.56
55	0.0	0.0	-976.30	0.0	-6230.46	2918.89	818.52
56	0.0	0.0	-1286.44	0.0	-6210.36	2941.44	1100.08

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57	0.0	0.0	-1132.93	0.0	-6197.59	2916.87	922.44
58	0.0	0.0	-1029.99	0.0	-6186.80	2903.94	854.42
59	0.0	0.0	-1141.95	0.0	-6176.82	2905.11	972.87
60	0.0	0.0	-1202.35	0.0	-6166.61	2899.72	1000.22
61	0.0	0.0	-1389.21	0.0	-6154.08	2905.39	1156.77
62	0.0	0.0	-1188.61	0.0	-6147.28	2870.81	953.29
63	0.0	0.0	-1048.26	0.0	-6140.34	2851.62	864.31
64	0.0	0.0	-960.40	0.0	-6133.35	2836.54	808.44
65	0.0	0.0	-909.94	0.0	-6126.60	2824.23	777.00
66	0.0	0.0	-441.52	0.0	-6128.80	2766.69	446.46
67	0.0	0.0	-899.73	0.0	-6115.59	2817.24	613.77
68	0.0	0.0	-430.94	0.0	-6118.55	2752.38	440.02
69	0.0	0.0	-271.79	0.0	-6119.84	2734.55	217.28
70	0.0	0.0	-652.53	0.0	-6108.23	2780.70	621.45
71	0.0	0.0	-310.55	0.0	-6111.64	2726.42	314.35
72	0.0	0.0	-269.90	0.0	-6112.60	2721.31	194.02
73	0.0	0.0	-269.90	0.0	-6112.60	2721.31	194.02
74	0.0	0.0	-269.90	0.0	-6112.60	2721.31	194.02
75	0.0	0.0	-413.93	0.0	-6100.30	2746.62	512.97
76	0.0	0.0	-269.90	0.0	-6108.30	2714.08	193.66
77	0.0	0.0	-646.21	0.0	-6097.49	2761.59	612.29
78	0.0	0.0	-741.58	0.0	-6090.59	2758.73	666.24
79	0.0	0.0	-331.33	0.0	-6092.98	2697.81	320.43
80	0.0	0.0	-266.07	0.0	-6093.75	2686.39	152.75
81	0.0	0.0	-397.50	0.0	-6087.41	2711.99	506.26
82	0.0	0.0	-350.88	0.0	-6097.15	2656.13	-537.90
83	0.0	0.0	-266.07	0.0	-6093.75	2686.39	152.75
84	0.0	0.0	-266.07	0.0	-6093.75	2686.39	152.75

I	NO	X
5	20	0.0

180.00	0.0	190.00	280.00	200.00	960.00	210.00	2100.00
220.00	3500.00	230.00	5010.00	240.00	6950.00	250.00	9540.00
260.00	12150.00	270.00	15310.00				
85	0.0	0.0	-127552.38	0.0	-5227.85	4756.46	31455.05

	H1	H2	H3	H4	HR	QR
	FT	FT	FT	FT	FT	CFS
1	250.02	250.02	250.02	250.02	250.02	0.0
2	250.04	250.03	250.03	249.93	250.02	-796.03
3	250.05	250.03	250.03	249.93	250.02	64.22
4	250.05	250.03	250.03	249.94	250.03	53.87
5	250.07	250.05	250.05	249.96	250.03	-3137.63
6	250.11	250.10	250.09	250.00	250.03	-4416.66
7	250.15	250.13	250.12	250.04	250.01	-5256.10
8	250.15	250.13	250.12	250.04	250.02	-699.71
9	250.13	250.11	250.10	250.02	250.03	3027.13
10	250.12	250.10	250.10	250.01	250.04	-514.98
11	250.19	250.17	250.16	250.08	250.06	587.84
12	250.25	250.23	250.22	250.14	250.12	7625.92
13	250.25	250.24	250.23	250.14	250.14	3589.57
14	250.24	250.22	250.21	250.13	250.14	1488.68
15	250.22	250.20	250.20	250.11	250.16	4782.27
16	250.22	250.21	250.21	250.11	250.20	7932.61
17	250.22	250.21	250.20	250.11	250.20	3491.60
18	250.28	250.27	250.28	250.17	250.35	23776.18

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19	250.34	250.32	250.33	250.23	250.36	6349.66
20	250.40	250.38	250.39	250.29	250.44	16164.48
21	250.48	250.47	250.48	250.37	250.62	26971.09
22	250.58	250.57	250.58	250.47	250.70	17585.91
23	250.67	250.65	250.66	250.56	250.75	14095.65
24	250.74	250.73	250.73	250.63	250.82	16428.98
25	250.80	250.79	250.79	250.69	250.85	11257.97
26	250.86	250.84	250.85	250.75	250.90	13519.14
27	250.91	250.89	250.89	250.80	250.92	9454.59
28	250.93	250.92	250.92	250.82	250.92	6083.02
29	250.94	250.92	250.92	250.83	250.92	5503.30
30	250.94	250.92	250.92	250.83	250.92	5503.30
31	250.93	250.91	250.91	250.82	250.90	2702.92
32	250.91	250.90	250.90	250.80	250.89	3984.63
33	250.90	250.88	250.88	250.79	250.87	2619.91
34	250.89	250.87	250.87	250.77	250.86	3938.47
35	250.87	250.85	250.85	250.76	250.84	2606.42
36	250.86	250.84	250.84	250.75	250.84	5343.60
37	250.85	250.83	250.83	250.74	250.82	2674.49
38	250.82	250.80	250.80	250.71	250.78	-153.71
39	250.81	250.79	250.79	250.70	250.78	5067.00
40	250.79	250.77	250.77	250.68	250.76	2569.21
41	250.77	250.75	250.75	250.66	250.74	2535.68
42	250.74	250.72	250.71	250.63	250.66	-5467.55
43	250.70	250.68	250.68	250.59	250.64	1862.08
44	250.67	250.65	250.65	250.56	250.62	2084.41
45	250.64	250.62	250.62	250.53	250.60	2242.13
46	250.61	250.60	250.59	250.50	250.57	1604.40
47	250.59	250.57	250.57	250.48	250.55	2302.53
48	250.57	250.55	250.55	250.46	250.53	2366.36
49	250.54	250.52	250.52	250.43	250.50	1087.03
50	250.52	250.50	250.50	250.41	250.48	2354.89
51	250.49	250.48	250.47	250.39	250.46	2418.37
52	250.47	250.45	250.44	250.36	250.42	-224.14
53	250.44	250.42	250.42	250.33	250.40	2262.12
54	250.42	250.40	250.40	250.31	250.38	2364.64
55	250.39	250.38	250.37	250.29	250.36	2427.67
56	250.37	250.35	250.34	250.26	250.32	-210.69
57	250.34	250.32	250.32	250.23	250.30	2270.03
58	250.32	250.30	250.30	250.21	250.28	2374.32
59	250.29	250.27	250.27	250.18	250.25	1098.39
60	250.26	250.24	250.24	250.15	250.22	1036.56
61	250.23	250.21	250.21	250.12	250.18	-307.46
62	250.20	250.18	250.18	250.09	250.16	2211.49
63	250.18	250.16	250.16	250.07	250.14	698.42
64	250.15	250.14	250.13	250.04	250.12	784.63
65	250.13	250.11	250.11	250.02	250.10	835.21
66	250.12	250.10	250.10	250.01	250.10	1965.36
67	250.10	250.08	250.08	249.99	250.07	-1963.20
68	250.09	250.07	250.07	249.98	250.07	1975.00
69	250.09	250.07	250.07	249.98	250.07	2134.15
70	250.07	250.06	250.06	249.96	250.05	-559.55
71	250.07	250.05	250.05	249.96	250.05	2094.76
72	250.07	250.05	250.05	249.96	250.05	2135.41
73	250.07	250.05	250.05	249.96	250.05	2135.41
74	250.07	250.05	250.05	249.96	250.05	2135.41
75	250.06	250.04	250.04	249.95	250.04	836.10
76	250.06	250.04	250.04	249.95	250.04	2135.10
77	250.04	250.03	250.03	249.93	250.02	-557.27
78	250.03	250.01	250.01	249.92	250.00	-645.25
79	250.02	250.00	250.00	249.91	250.00	2072.41
80	250.02	250.00	250.00	249.91	250.00	486.53
81	250.01	249.99	249.99	249.90	249.99	-800.10

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82	250.02	250.00	250.00	249.91	250.00	1557.18
83	250.02	250.00	250.00	249.91	250.00	486.53
84	250.02	250.00	250.00	249.91	250.00	486.53
85	249.25	249.19	241.96	249.16	0.0	**********

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C. Optimized Unit Hydrographs, HEC-1 Printout

RUN NO. VEPCO-53
OPTIMIZATION OF THE UNIT HYDROGRAPH
AT THE NORTH ANNA DAM SITE-JUNE 20, 1972

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
120	1	0	20	0	0	0	2	0	5

JOPER	NWT
2	0

HYDROGRAPH AND LOSS RATE OPTIMIZATION COMPUTATIONS

ISTAQ	ISNOW	TAREA	SNAP	STRTQ	QRCSN	RTIOR	NCLRK
100	0	297.00	0.0	0.0	2000.00	1.33	0

INPUT DATA

TC	R	COEF	STRKR	STRKS	RTIOK	ERAIN	FRZTP	DLTKR	RTIOL
-1.00	-1.00	0.0	0.23	0.0	0.0	0.47	0.0	-0.50	12.11

INITIAL ESTIMATES

TC+R	R/(TC+R)	COEF	STRKR	STRKS	RTIOK	ERAIN	FRZTP	DLTKR	RTIOL
17.23	0.50	0.0	0.23	0.0	0.0	0.47	0.0	0.50	12.11

5 NON-RECORDING STATION(S)

STA	STORM	SEASON
1	8.99	1.00
2	7.80	1.00
3	8.06	1.00
4	7.20	1.00
5	8.31	1.00

2 RECORDING STATION(S)

STA NO. 1

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.10	0.0	0.20	0.10	0.10
0.0	0.0	0.0	0.10	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.10	0.0	0.20	0.10	0.40	1.40	1.70	1.00	1.00
0.70	0.20	0.30	0.20	0.20	0.20	0.20	0.10	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10	0.0	0.0
0.0	0.10	0.10	0.0	0.0	0.0	0.0	0.10	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10	0.0

STA NO. 4

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.10
0.0	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.20	0.40	0.10	0.0	0.0
0.20	0.90	1.50	0.80	0.40	0.40	0.50	0.20	0.20	0.30
0.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10
0.10	0.0	0.10	0.0	0.10	0.0	0.0	0.10	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

N02FA249

```
     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0

                    NON-RECORDING STATION WEIGHTINGS (ISTN,WTN)
              1,  7.48              2,  3.66              3,  6.16
              4,  0.0               5,  1.79

                    RECORDING STATION WEIGHTINGS (ISTR,WTR)
              1, 18.62              4,  0.45

STANDARD ERROR FOR VARIABLE 1   9671.7539   9779.0352   9891.1094
VAR  1 ADJ FROM  17.23 TO  21.00

STANDARD ERROR FOR VARIABLE 2   8693.4023   8650.2656   8607.5313
VAR  2 ADJ FROM   0.50 TO   0.33

STANDARD ERROR FOR VARIABLE 9   7626.9531   7635.3555   7645.8945
VAR  9 ADJ FROM   3.99 TO   4.12

STANDARD ERROR FOR VARIABLE 1   7614.7188   7616.4688   7631.5547
VAR  1 ADJ FROM  21.00 TO  20.93

STANDARD ERROR FOR VARIABLE 2   7613.8516   7600.8984   7589.6953
VAR  2 ADJ FROM   0.33 TO   0.31

STANDARD ERROR FOR VARIABLE 9   7542.9531   7552.5234   7564.5586
VAR  9 ADJ FROM   4.12 TO   4.26

STANDARD ERROR FOR VARIABLE 1   7529.1563   7521.8203   7529.8047
VAR  1 ADJ FROM  20.93 TO  20.72

STANDARD ERROR FOR VARIABLE 2   7521.6203   7513.9531   7506.6602
VAR  2 ADJ FROM   0.31 TO   0.26

STANDARD ERROR FOR VARIABLE 9   7464.4922   7462.4844   7503.3086
VAR  9 ADJ FROM   4.26 TO   4.51

STANDARD ERROR FOR VARIABLE 1   7418.3789   7407.3984   7414.6875
VAR  1 ADJ FROM  20.72 TO  20.49

STANDARD ERROR FOR VARIABLE 2   7407.2500   7403.5977   7400.3906
VAR  2 ADJ FROM   0.26 TO   0.24

STANDARD ERROR FOR VARIABLE 9   7391.4688   7403.8398   7419.7031
VAR  9 ADJ FROM   4.51 TO   4.65

STANDARD ERROR FOR VARIABLE 1   7375.6984   7373.9922   7389.6445
VAR  1 ADJ FROM  20.49 TO  20.37

                    INFILTRATION INDEX =0.177 IN/HR

                    STRKR FOR RTIOL OF 3. = 0.18

                    OPTIMIZATION RESULTS
         TC      R   COEF  STRKR  STRKS  RTIOK  ERAIN  FRZTP  DLTKR  RTIOL
      15.47   4.90    0.0   0.23    0.0    0.0   0.47    0.0   4.02  12.11

        UNIT HYDROGRAPH 35 END-OF-PERIOD ORDINATES, LAG=  11.49 HOURS, CP= 0.80  VOL= 1.00
     412.    1502.    2954.    4539.    6166.    7785.    9369.   10896.   12196.   13080.
   13547.   13648.   13416.   12662.   11948.   10470.    8604.    7059.    5752.    4666.
    3818.    3111.    2535.    2065.    1683.    1371.    1117.     910.     741.     604.
     492.     401.     327.     266.     217.

                    END-OF-PERIOD FLOW
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TIME			RAIN	EXCS	COMP Q	OBS Q
20	1	0	0.0	0.0	0.	0.
20	2	0	0.0	0.0	0.	225.
20	3	0	0.0	0.0	0.	225.
20	4	0	0.0	0.0	0.	225.
20	5	0	0.0	0.0	0.	225.
20	6	0	0.0	0.0	0.	225.
20	7	0	0.0	0.0	0.	225.
20	8	0	0.0	0.0	0.	225.
20	9	0	0.0	0.0	0.	225.
20	10	0	0.0	0.0	0.	225.
20	11	0	0.0	0.0	0.	247.
20	12	0	0.0	0.0	0.	247.
20	13	0	0.00	0.00	0.	86.
20	14	0	0.0	0.0	0.	227.
20	15	0	0.0	0.0	0.	228.
20	16	0	0.09	0.00	0.	0.
20	17	0	0.0	0.0	0.	129.
20	18	0	0.18	0.00	0.	0.
20	19	0	0.09	0.00	0.	0.
20	20	0	0.09	0.00	0.	0.
20	21	0	0.0	0.0	0.	62.
20	22	0	0.00	0.00	0.	3.
20	23	0	0.0	0.0	0.	153.
21	0	0	0.09	0.00	0.	0.
21	1	0	0.0	0.0	0.	119.
21	2	0	0.0	0.0	0.	155.
21	3	0	0.0	0.0	0.	163.
21	4	0	0.0	0.0	0.	161.
21	5	0	0.0	0.0	0.	170.
21	6	0	0.0	0.0	0.	170.
21	7	0	0.0	0.0	0.	172.
21	8	0	0.09	0.00	0.	0.
21	9	0	0.0	0.0	0.	99.
21	10	0	0.18	0.00	0.	0.
21	11	0	0.09	0.00	0.	386.
21	12	0	0.37	0.00	0.	0.
21	13	0	1.28	0.68	279.	0.
21	14	0	1.55	1.10	1467.	0.
21	15	0	0.91	0.65	3913.	21400.
21	16	0	0.91	0.70	7576.	21082.
21	17	0	0.64	0.49	12325.	26028.
21	18	0	0.20	0.12	17638.	29616.
21	19	0	0.31	0.22	23791.	27620.
21	20	0	0.20	0.13	30002.	29180.
21	21	0	0.19	0.13	36225.	31500.
21	22	0	0.19	0.13	42077.	36359.
21	23	0	0.19	0.14	47200.	37828.
22	0	0	0.10	0.06	51339.	39274.
22	1	0	0.00	0.00	54272.	34148.
22	2	0	0.01	0.00	55885.	41354.
22	3	0	0.01	0.00	56122.	59003.
22	4	0	0.0	0.0	54780.	67877.
22	5	0	0.0	0.0	51743.	44156.
22	6	0	0.0	0.0	47435.	35215.
22	7	0	0.0	0.0	42462.	34621.
22	8	0	0.0	0.0	37276.	34050.
22	9	0	0.0	0.0	32301.	33464.
22	10	0	0.0	0.0	27749.	24652.
22	11	0	0.0	0.0	23631.	19045.
22	12	0	0.0	0.0	19947.	16646.
22	13	0	0.0	0.0	16671.	12579.
22	14	0	0.0	0.0	13782.	11710.

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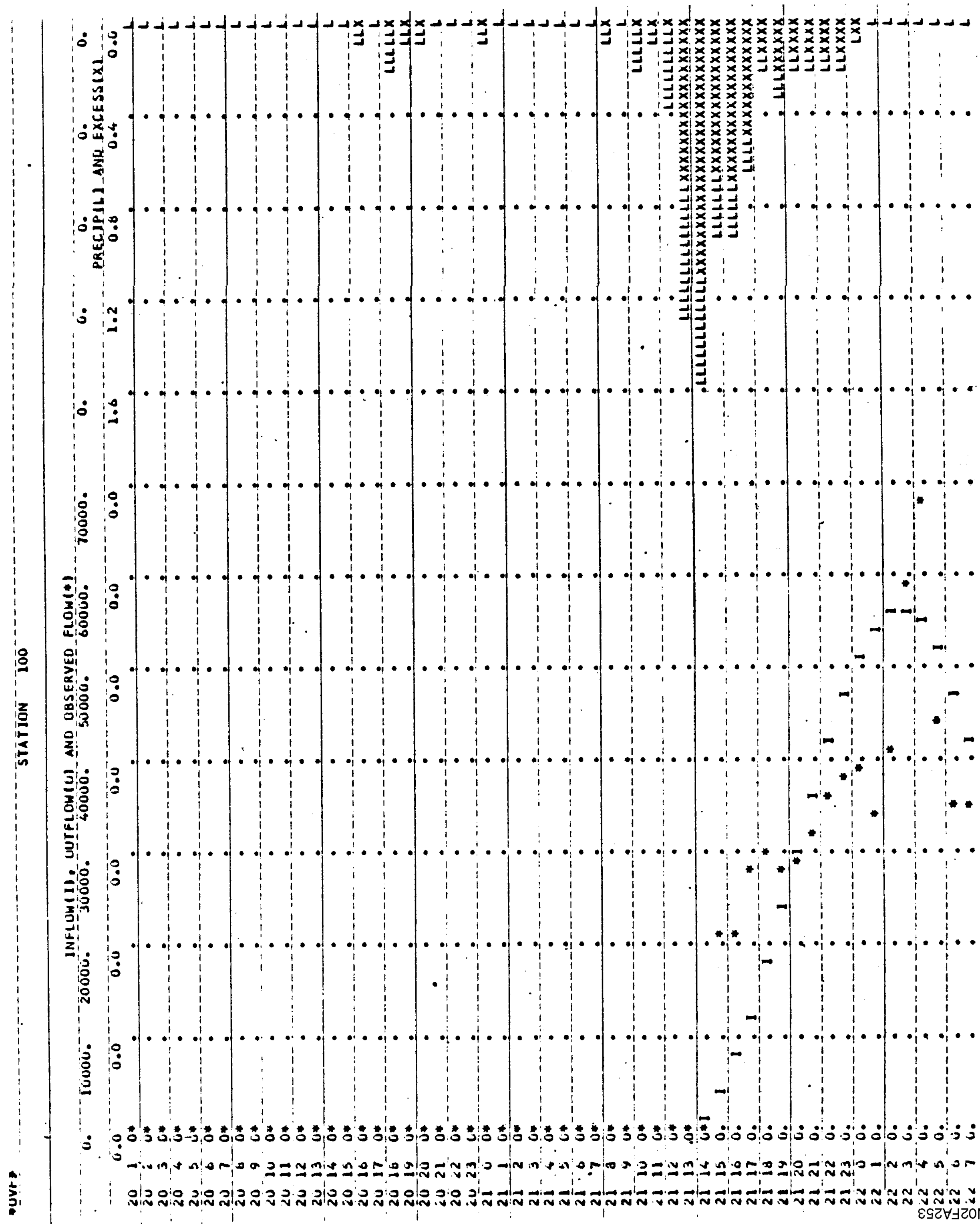
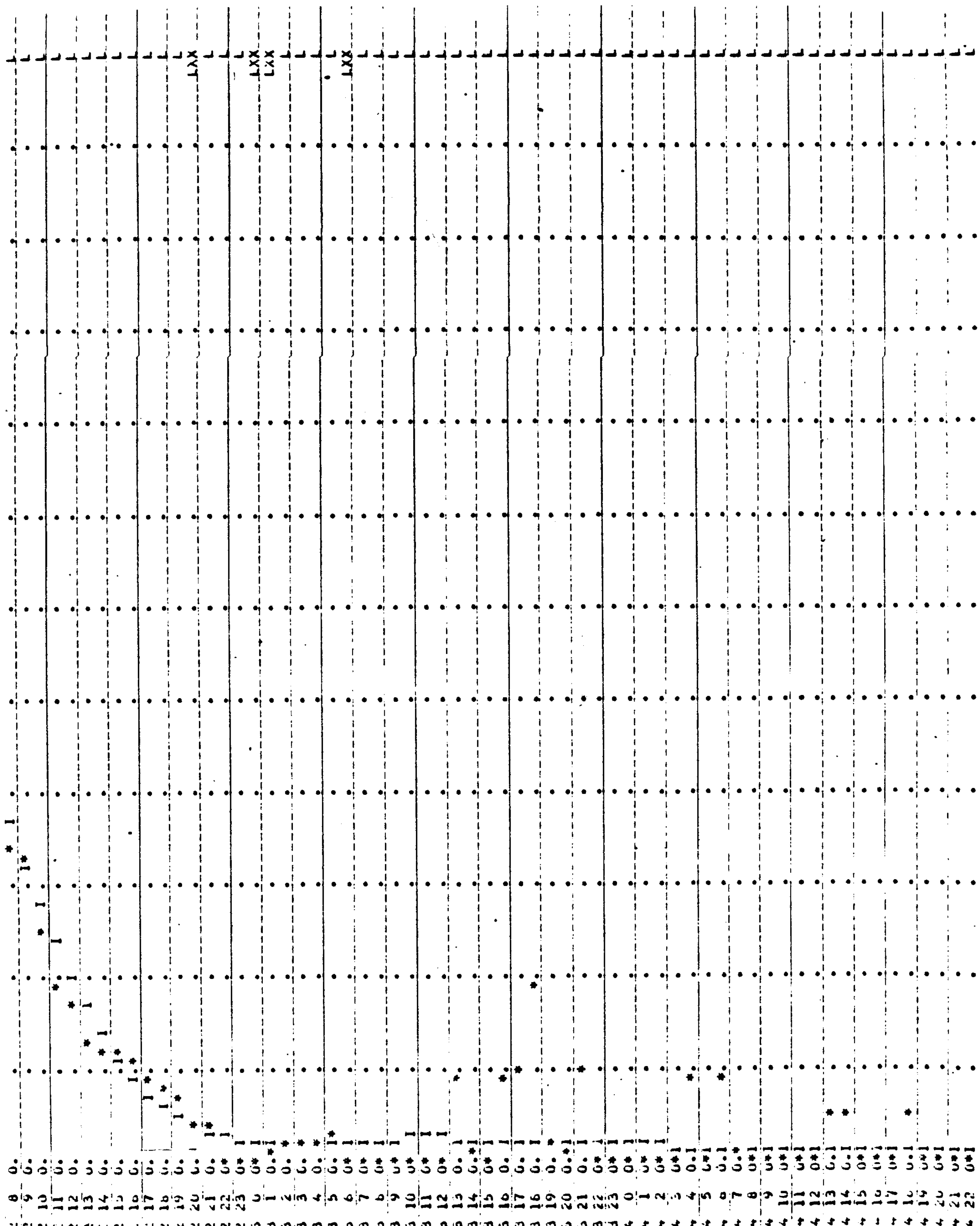
22	15	0	0.0	0.0	11288.	12485.
22	16	0	0.0	0.0	9205.	10500.
22	17	0	0.0	0.0	7500.	9239.
22	18	0	0.0	0.0	6110.	7556.
22	19	0	0.0	0.0	4979.	6762.
22	20	0	0.09	0.05	4078.	3515.
22	21	0	0.0	0.0	3386.	3777.
22	22	0	0.00	0.00	2852.	0.
22	23	0	0.00	0.00	2436.	0.
23	0	0	0.09	0.05	2022.	0.
23	1	0	0.09	0.06	1948.	1380.
23	2	0	0.0	0.0	1693.	1893.
23	3	0	0.00	0.00	1840.	1941.
23	4	0	0.0	0.0	1788.	2359.
23	5	0	0.0	0.0	1762.	2607.
23	6	0	0.09	0.06	1902.	0.
23	7	0	0.0	0.0	2088.	0.
23	8	0	0.0	0.0	2273.	10.
23	9	0	0.0	0.0	2421.	115.
23	10	0	0.0	0.0	2511.	152.
23	11	0	0.0	0.0	2546.	198.
23	12	0	0.0	0.0	2535.	198.
23	13	0	0.0	0.0	2494.	9399.
23	14	0	0.0	0.0	2418.	732.
23	15	0	0.0	0.0	2278.	166.
23	16	0	0.0	0.0	2075.	9442.
23	17	0	0.0	0.0	1963.	9834.
23	18	0	0.0	0.0	1907.	19073.
23	19	0	0.0	0.0	1854.	1811.
23	20	0	0.0	0.0	1802.	1168.
23	21	0	0.0	0.0	1751.	9820.
23	22	0	0.0	0.0	1702.	0.
23	23	0	0.0	0.0	1654.	129.
24	0	0	0.0	0.0	1607.	262.
24	1	0	0.0	0.0	1562.	262.
24	2	0	0.0	0.0	1518.	262.
24	3	0	0.0	0.0	1476.	0.
24	4	0	0.0	0.0	1434.	9220.
24	5	0	0.0	0.0	1394.	0.
24	6	0	0.0	0.0	1355.	9313.
24	7	0	0.0	0.0	1317.	553.
24	8	0	0.0	0.0	1280.	0.
24	9	0	0.0	0.0	1244.	0.
24	10	0	0.0	0.0	1209.	175.
24	11	0	0.0	0.0	1175.	175.
24	12	0	0.0	0.0	1142.	175.
24	13	0	0.0	0.0	1109.	4866.
24	14	0	0.0	0.0	1078.	5030.
24	15	0	0.0	0.0	1048.	390.
24	16	0	0.0	0.0	1018.	294.
24	17	0	0.0	0.0	990.	294.
24	18	0	0.0	0.0	962.	4891.
24	19	0	0.0	0.0	935.	285.
24	20	0	0.0	0.0	909.	198.
24	21	0	0.0	0.0	883.	198.
24	22	0	0.0	0.0	858.	198.
24	23	0	0.09	0.06	834.	0.
25	0	0	0.0	0.0	811.	0.
		SUM	6.41	4.83	938499.	938937.

N02FA252

Best Copy Available





N02FA254

RUN NO. VEPCO-55
OPTIMIZATION OF THE UNIT HYDROGRAPH
AT THE NORTH ANNA DAM SITE-APRIL 25, 1973

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
96	1	0	25	0	0	0	2	0	5

JOPER	NWT
2	0

HYDROGRAPH AND LOSS RATE OPTIMIZATION COMPUTATIONS

ISTAQ	ISNOW	TAREA	SNAP	STRTQ	QRCSN	RTIOR	NCLRK
100	0	297.00	0.0	0.0	7000.00	1.27	0

INPUT DATA

TC	R	COEF	STRKR	STRKS	RTICK	ERAIN	FRZTP	DLTKR	RTIOL
-1.00	-1.00	0.0	0.23	0.0	0.0	0.47	0.0	-0.50	12.11

INITIAL ESTIMATES

TC+R	R/(TC+R)	COEF	STRKR	STRKS	RTIOK	ERAIN	FRZTP	DLTKR	RTIOL
17.23	0.50	0.0	0.23	0.0	0.0	0.47	0.0	0.50	12.11

5 NON-RECORDING STATION(S)

STA	STORM	SEASON
1	3.12	1.00
2	3.30	1.00
3	3.16	1.00
4	2.62	1.00
5	3.93	1.00

2 RECORDING STATION(S)

STA NO. 1

0.0	0.0	0.0	0.0	0.0	0.20	0.0	0.30	0.30	0.20
0.10	0.10	0.0	0.0	0.10	0.0	0.0	0.0	0.0	0.0
0.10	0.10	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.10	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.30
0.10	0.20	0.30	0.30	0.0	0.10	0.10	0.10	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0				

STA NO. 4

0.0	0.0	0.0	0.0	0.0	0.0	0.10	0.0	0.0	0.0
0.10	0.10	0.0	0.0	0.0	0.10	0.0	0.0	0.0	0.0
0.0	0.0	0.10	0.20	0.0	0.10	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.20	0.20	0.20	0.40	0.50	0.10	0.10	0.0	0.0	0.10
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0				

NON-RECORDING STATION WEIGHTINGS (ISTN,WTN)

1, 7.46 2, 3.66 3, 6.16

N02FA255

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                              4, 0.0                  5, 1.79

                              RECORDING STATION WEIGHTINGS (ISTR,WTR)
                              1, 18.62                4, 0.45

STANDARD ERROR FOR VARIABLE 1   5106.8906   5123.6172   5141.3164
VAR  1 ADJ FROM  17.23 TO  20.11

STANDARD ERROR FOR VARIABLE 2   4921.0352   4904.6094   4889.0547
VAR  2 ADJ FROM   0.50 TO   0.40

STANDARD ERROR FOR VARIABLE 9   4598.0234   4594.1523   4589.8828
VAR  9 ADJ FROM   1.65 TO   1.10

STANDARD ERROR FOR VARIABLE 1   4554.7031   4566.4648   4579.5391
VAR  1 ADJ FROM  20.11 TO  21.81

STANDARD ERROR FOR VARIABLE 2   4508.3281   4494.6016   4481.4688
VAR  2 ADJ FROM   0.40 TO   0.31

STANDARD ERROR FOR VARIABLE 9   4230.1445   4231.2773   4232.5076
VAR  9 ADJ FROM   1.10 TO   1.22

STANDARD ERROR FOR VARIABLE 1   4221.6359   4217.2617   4212.8750
VAR  1 ADJ FROM  21.81 TO  21.32

STANDARD ERROR FOR VARIABLE 2   4212.0508   4205.0313   4197.0391
VAR  2 ADJ FROM   0.31 TO   0.21

STANDARD ERROR FOR VARIABLE 9   4010.1047   4011.2576   4012.5210
VAR  9 ADJ FROM   1.22 TO   1.34

STANDARD ERROR FOR VARIABLE 1   4005.2703   4000.0544   3997.0806
VAR  1 ADJ FROM  21.32 TO  20.72

STANDARD ERROR FOR VARIABLE 2   3995.6953   3993.2029   3990.7825
VAR  2 ADJ FROM   0.21 TO   0.14

STANDARD ERROR FOR VARIABLE 9   3962.1069   3962.4536   3962.9563
VAR  9 ADJ FROM   1.34 TO   1.37

STANDARD ERROR FOR VARIABLE 1   3961.8828   3963.3311   3967.7183
VAR  1 ADJ FROM  20.72 TO  20.72

                              INFILTRATION INDEX =0.113 IN/HR

                              STRKR FOR RTIOL OF 3. = 0.20

                              OPTIMIZATION RESULTS
          TC      R    COEF   STRKR   STRKS   RTIOK   ERAIN   FRZTP   DLTKR   RTIOL
       17.88   2.84     0.0    0.23     0.0     0.0    0.47     0.0    1.93   12.11

UNIT HYDROGRAPH 27 END-OF-PERIOD ORDINATES, LAG= 11.40 HOURS, CP= 0.81  VOL= 1.00
      537.    1894.    3579.    5262.    6911.    8435.    9846.   11152.   12361.   13334.
    13656.   13925.   13653.   13114.   12348.   11368.   10144.    8493.    6394.    4478.
     3135.    2196.    1538.    1077.     754.     528.     370.

                              END-OF-PERIOD FLOW
                       TIME   RAIN    EXCS    COMP Q    OBS Q
                     25 1 0    0.0     0.0        0.       0.
                     25 2 0    0.0     0.0        0.      61.
                     25 3 0    0.0     0.0        0.      61.
                     25 4 0    0.0     0.0        0.      61.
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25	5	0	0.0	0.0	0.	61.
25	6	0	0.20	0.00	0.	0.
25	7	0	0.00	0.00	0.	0.
25	8	0	0.30	0.00	0.	0.
25	9	0	0.30	0.06	34.	0.
25	10	0	0.20	0.04	144.	0.
25	11	0	0.10	0.00	308.	0.
25	12	0	0.10	0.01	493.	0.
25	13	0	0.0	0.0	682.	0.
25	14	0	0.0	0.0	865.	284.
25	15	0	0.10	0.02	1045.	0.
25	16	0	0.00	0.00	1225.	1378.
25	17	0	0.0	0.0	1399.	2332.
25	18	0	0.0	0.0	1553.	2601.
25	19	0	0.0	0.0	1666.	1291.
25	20	0	0.0	0.0	1726.	261.
25	21	0	0.10	0.02	1758.	0.
25	22	0	0.10	0.03	1782.	0.
25	23	0	0.10	0.03	1820.	0.
26	0	0	0.00	0.00	1865.	0.
26	1	0	0.0	0.0	1885.	16139.
26	2	0	0.00	0.00	1854.	3112.
26	3	0	0.0	0.0	1810.	2813.
26	4	0	0.0	0.0	1768.	2857.
26	5	0	0.0	0.0	1726.	2883.
26	6	0	0.0	0.0	1685.	2894.
26	7	0	0.0	0.0	1645.	2906.
26	8	0	0.0	0.0	1607.	2913.
26	9	0	0.0	0.0	1569.	2913.
26	10	0	0.0	0.0	1532.	2913.
26	11	0	0.0	0.0	1495.	2913.
26	12	0	0.10	0.04	1460.	2034.
26	13	0	0.0	0.0	1426.	2465.
26	14	0	0.0	0.0	1392.	2671.
26	15	0	0.0	0.0	1359.	2794.
26	16	0	0.0	0.0	1327.	2867.
26	17	0	0.0	0.0	1296.	2888.
26	18	0	0.0	0.0	1265.	2903.
26	19	0	0.0	0.0	1235.	0.
26	20	0	0.0	0.0	1206.	0.
26	21	0	0.0	0.0	1177.	0.
26	22	0	0.0	0.0	1150.	0.
26	23	0	0.0	0.0	1123.	2659.
27	0	0	0.0	0.0	1096.	2895.
27	1	0	0.0	0.0	1070.	2913.
27	2	0	0.30	0.20	1045.	4085.
27	3	0	0.11	0.05	1020.	4102.
27	4	0	0.21	0.13	1220.	4488.
27	5	0	0.31	0.22	1865.	1109.
27	6	0	0.31	0.22	2621.	0.
27	7	0	0.01	0.00	4015.	1458.
27	8	0	0.10	0.05	5300.	1918.
27	9	0	0.10	0.05	6619.	5829.
27	10	0	0.10	0.05	7960.	6569.
27	11	0	0.0	0.0	9257.	9152.
27	12	0	0.00	0.00	10414.	8180.
27	13	0	0.0	0.0	11379.	8857.
27	14	0	0.0	0.0	12114.	9608.
27	15	0	0.0	0.0	12546.	12577.
27	16	0	0.0	0.0	12676.	14172.
27	17	0	0.0	0.0	12520.	17038.
27	18	0	0.0	0.0	12101.	25062.
27	19	0	0.0	0.0	11389.	18100.

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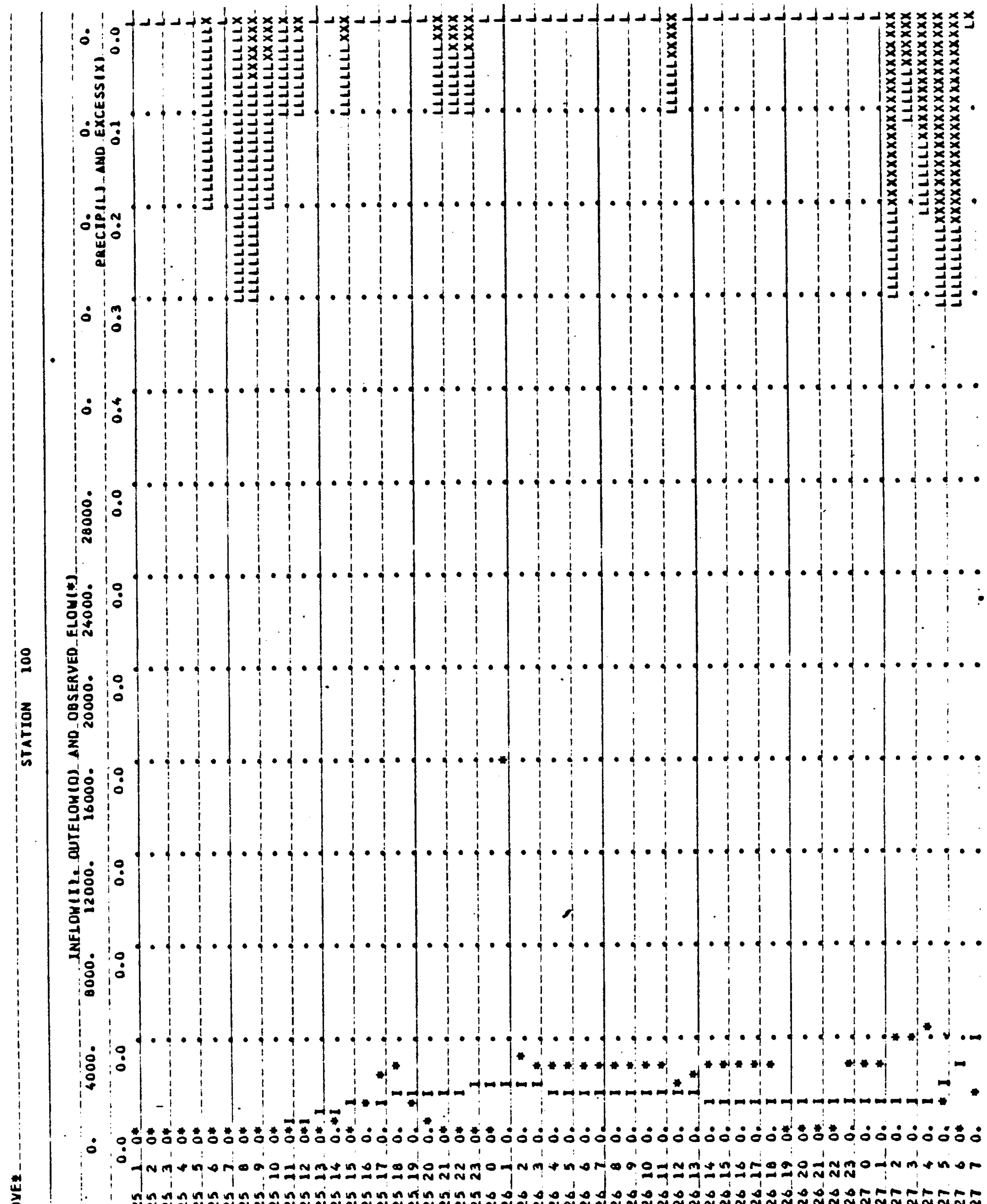
27	20	0	0.0	0.0	10376.	7858.
27	21	0	0.0	0.0	9165.	6993.
27	22	0	0.0	0.0	7828.	5948.
27	23	0	0.0	0.0	6930.	5664.
28	0	0	0.0	0.0	6766.	5664.
28	1	0	0.0	0.0	6606.	5664.
28	2	0	0.0	0.0	6450.	5664.
28	3	0	0.0	0.0	6298.	5664.
28	4	0	0.0	0.0	6149.	5664.
28	5	0	0.0	0.0	6004.	0.
28	6	0	0.0	0.0	5862.	4493.
28	7	0	0.0	0.0	5724.	5042.
28	8	0	0.0	0.0	5589.	5427.
28	9	0	0.0	0.0	5457.	5587.
28	10	0	0.0	0.0	5328.	5598.
28	11	0	0.0	0.0	5202.	5598.
28	12	0	0.0	0.0	5079.	5598.
28	13	0	0.0	0.0	4959.	5598.
28	14	0	0.0	0.0	4842.	5598.
28	15	0	0.0	0.0	4728.	2811.
28	16	0	0.0	0.0	4616.	1300.
28	17	0	0.0	0.0	4507.	1155.
28	18	0	0.0	0.0	4400.	2422.
28	19	0	0.0	0.0	4296.	5247.
28	20	0	0.0	0.0	4195.	0.
28	21	0	0.0	0.0	4096.	0.
28	22	0	0.0	0.0	3999.	4768.
28	23	0	0.0	0.0	3905.	0.
29	0	0	0.0	0.0	3813.	1670.
	SUM		3.25	1.22	353955.	355775.

N02FA258

Best Copy Available



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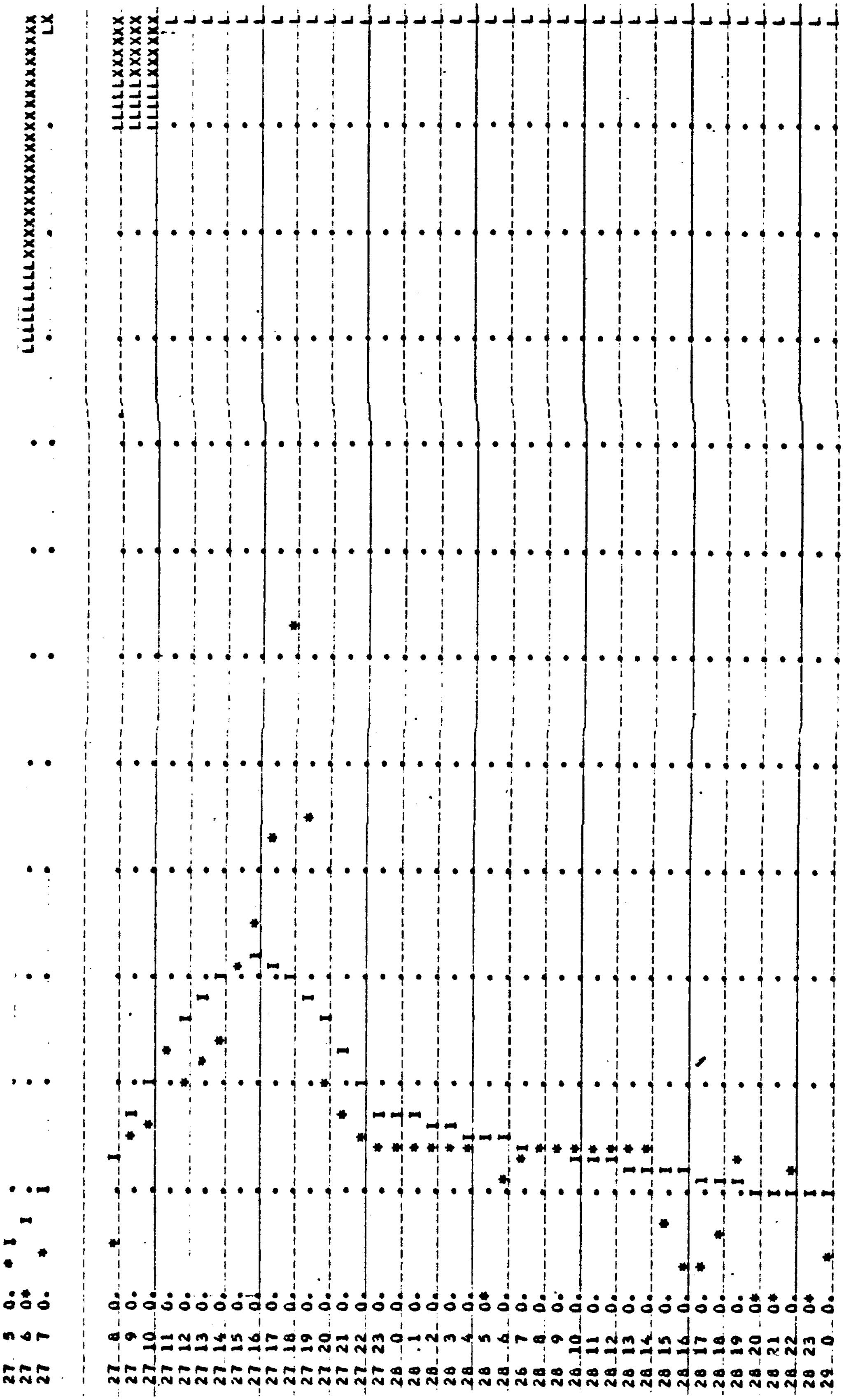

N02FA260

RUN NO. VEPCO-52
OPTIMIZATION OF THE UNIT HYDROGRAPH
AT THE NORTH ANNA DAM SITE-SEPT. 6, 1974

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
96	1	0	6	0	0	0	2	0	5

JOPER	NWT
2	0

HYDROGRAPH AND LOSS RATE OPTIMIZATION COMPUTATIONS

ISTAQ	ISNOW	TAREA	SNAP	STRTQ	QRCSN	RTIOR	NCLRK
100	0	297.00	0.0	0.0	1000.00	2.00	0

INPUT DATA

TC	R	COEF	STRKR	STRKS	RTIOK	ERAIN	FRZTP	DLTKR	RTIOL
-1.00	-1.00	0.0	0.23	0.0	0.0	0.50	0.0	-0.50	4.36

INITIAL ESTIMATES

TC+R	R/(TC+R)	COEF	STRKR	STRKS	RTIOK	ERAIN	FRZTP	DLTKR	RTIOL
17.23	0.50	0.0	0.23	0.0	0.0	0.50	0.0	0.50	4.36

5 NON-RECORDING STATION(S)

STA	STORM	SEASON
1	1.97	1.00
2	3.60	1.00
3	0.0	1.00
4	2.60	1.00
5	2.06	1.00

2 RECORDING STATION(S)

STA NO. 1

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10	0.0
0.0	0.10	0.0	0.10	0.10	0.10	0.10	0.20	0.20	0.20
0.20	0.20	0.10	0.10	0.0	0.10	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0				

STA NO. 4

0.0	0.0	0.0	0.0	0.10	0.10	0.0	0.10	0.0	0.10
0.0	0.0	0.0	0.10	0.10	0.20	0.10	0.20	0.20	0.20
0.20	0.20	0.20	0.20	0.10	0.10	0.0	0.0	0.10	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0				

NON-RECORDING STATION WEIGHTINGS (ISIN,WTN)

1, 8.71 2, 6.17 3, 0.0

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```
                              4, 0.0                5, 4.20

                                          RECORDING STATION WEIGHTINGS (ISTR,WTR)
                              1, 18.62 .            4, 0.45

STANDARD ERROR FOR VARIABLE 1   1693.5163   1714.8059   1736.5056
VAR  1 ADJ FROM  17.23 TO  25.65

STANDARD ERROR FOR VARIABLE 2   1027.6687 . 1024.2129   1020.8115
VAR  2 ADJ FROM   0.50 TO   0.33

STANDARD ERROR FOR VARIABLE 9   1003.7639   1018.4355   1035.0325
VAR  9 ADJ FROM   2.48 TO   2.65

STANDARD ERROR FOR VARIABLE 1    963.4438    967.1760    972.0654
VAR  1 ADJ FROM  25.85 TO  26.55

STANDARD ERROR FOR VARIABLE 2    959.6660    959.1887    958.7598
VAR  2 ADJ FROM   0.33 TO   0.31

STANDARD ERROR FOR VARIABLE 9    957.4387    955.4089    956.2534
VAR  9 ADJ FROM   2.65 TO   2.62

STANDARD ERROR FOR VARIABLE 1    955.3469    957.1228    960.2566
VAR  1 ADJ FROM  26.55 TO  26.77

STANDARD ERROR FOR VARIABLE 2    954.9141    955.1912    955.5176
VAR  2 ADJ FROM   0.31 TO   0.32

STANDARD ERROR FOR VARIABLE 9    954.2549 .  953.3735    955.2075
VAR  9 ADJ FROM   2.62 TO   2.60

STANDARD ERROR FOR VARIABLE 1    953.3311    954.6753    957.3821
VAR  1 ADJ FROM  26.77 TO  26.90

STANDARD ERROR FOR VARIABLE 2    953.1489    953.4060    953.7183
VAR  2 ADJ FROM   0.32 TO   0.34

STANDARD ERROR FOR VARIABLE 9    952.6521    952.2659    954.4712
VAR  9 ADJ FROM   2.60 TO   2.58

STANDARD ERROR FOR VARIABLE 1    952.1050    953.3679    956.0088
VAR  1 ADJ FROM  26.90 TO  27.01

                                        INFILTRATION INDEX =0.141 IN/HR

                                        STRKR FOR RTIOL OF 3. = 0.22

                                                OPTIMIZATION RESULTS
                    TC       R    COEF   STRKR   STRKS   RTIOK   ERAIN   FRZTP   DLTKR   RTIOL
                 17.92    9.09     0.0    0.23     0.0     0.0    0.50     0.0    2.47    4.36 .

                 UNIT HYDROGRAPH 59 END-OF-PERIOD ORDINATES, LAG=  14.96 HOURS, CP= 0.75  VOL= 1.00
              186.      693.     1402.     2219.     3102.     4025.     4972.     5930.     6891.     7796.
             8554.     9130.     9536.     9778.     9861.     9783.     9527.     9029.     8252.     7391.
             6621.     5931.     5312.     4758.     4262.     3816.     3420.     3063.     2744.     2458.
             2202.     1972.     1766.     1582.     1417.     1270.     1137.     1019.      912.      817.
              732.      656.      587.      526.      471.      422.      378.      339.      303.      272.
              243.      216.      195.      175.      157.      140.      126.      113.      101.

                                              END-OF-PERIOD FLOW
                                   TIME    RAIN    EXCS     COMP Q     OBS Q
                                 6 1 0     0.0     0.0        0.        0.
```

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6	2	0	0.0	0.0	0.	0.
6	3	0	0.0	0.0	0.	0.
6	4	0	0.0	0.0	0.	0.
6	5	0	0.00	0.00	0.	0.
6	6	0	0.00	0.00	0.	0.
6	7	0	0.0	0.0	0.	866.
6	8	0	0.00	0.00	0.	2430.
6	9	0	0.13	0.00	0.	0.
6	10	0	0.00	0.00	0.	417.
6	11	0	0.0	0.0	0.	431.
6	12	0	0.13	0.00	0.	0.
6	13	0	0.0	0.0	0.	2371.
6	14	0	0.13	0.00	0.	0.
6	15	0	0.13	0.00	0.	0.
6	16	0	0.13	0.00	0.	0.
6	17	0	0.13	0.00	0.	0.
6	18	0	0.26	0.04	7.	226.
6	19	0	0.26	0.07	39.	0.
6	20	0	0.26	0.09	120.	0.
6	21	0	0.26	0.11	269.	1960.
6	22	0	0.26	0.13	506.	0.
6	23	0	0.13	0.05	835.	3721.
7	0	0	0.13	0.05	1235.	2752.
7	1	0	0.00	0.00	1686.	749.
7	2	0	0.13	0.05	2182.	3580.
7	3	0	0.0	0.0	2709.	1729.
7	4	0	0.0	0.0	3247.	3298.
7	5	0	0.00	0.00	3773.	3293.
7	6	0	0.0	0.0	4265.	1704.
7	7	0	0.0	0.0	4701.	4244.
7	8	0	0.0	0.0	5063.	4709.
7	9	0	0.0	0.0	5341.	3817.
7	10	0	0.0	0.0	5530.	5323.
7	11	0	0.0	0.0	5622.	5470.
7	12	0	0.0	0.0	5606.	5491.
7	13	0	0.0	0.0	5482.	5503.
7	14	0	0.0	0.0	5253.	4173.
7	15	0	0.0	0.0	4937.	4141.
7	16	0	0.0	0.0	4564.	4144.
7	17	0	0.0	0.0	4172.	2737.
7	18	0	0.0	0.0	3786.	5416.
7	19	0	0.0	0.0	3418.	2769.
7	20	0	0.0	0.0	3071.	2667.
7	21	0	0.0	0.0	2750.	977.
7	22	0	0.0	0.0	2464.	2336.
7	23	0	0.0	0.0	2207.	789.
8	0	0	0.0	0.0	1977.	2202.
8	1	0	0.0	0.0	1771.	901.
8	2	0	0.0	0.0	1566.	875.
8	3	0	0.0	0.0	1421.	2238.
8	4	0	0.0	0.0	1273.	2247.
8	5	0	0.0	0.0	1140.	0.
8	6	0	0.0	0.0	1021.	1556.
8	7	0	0.0	0.0	946.	596.
8	8	0	0.0	0.0	883.	0.
8	9	0	0.0	0.0	824.	1620.
8	10	0	0.0	0.0	764.	0.
8	11	0	0.0	0.0	717.	583.
8	12	0	0.0	0.0	669.	563.
8	13	0	0.0	0.0	624.	563.
8	14	0	0.0	0.0	583.	563.
8	15	0	0.0	0.0	543.	1641.
8	16	0	0.0	0.0	507.	0.

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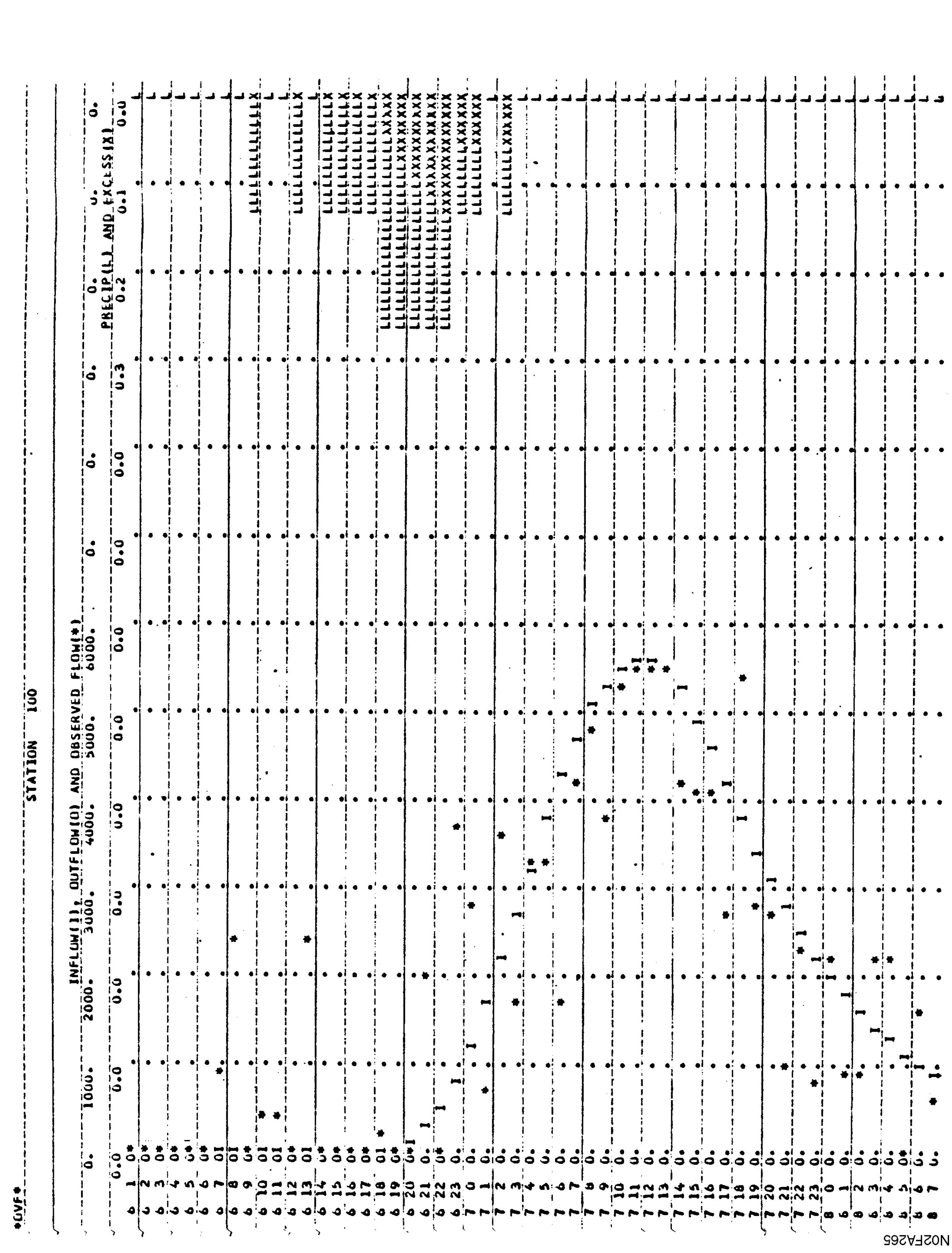
8	17	0	0.0	0.0	473.	583.
8	18	0	0.0	0.0	441.	583.
8	19	0	0.0	0.0	412.	583.
8	20	0	0.0	0.0	384.	583.
8	21	0	0.0	0.0	359.	583.
8	22	0	0.0	0.0	335.	583.
8	23	0	0.0	0.0	312.	583.
9	0	0	0.0	0.0	291.	583.
9	1	0	0.0	0.0	272.	0.
9	2	0	0.0	0.0	254.	364.
9	3	0	0.0	0.0	237.	364.
9	4	0	0.0	0.0	221.	207.
9	5	0	0.0	0.0	206.	73.
9	6	0	0.0	0.0	192.	73.
9	7	0	0.0	0.0	179.	73.
9	8	0	0.0	0.0	167.	0.
9	9	0	0.0	0.0	156.	0.
9	10	0	0.0	0.0	146.	0.
9	11	0	0.0	0.0	136.	0.
9	12	0	0.0	0.0	127.	0.
9	13	0	0.0	0.0	118.	0.
9	14	0	0.0	0.0	110.	0.
9	15	0	0.0	0.0	103.	993.
9	16	0	0.0	0.0	96.	0.
9	17	0	0.0	0.0	90.	0.
9	18	0	0.0	0.0	84.	0.
9	19	0	0.0	0.0	78.	0.
9	20	0	0.0	0.0	73.	0.
9	21	0	0.0	0.0	68.	0.
9	22	0	0.0	0.0	63.	0.
9	23	0	0.0	0.0	59.	998.
10	0	0	0.0	0.0	55.	0.
		SUM	2.47	0.59	118397.	118312.

N02FA264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PRECIP(L) AND EXCESS(X)
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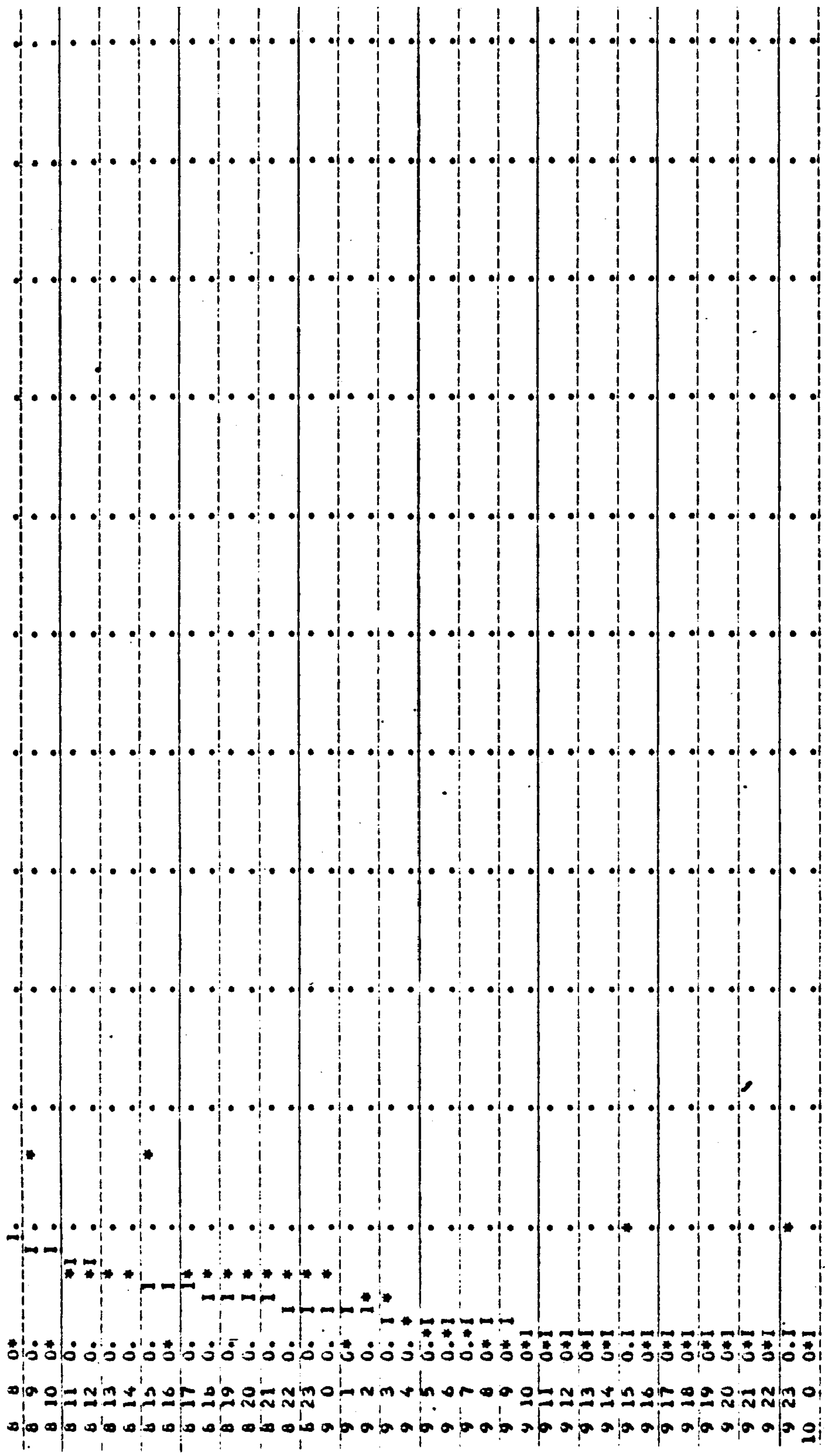

N02FA266

RUN NO. VEPCO-51
OPTIMIZATION OF THE UNIT HYDROGRAPH
AT THE NORTH ANNA DAM SITE-MARCH 19, 1975

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
84	1	0	19	0	0	0	2	0	5

JOPER	NWT
2	0

HYDROGRAPH AND LOSS RATE OPTIMIZATION COMPUTATIONS

ISTAQ	ISNOW	TAREA	SNAP	STRTQ	QRCSN	RTIOR	NCLRK
100	0	297.00	0.0	0.0	3000.00	1.30	0

INPUT DATA

TC	R	COEF	STRKR	STRKS	RTIOK	ERAIN	FRZTP	DLTKR	RTIOL
-1.00	-1.00	0.0	0.23	0.0	0.0	0.47	0.0	-0.50	12.11

INITIAL ESTIMATES

TC+R	R/(TC+R)	COEF	STRKR	STRKS	RTIOK	ERAIN	FRZTP	DLTKR	RTIOL
17.23	0.50	0.0	0.23	0.0	0.0	0.47	0.0	0.50	12.11

5 NON-RECORDING STATION(S)

STA	STORM	SEASON
1	1.84	1.00
2	2.65	1.00
3	1.61	1.00
4	1.94	1.00
5	2.02	1.00

2 RECORDING STATION(S)

STA NO. 1

0.10	0.10	0.0	0.10	0.30	0.30	0.10	0.0	0.0	0.40
0.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0						

STA NO. 4

0.0	0.0	0.0	0.10	0.0	0.10	0.0	0.0	0.0	0.0
0.10	0.20	0.10	0.10	0.0	0.0	0.0	0.0	0.10	0.20
0.80	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0						

NON-RECORDING STATION WEIGHTINGS (ISTN,WTN)

1, 7.40 2, 3.66 3, 6.10
4, 0.0 5, 1.79

N02FA267

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                    RECORDING STATION WEIGHTINGS (ISTR,WTR)
                    1, 18.62                 4, 0.45

STANDARD ERROR FOR VARIABLE 1   6531.7734   6558.4414   6586.0898
VAR  1 ADJ FROM  17.23 TO  21.63

STANDARD ERROR FOR VARIABLE 2   6151.4336   6126.6523   6102.4023
VAR  2 ADJ FROM   0.50 TO   0.33

STANDARD ERROR FOR VARIABLE 9   5423.3906   5425.3867   5423.3867
VAR  9 ADJ FROM   0.00 TO   0.00

STANDARD ERROR FOR VARIABLE 1   5423.3867   5427.0742   5432.6602
VAR  1 ADJ FROM  21.83 TO  22.15

STANDARD ERROR FOR VARIABLE 2   5421.4453   5408.4648   5395.4961
VAR  2 ADJ FROM   0.33 TO   0.22

STANDARD ERROR FOR VARIABLE 9   5054.9570   5054.9531   5054.9531
VAR  9 ADJ FROM   0.00 TO   0.00

STANDARD ERROR FOR VARIABLE 1   5054.9531   5055.0039   5059.4609
VAR  1 ADJ FROM  22.15 TO  22.04

STANDARD ERROR FOR VARIABLE 2   5054.4961   5049.5039   5044.6523
VAR  2 ADJ FROM   0.22 TO   0.15

STANDARD ERROR FOR VARIABLE 9   4960.2227   4960.2188   4960.2188
VAR  9 ADJ FROM   0.00 TO   0.00

STANDARD ERROR FOR VARIABLE 1   4960.2100   4965.7305   4974.6523
VAR  1 ADJ FROM  22.04 TO  22.29

STANDARD ERROR FOR VARIABLE 2   4957.7656   4957.3789   4957.1055
VAR  2 ADJ FROM   0.15 TO   0.14

STANDARD ERROR FOR VARIABLE 9   4956.6201   4956.8242   4956.6242
VAR  9 ADJ FROM   0.00 TO   0.00

STANDARD ERROR FOR VARIABLE 1   4956.6261   4959.4883   4965.5078
VAR  1 ADJ FROM  22.29 TO  22.35

                    INFILTRATION INDEX =0.104 IN/HR

                    STRKR FOR RTIOL OF 3. = 0.22

                              OPTIMIZATION RESULTS
     TC       K     COEF    STRKR   STRKS   RTIOK   ERAIN   FRZTP   DLTKR   RTIOL
   19.17    3.18    0.0     0.23    0.0     0.0     0.47    0.0     0.00    12.11

  UNIT HYDROGRAPH 30 END-OF-PERIOD ORDINATES, LAG=  12.37 HOURS, CP= 0.81  VOL= 1.00
    438.    1559.    2975.    4433.    5852.    7198.    8460.    9638.   10737.   11745.
  12499.   12860.   12886.   12649.   12199.   11564.   10755.    9753.    8475.    6729.
   4932.    3593.    2617.    1906.    1388.    1011.     737.     537.     391.     285.

                              END-OF-PERIOD FLOW
                   TIME     RAIN    EXCS    COMP Q    OBS Q
                  19 1 0    0.11    0.03      12.       0.
                  19 2 0    0.11    0.03      58.       0.
                  19 3 0    0.0     0.0      132.      64.
                  19 4 0    0.11    0.03     230.      54.
                  19 5 0    0.33    0.20     441.       0.
                  19 6 0    0.34    0.21     690.       0.
```

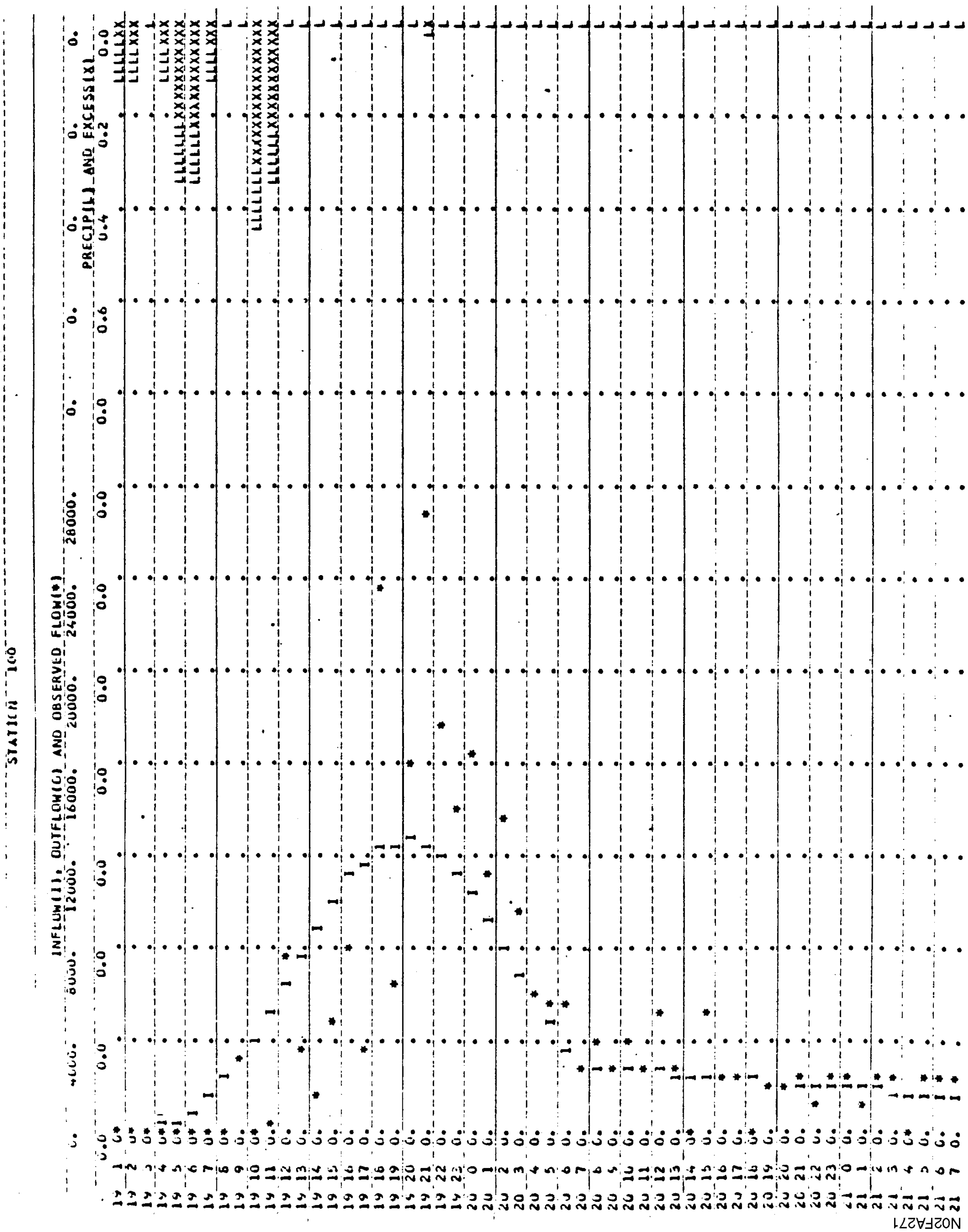
N02FA268

19	7	0	0.11	0.04	1556.	0.
19	8	0	0.0	0.0	2312.	0.
19	9	0	0.0	0.0	3074.	3027.
19	10	0	0.45	0.31	3941.	0.
19	11	0	0.34	0.22	5068.	568.
19	12	0	0.01	0.00	6377.	7026.
19	13	0	0.00	0.00	7703.	3590.
19	14	0	0.00	0.00	8962.	1469.
19	15	0	0.0	0.0	10089.	4782.
19	16	0	0.0	0.0	11014.	7933.
19	17	0	0.0	0.0	11714.	3492.
19	18	0	0.0	0.0	12215.	23776.
19	19	0	0.00	0.00	12540.	6356.
19	20	0	0.01	0.00	12646.	16164.
19	21	0	0.02	0.00	12471.	26971.
19	22	0	0.00	0.00	12025.	17586.
19	23	0	0.0	0.0	11530.	14046.
20	0	0	0.0	0.0	10366.	16429.
20	1	0	0.0	0.0	9209.	11258.
20	2	0	0.0	0.0	8044.	13519.
20	3	0	0.0	0.0	6966.	9460.
20	4	0	0.0	0.0	5919.	6083.
20	5	0	0.0	0.0	4785.	5503.
20	6	0	0.0	0.0	3617.	5503.
20	7	0	0.0	0.0	2971.	2703.
20	8	0	0.0	0.0	2894.	3985.
20	9	0	0.0	0.0	2819.	2620.
20	10	0	0.0	0.0	2746.	3938.
20	11	0	0.0	0.0	2675.	2606.
20	12	0	0.0	0.0	2606.	5344.
20	13	0	0.0	0.0	2538.	2674.
20	14	0	0.0	0.0	2473.	0.
20	15	0	0.0	0.0	2409.	5067.
20	16	0	0.0	0.0	2346.	2569.
20	17	0	0.0	0.0	2285.	2536.
20	18	0	0.0	0.0	2226.	0.
20	19	0	0.0	0.0	2169.	1662.
20	20	0	0.0	0.0	2113.	2084.
20	21	0	0.0	0.0	2058.	2242.
20	22	0	0.0	0.0	2005.	1004.
20	23	0	0.0	0.0	1953.	2303.
21	0	0	0.0	0.0	1902.	2366.
21	1	0	0.0	0.0	1653.	1087.
21	2	0	0.0	0.0	1605.	2355.
21	3	0	0.0	0.0	1756.	2418.
21	4	0	0.0	0.0	1713.	0.
21	5	0	0.0	0.0	1668.	2262.
21	6	0	0.0	0.0	1625.	2365.
21	7	0	0.0	0.0	1583.	2428.
21	8	0	0.0	0.0	1542.	0.
21	9	0	0.0	0.0	1502.	2270.
21	10	0	0.0	0.0	1463.	2374.
21	11	0	0.0	0.0	1425.	1098.
21	12	0	0.0	0.0	1386.	1037.
21	13	0	0.0	0.0	1352.	0.
21	14	0	0.0	0.0	1317.	2211.
21	15	0	0.0	0.0	1283.	696.
21	16	0	0.0	0.0	1250.	785.
21	17	0	0.0	0.0	1216.	835.
21	18	0	0.0	0.0	1186.	1565.
21	19	0	0.0	0.0	1155.	0.
21	20	0	0.0	0.0	1125.	1975.
21	21	0	0.0	0.0	1096.	2134.

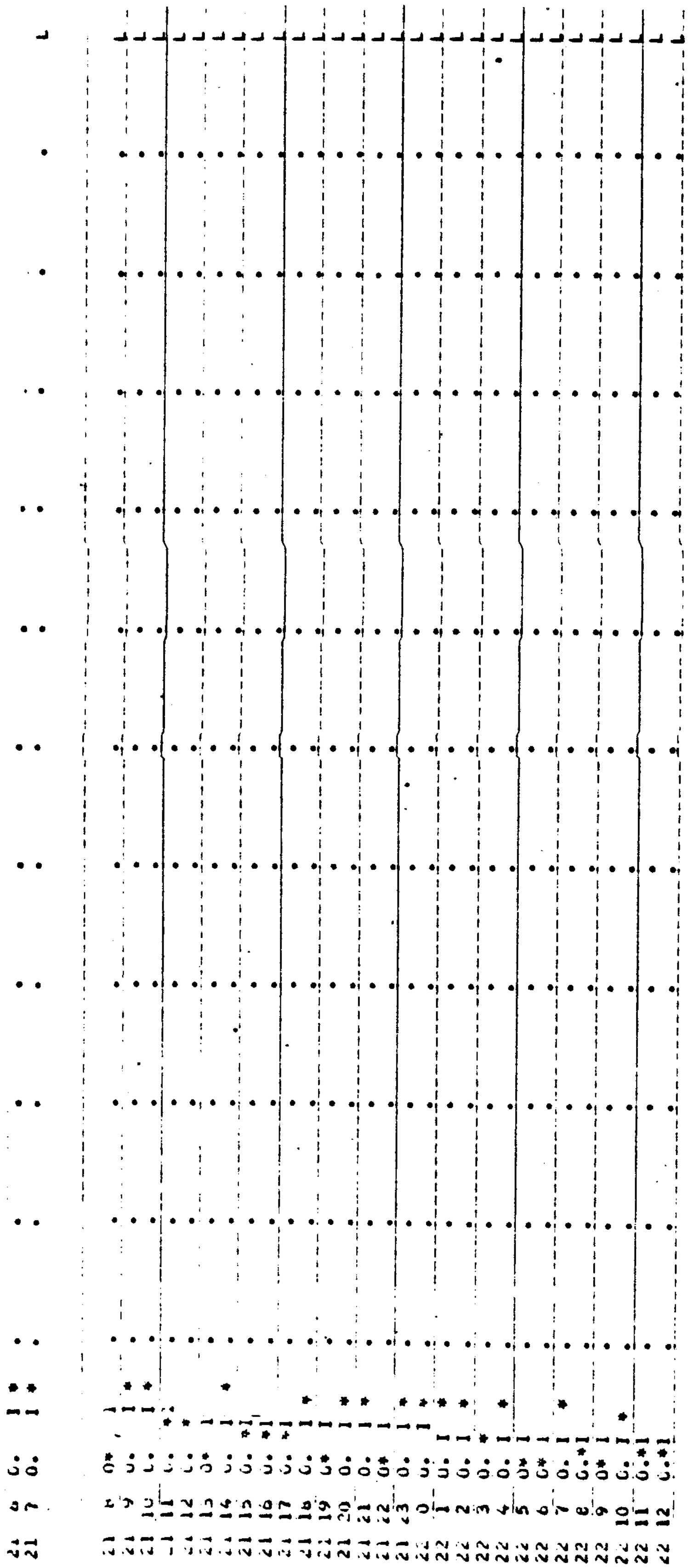
N02FA269

21	22	0	0.0	0.0	1068.	0.
21	23	0	0.0	0.0	1040.	2095.
22	0	0	0.0	0.0	1013.	2135.
22	1	0	0.0	0.0	987.	2135.
22	2	0	0.0	0.0	962.	2135.
22	3	0	0.0	0.0	937.	836.
22	4	0	0.0	0.0	912.	2135.
22	5	0	0.0	0.0	869.	0.
22	6	0	0.0	0.0	866.	0.
22	7	0	0.0	0.0	843.	2072.
22	8	0	0.0	0.0	821.	487.
22	9	0	0.0	0.0	800.	0.
22	10	0	0.0	0.0	779.	1557.
22	11	0	0.0	0.0	759.	467.
22	12	0	0.0	0.0	740.	487.
		SUM	1.94	1.07	282617.	296144.

N02FA270


STATION 100
INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)
PRECIP(L) AND EXCESS(X)
N02FA271

Best Copy Available



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Appendix 2A
Attachment 3[1]
Generation and Routing of Floods

1. Attachment 3 to Appendix 2A was submitted as Appendix J, Section 7.3 in the original FSAR.

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A. Computer Inflow Analysis, HEC-1 Printout

RUN NO VEPCO 66 - APRIL 1973 UH
AT THE NORTH ANNA DAM SITE
REGENERATION OF HYDROGRAPH DUE TO PROB. MAX. PREC.

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
149	3	0	0	0	0	0	2	0	0

JOPER	NWT
3	0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	0	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	-1	322.70	0.0	322.70	0.0	0.0	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
56	40.58	0.0	0.0

PRECIP PATTERN

0.04	0.04	0.07	0.07	0.51	1.02	0.06	0.06	0.25	0.25
0.44	0.44	3.15	6.40	0.37	0.37	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.08	0.06	0.14	0.14	1.01	2.04	0.12	0.12	0.50	0.50
0.07	0.07	6.30	12.79	0.74	0.74				

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.23	2.00	12.11	0.47	0.0	1.00	0.0	0.0	0.50	0.0

GIVEN UNIT GRAPH, NUHGQ= 9

2176.	7471.	12062.	14690.	14166.	10867.	5073.	1743.	599.

UNIT GRAPH TOTALS 69067. CFS OR 1.00 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 300.00 QRCSN=10000.00 RTIOR= 1.30

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.04	0.00	292.
2	0.04	0.00	265.
3	0.07	0.00	277.
4	0.07	0.00	270.
5	0.51	0.00	263.
6	1.02	0.36	1070.
7	0.06	0.00	3071.
8	0.06	0.00	4106.
9	0.25	0.00	3920.
10	0.25	0.10	3359.
11	0.44	0.26	3524.

N02FA303

12	0.44	0.27	6925.
13	3.15	2.73	14426.
14	6.40	5.08	42884.
15	0.37	0.25	80737.
16	0.37	0.25	121534.
17	0.0	0.0	135772.
18	0.0	0.0	121600.
19	0.0	0.0	65852.
20	0.0	0.0	41222.
21	0.0	0.0	16075.
22	0.0	0.0	9869.
23	0.0	0.0	9632.
24	0.0	0.0	9303.
25	0.0	0.0	9140.
26	0.0	0.0	8903.
27	0.0	0.0	8673.
28	0.0	0.0	8448.
29	0.0	0.0	8229.
30	0.0	0.0	8016.
31	0.0	0.0	7809.
32	0.0	0.0	7607.
33	0.0	0.0	7410.
34	0.0	0.0	7216.
35	0.0	0.0	7031.
36	0.0	0.0	6849.
37	0.0	0.0	6671.
38	0.0	0.0	6499.
39	0.0	0.0	6330.
40	0.0	0.0	6165.
41	0.06	0.02	6007.
42	0.06	0.03	5851.
43	0.14	0.07	5700.
44	0.14	0.07	5552.
45	1.01	0.84	5406.
46	2.04	1.81	12843.
47	0.12	0.06	26305.
48	0.12	0.06	37036.
49	0.50	0.39	42242.
50	0.50	0.39	40675.
51	0.87	0.74	35335.
52	0.87	0.74	30697.
53	6.30	5.98	43052.
54	12.79	12.38	103055.
55	0.74	0.64	194199.
56	0.74	0.65	200240.
57	0.0	0.0	294546.
58	0.0	0.0	263160.
59	0.0	0.0	185458.
60	0.0	0.0	89901.
61	0.0	0.0	35513.
62	0.0	0.0	11875.
63	0.0	0.0	9766.
64	0.0	0.0	9535.
65	0.0	0.0	9266.
66	0.0	0.0	9047.
67	0.0	0.0	8813.
68	0.0	0.0	8585.
69	0.0	0.0	8362.
70	0.0	0.0	8146.
71	0.0	0.0	7935.
72	0.0	0.0	7724.
73	0.0	0.0	7529.
74	0.0	0.0	7334.

N02FA304

75	0.0	0.0	7144.
76	0.0	0.0	6959.
77	0.0	0.0	6779.
78	0.0	0.0	6604.
79	0.0	0.0	6433.
80	0.0	0.0	6266.
81	0.0	0.0	6104.
82	0.0	0.0	5946.
83	0.0	0.0	5792.
84	0.0	0.0	5642.
85	0.0	0.0	5496.
86	0.0	0.0	5353.
87	0.0	0.0	5215.
88	0.0	0.0	5080.
89	0.0	0.0	4948.
90	0.0	0.0	4820.
91	0.0	0.0	4692.
92	0.0	0.0	4574.
93	0.0	0.0	4455.
94	0.0	0.0	4340.
95	0.0	0.0	4227.
96	0.0	0.0	4118.
97	0.0	0.0	4011.
98	0.0	0.0	3907.
99	0.0	0.0	3806.
100	0.0	0.0	3708.
101	0.0	0.0	3612.
102	0.0	0.0	3516.
103	0.0	0.0	3427.
104	0.0	0.0	3336.
105	0.0	0.0	3252.
106	0.0	0.0	3168.
107	0.0	0.0	3086.
108	0.0	0.0	3006.
109	0.0	0.0	2928.
110	0.0	0.0	2852.
111	0.0	0.0	2778.
112	0.0	0.0	2706.
113	0.0	0.0	2636.
114	0.0	0.0	2568.
115	0.0	0.0	2501.
116	0.0	0.0	2437.
117	0.0	0.0	2374.
118	0.0	0.0	2312.
119	0.0	0.0	2252.
120	0.0	0.0	2194.
121	0.0	0.0	2137.
122	0.0	0.0	2082.
123	0.0	0.0	2028.
124	0.0	0.0	1975.
125	0.0	0.0	1924.
126	0.0	0.0	1874.
127	0.0	0.0	1826.
128	0.0	0.0	1779.
129	0.0	0.0	1732.
130	0.0	0.0	1688.
131	0.0	0.0	1644.
132	0.0	0.0	1601.
133	0.0	0.0	1560.
134	0.0	0.0	1519.
135	0.0	0.0	1480.
136	0.0	0.0	1442.
137	0.0	0.0	1404.

N02FA305

138	0.0	0.0	1366.
139	0.0	0.0	1333.
140	0.0	0.0	1298.
141	0.0	0.0	1265.
142	0.0	0.0	1232.
143	0.0	0.0	1200.
144	0.0	0.0	1169.
145	0.0	0.0	1139.
146	0.0	0.0	1109.
147	0.0	0.0	1080.
148	0.0	0.0	1052.
149	0.0	0.0	1025.
SUM	40.56	35.07	2932725.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	294546.	280393.	180027.	73992.	2932673.
INCHES		6.08	20.76	25.60	42.27
AC-FT		139110.	357262.	440509.	727405.

N02FA306

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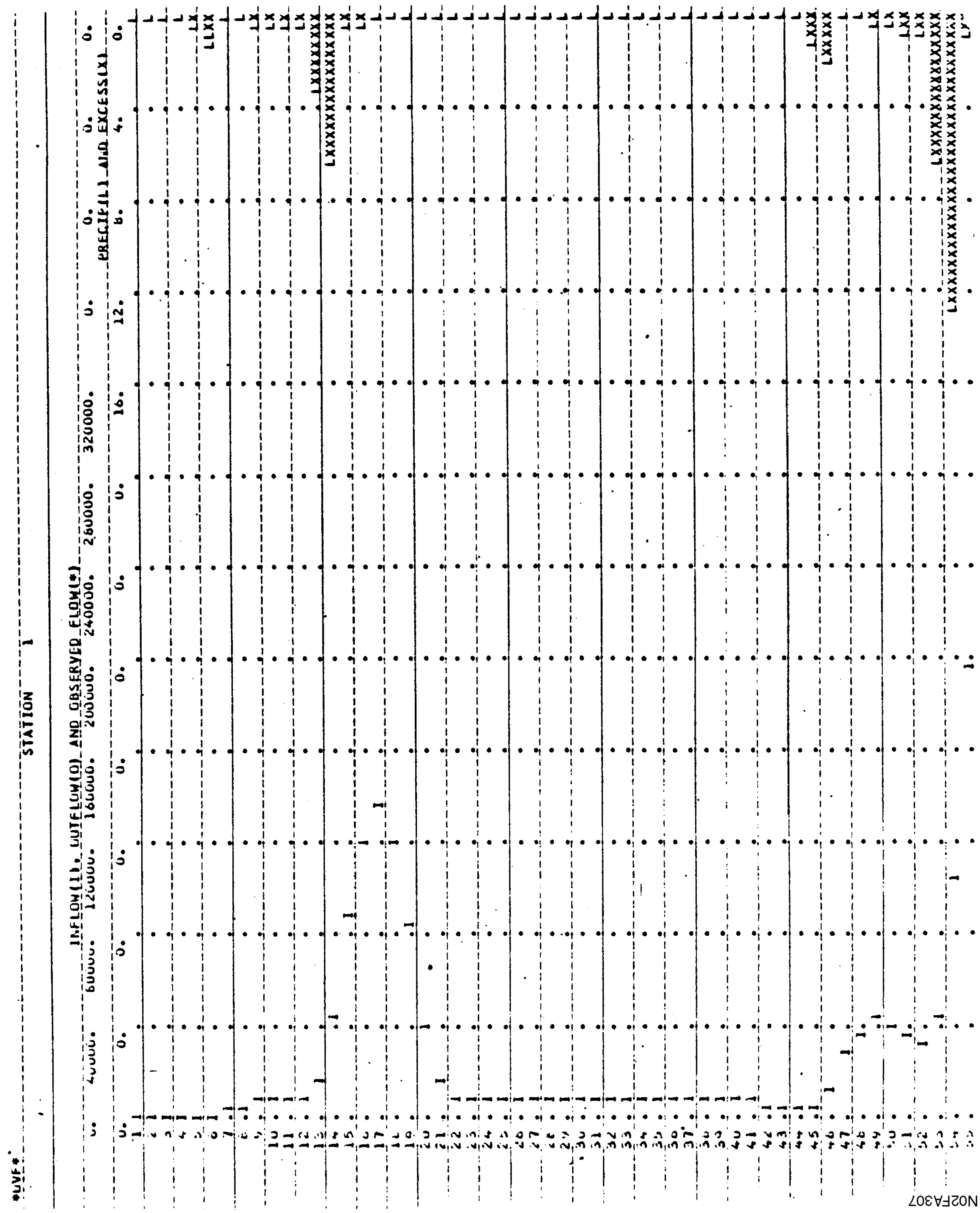

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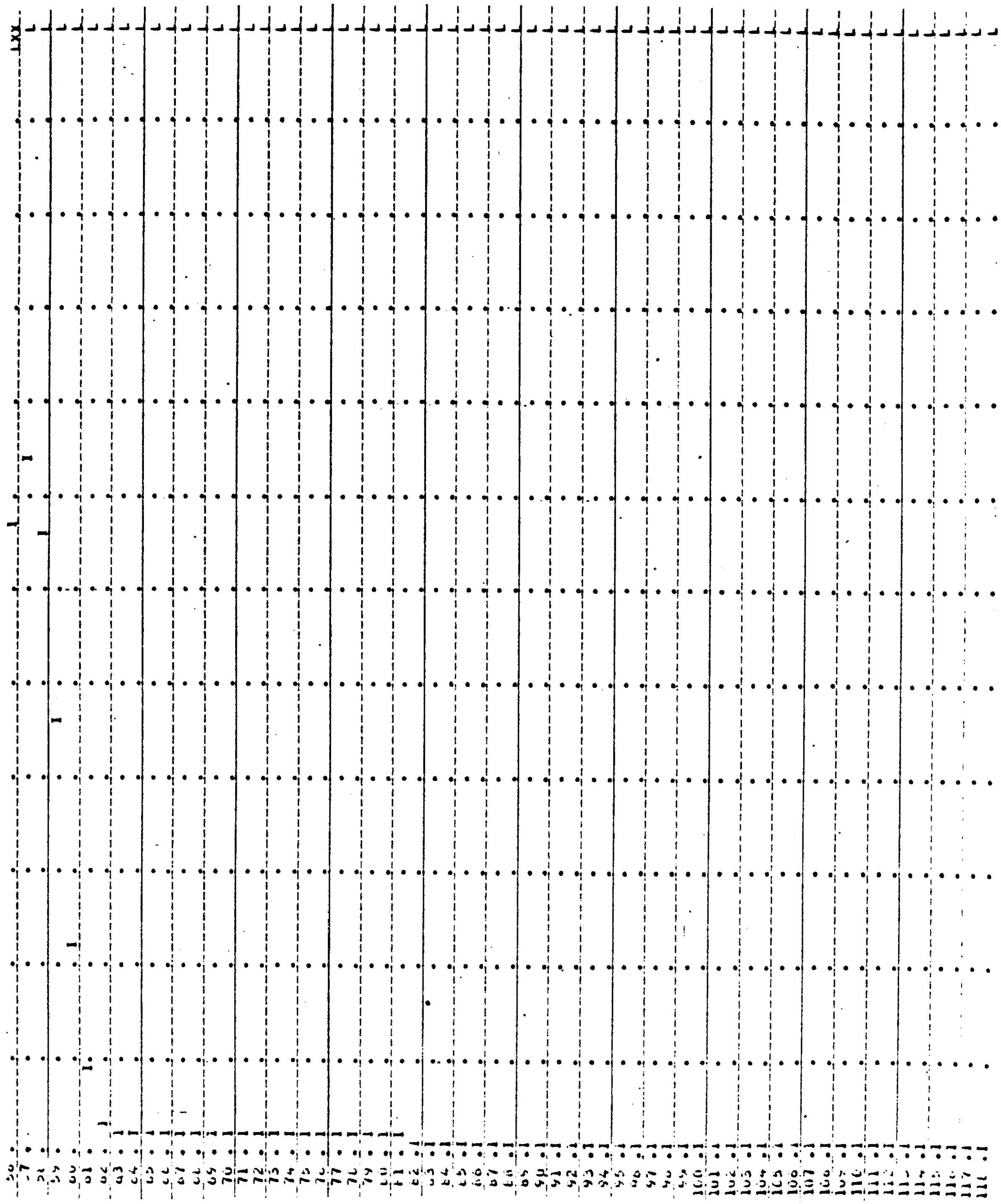

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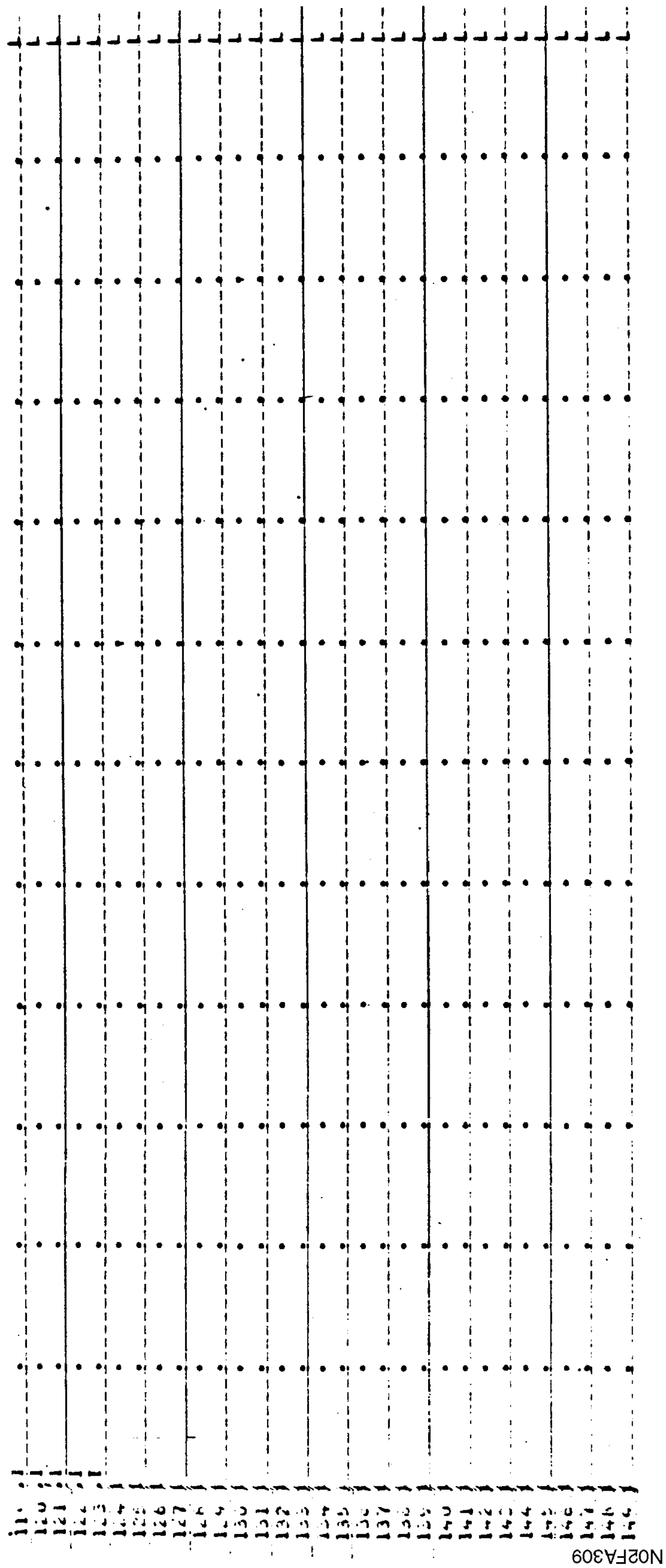

HYDROGRAPH ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	1	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	1	0	0.0	0.0	0.0	0.

ROUTED FLOWS AT 2

292.	285.	277.	270.	263.	1078.	3071.	4806.	6026.	6359.
6524.	6925.	14426.	42889.	86737.	121534.	135772.	121800.	85852.	41222.
16075.	9669.	9632.	9383.	9140.	8905.	8673.	8446.	8229.	8016.
7609.	7607.	7410.	7218.	7031.	6849.	6671.	6499.	6330.	6166.
6007.	5851.	5700.	5552.	5408.	12643.	26365.	37036.	42242.	40875.
35535.	30097.	43652.	103035.	194199.	266240.	294546.	263166.	185456.	89901.
35513.	11675.	9766.	9535.	9288.	9047.	8813.	8585.	8362.	8146.
7935.	7729.	7529.	7334.	7144.	6959.	6779.	6604.	6433.	6266.
6104.	5946.	5792.	5642.	5496.	5353.	5215.	5080.	4948.	4820.
4695.	4574.	4455.	4340.	4227.	4118.	4011.	3907.	3806.	3708.
3612.	3518.	3427.	3338.	3252.	3166.	3086.	3006.	2926.	2852.
2776.	2706.	2636.	2568.	2501.	2437.	2374.	2312.	2252.	2194.
2137.	2082.	2028.	1975.	1924.	1874.	1826.	1779.	1732.	1688.
1644.	1601.	1560.	1519.	1480.	1442.	1404.	1368.	1333.	1298.
1265.	1232.	1200.	1169.	1139.	1109.	1080.	1052.	1025.	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	294546.	280393.	180027.	73992.	2932673.
INCHES		8.66	20.76	25.60	42.27
AC-FT		139110.	357262.	440509.	727485.

N02FA310

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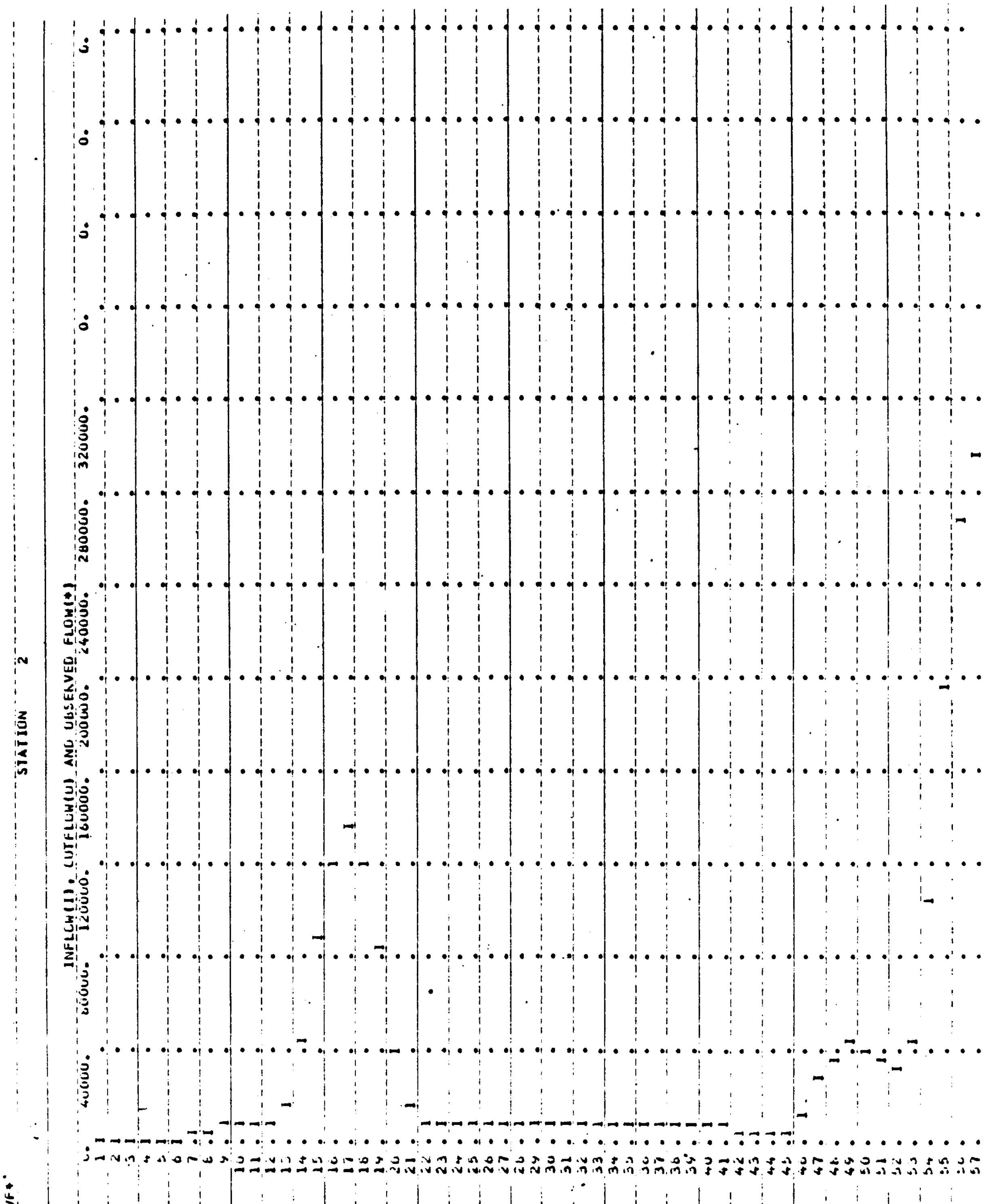

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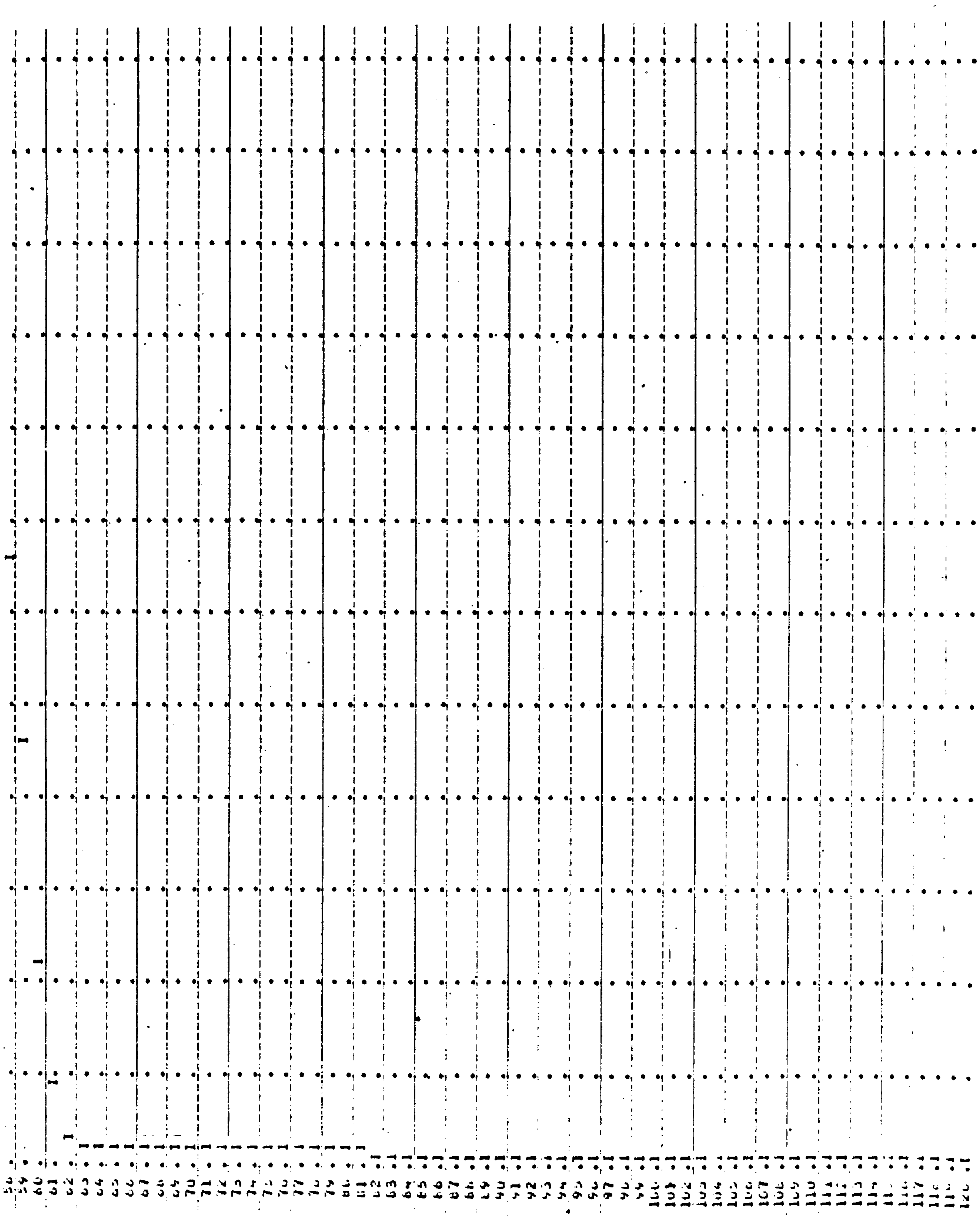

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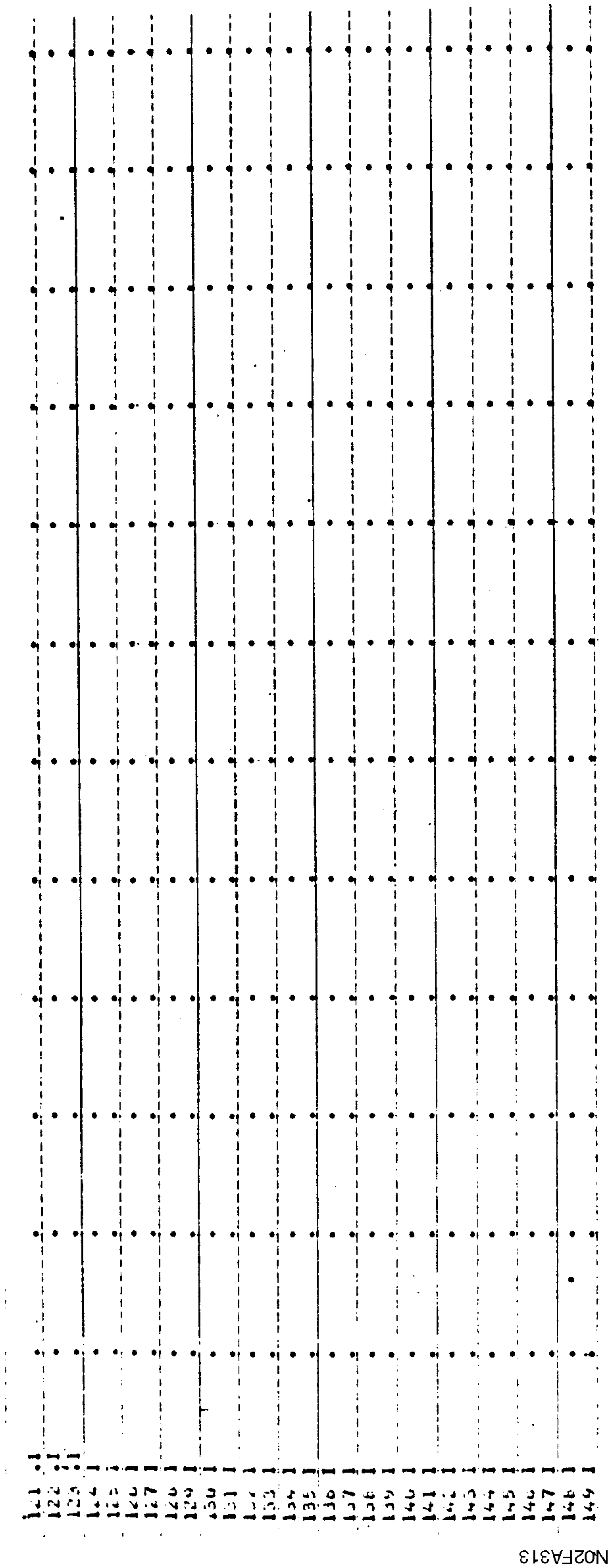

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*OVL.*

     **********          **********          **********          **********          **********

                              SUB-AREA RUNOFF COMPUTATION
                    ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME
                        2       0       0       0       0       0       0

                                    HYDROGRAPH DATA
           IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
               0      -1   20.00     0.0   20.00    1.00     0.0       0       0       0

                                     PRECIP DATA
                               NP   STORM     DAJ     DAK
                               56   40.58     0.0     0.0
                                    PRECIP PATTERN
     0.04      0.04      0.07      0.07      0.51      1.02      0.06      0.06      0.25      0.25
     0.44      0.44      3.15      6.40      0.37      0.37      0.0       0.0       0.0       0.0
     0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
     0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
     0.06      0.08      0.14      0.14      1.01      2.04      0.12      0.12      0.50      0.50
     0.67      0.87      6.30     12.79      0.74      0.74

                                      LOSS DATA
          STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
            0.0     0.0    1.00     0.0     0.0    1.00     0.0     0.0     0.0     0.0

                              GIVEN UNIT GRAPH, NUHGQ=    1
   4300.
                  UNIT GRAPH TOTALS    4300. CFS OR 1.00 INCHES OVER THE AREA

                                    RECESSION DATA
                    STRTQ=    0.0     QRCSN=    0.0     RTIOR= 1.00

                                 END-OF-PERIOD FLOW
                            TIME    RAIN    EXCS    CUMP Q
                               1    0.04    0.04      172.
                               2    0.04    0.04      172.
                               3    0.07    0.07      301.
                               4    0.07    0.07      301.
                               5    0.51    0.51     2193.
                               6    1.02    1.02     4366.
                               7    0.06    0.06      256.
                               8    0.06    0.06      258.
                               9    0.25    0.25     1075.
                              10    0.25    0.25     1075.
                              11    0.44    0.44     1892.
                              12    0.44    0.44     1892.
                              13    3.15    3.15    13545.
                              14    6.40    6.40    27520.
                              15    0.37    0.37     1591.
                              16    0.37    0.37     1591.
                              17    0.0     0.0         0.
                              18    0.0     0.0         0.
                              19    0.0     0.0         0.
                              20    0.0     0.0         0.
                              21    0.0     0.0         0.
                              22    0.0     0.0         0.
                              23    0.0     0.0         0.
                              24    0.0     0.0         0.
                              25    0.0     0.0         0.
```

N02FA314

26	0.0	0.0	0.
27	0.0	0.0	0.
28	0.0	0.0	0.
29	0.0	0.0	0.
30	0.0	0.0	0.
31	0.0	0.0	0.
32	0.0	0.0	0.
33	0.0	0.0	0.
34	0.0	0.0	0.
35	0.0	0.0	0.
36	0.0	0.0	0.
37	0.0	0.0	0.
38	0.0	0.0	0.
39	0.0	0.0	0.
40	0.0	0.0	0.
41	0.08	0.08	344.
42	0.06	0.04	344.
43	0.14	0.14	602.
44	0.14	0.14	602.
45	1.01	1.01	4343.
46	2.04	2.04	8772.
47	0.12	0.12	516.
48	0.12	0.12	516.
49	0.50	0.50	2150.
50	0.50	0.50	2150.
51	0.87	0.87	3741.
52	0.87	0.87	3741.
53	6.30	6.30	27090.
54	12.79	12.79	54997.
55	0.74	0.74	3182.
56	0.74	0.74	3182.
57	0.0	0.0	0.
58	0.0	0.0	0.
59	0.0	0.0	0.
60	0.0	0.0	0.
61	0.0	0.0	0.
62	0.0	0.0	0.
63	0.0	0.0	0.
64	0.0	0.0	0.
65	0.0	0.0	0.
66	0.0	0.0	0.
67	0.0	0.0	0.
68	0.0	0.0	0.
69	0.0	0.0	0.
70	0.0	0.0	0.
71	0.0	0.0	0.
72	0.0	0.0	0.
73	0.0	0.0	0.
74	0.0	0.0	0.
75	0.0	0.0	0.
76	0.0	0.0	0.
77	0.0	0.0	0.
78	0.0	0.0	0.
79	0.0	0.0	0.
80	0.0	0.0	0.
81	0.0	0.0	0.
82	0.0	0.0	0.
83	0.0	0.0	0.
84	0.0	0.0	0.
85	0.0	0.0	0.
86	0.0	0.0	0.
87	0.0	0.0	0.
88	0.0	0.0	0.

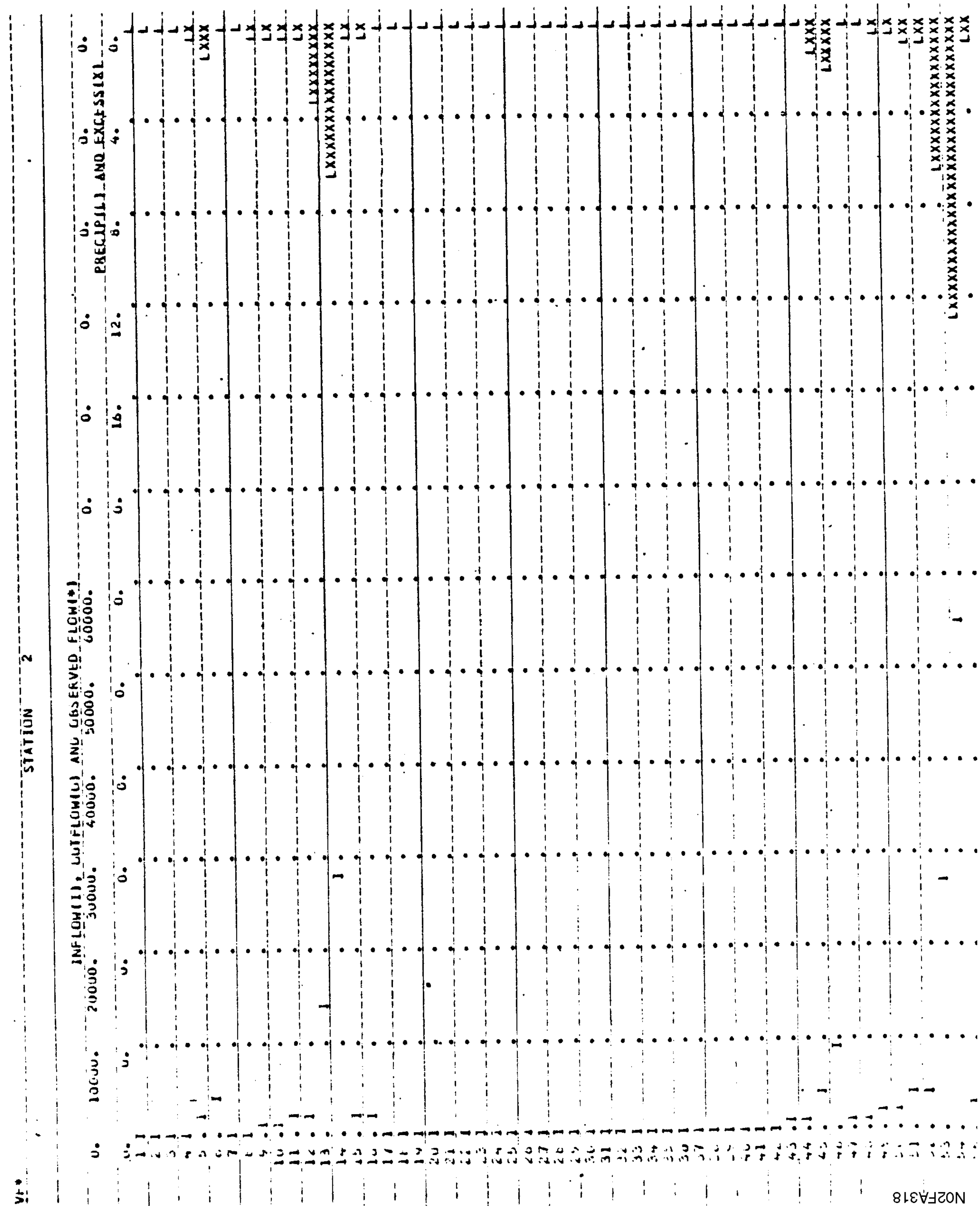
N02FA315

89	0.0	0.0	0.
90	0.0	0.0	0.
91	0.0	0.0	0.
92	0.0	0.0	0.
93	0.0	0.0	0.
94	0.0	0.0	0.
95	0.0	0.0	0.
96	0.0	0.0	0.
97	0.0	0.0	0.
98	0.0	0.0	0.
99	0.0	0.0	0.
100	0.0	0.0	0.
101	0.0	0.0	0.
102	0.0	0.0	0.
103	0.0	0.0	0.
104	0.0	0.0	0.
105	0.0	0.0	0.
106	0.0	0.0	0.
107	0.0	0.0	0.
108	0.0	0.0	0.
109	0.0	0.0	0.
110	0.0	0.0	0.
111	0.0	0.0	0.
112	0.0	0.0	0.
113	0.0	0.0	0.
114	0.0	0.0	0.
115	0.0	0.0	0.
116	0.0	0.0	0.
117	0.0	0.0	0.
118	0.0	0.0	0.
119	0.0	0.0	0.
120	0.0	0.0	0.
121	0.0	0.0	0.
122	0.0	0.0	0.
123	0.0	0.0	0.
124	0.0	0.0	0.
125	0.0	0.0	0.
126	0.0	0.0	0.
127	0.0	0.0	0.
128	0.0	0.0	0.
129	0.0	0.0	0.
130	0.0	0.0	0.
131	0.0	0.0	0.
132	0.0	0.0	0.
133	0.0	0.0	0.
134	0.0	0.0	0.
135	0.0	0.0	0.
136	0.0	0.0	0.
137	0.0	0.0	0.
138	0.0	0.0	0.
139	0.0	0.0	0.
140	0.0	0.0	0.
141	0.0	0.0	0.
142	0.0	0.0	0.
143	0.0	0.0	0.
144	0.0	0.0	0.
145	0.0	0.0	0.
146	0.0	0.0	0.
147	0.0	0.0	0.
148	0.0	0.0	0.
149	0.0	0.0	0.
SUM	40.58	40.58	174494.

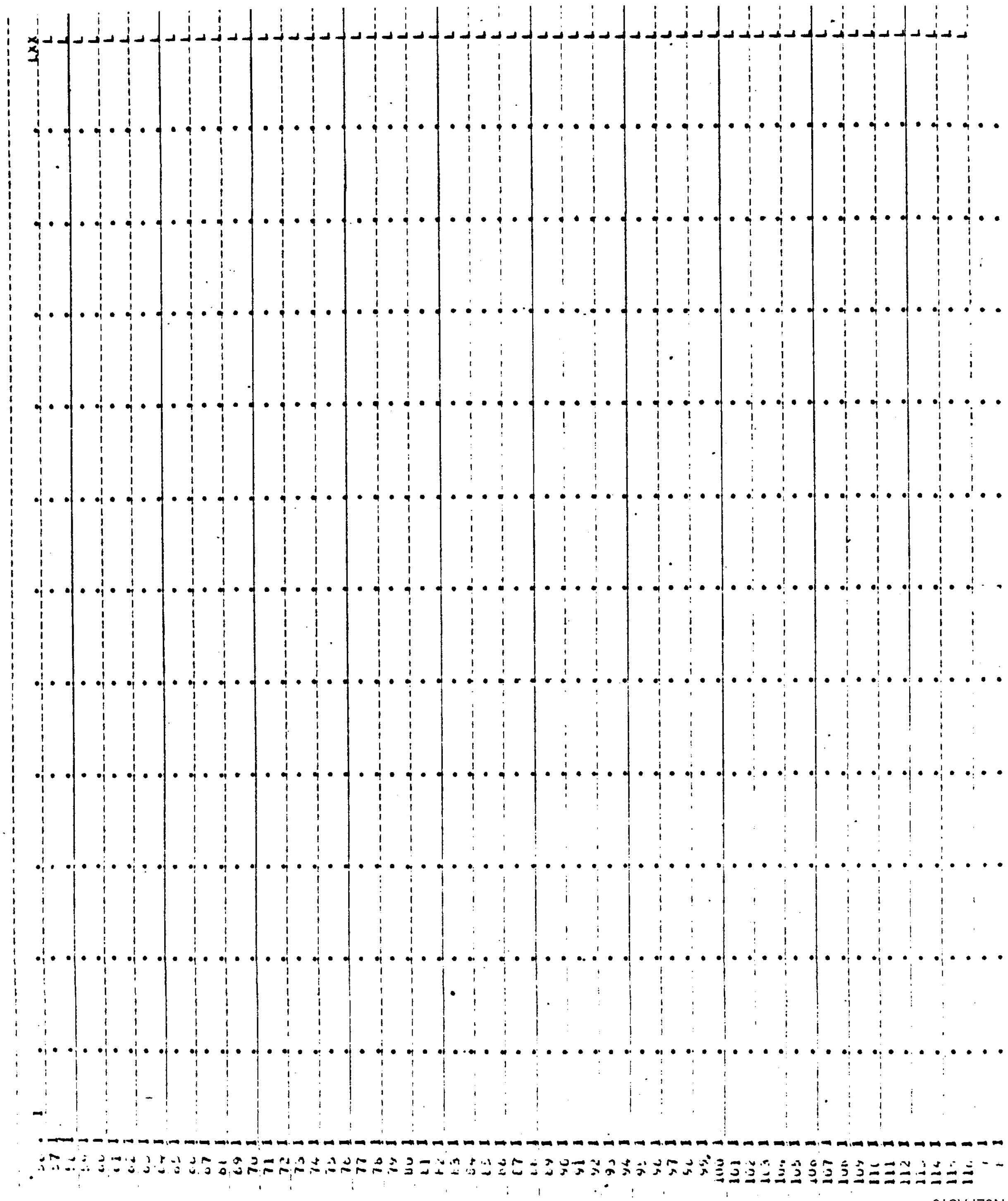
N02FA316

N02FA317

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	54997.	41044.	12529.	4845.	174494.
INCHES		19.09	23.31	27.04	40.56
AC-FT		20363.	24864.	26843.	43265.


STATION 2
INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)
10000. 20000. 30000. 40000. 50000. 60000.
PRECIP(L) AND EXCESS(X)
16. 12. 8. 4. 0.
N02FA318

Best Copy Available



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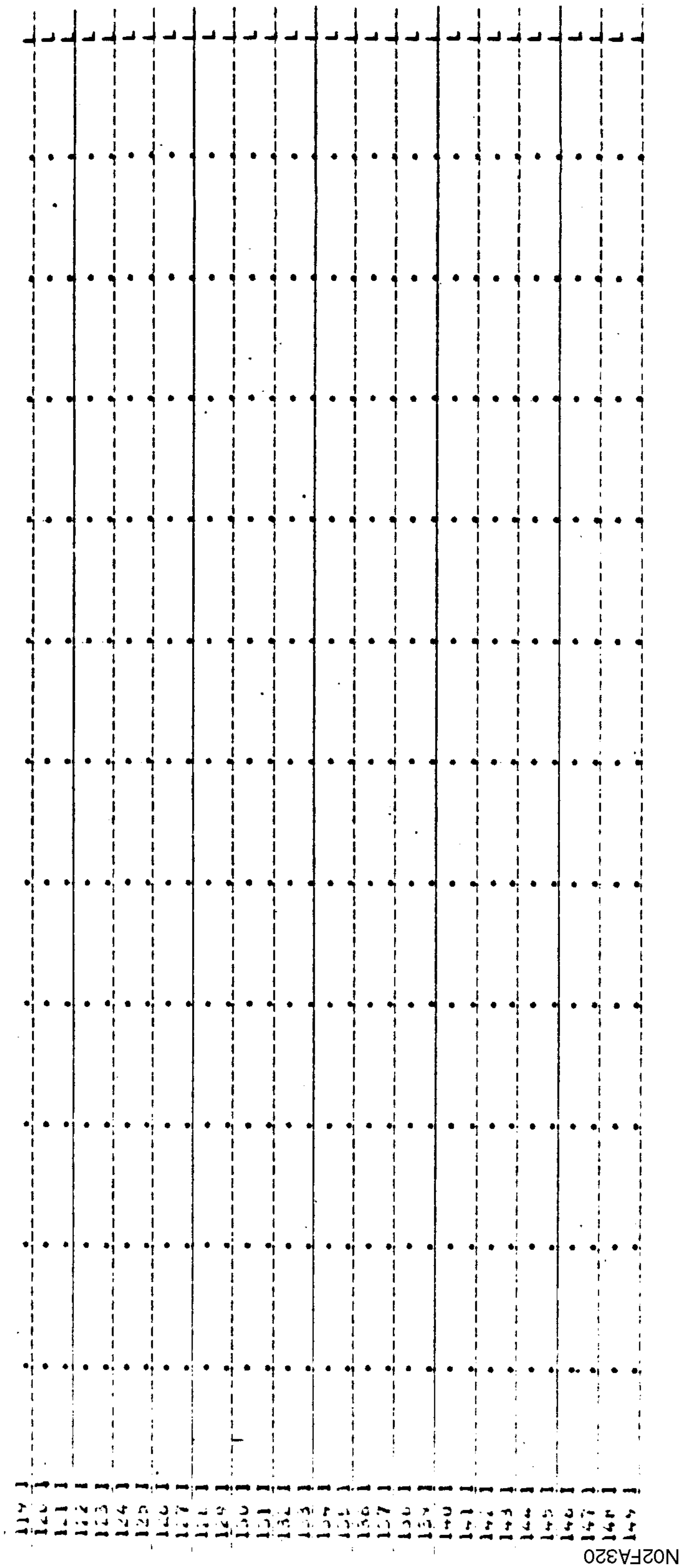

OVN

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	2	0	0	0	0	0

SUM OF 2 HYDROGRAPHS AT 2

464.	457.	570.	571.	2456.	5464.	3325.	5064.	7101.	7434.
8416.	6817.	27971.	70409.	83328.	123125.	135772.	121800.	85852.	41222.
10075.	9869.	9632.	9503.	9140.	8903.	8673.	8448.	8229.	8016.
7809.	7607.	7410.	7218.	7031.	6849.	6671.	6499.	6330.	6166.
6351.	6195.	6302.	6154.	9751.	21615.	26681.	37552.	44392.	43025.
39076.	35838.	70742.	159032.	197381.	269422.	294546.	263166.	185458.	69901.
35513.	11875.	9756.	9555.	9266.	9047.	8813.	8585.	8362.	8146.
7935.	7729.	7529.	7334.	7144.	6959.	6779.	6604.	6433.	6266.
6104.	5946.	5792.	5642.	5496.	5353.	5215.	5080.	4948.	4820.
4695.	4574.	4455.	4340.	4227.	4118.	4011.	3907.	3806.	3708.
3612.	3516.	3427.	3338.	3252.	3168.	3086.	3006.	2928.	2852.
2776.	2706.	2636.	2568.	2501.	2437.	2374.	2312.	2252.	2194.
2137.	2082.	2028.	1975.	1924.	1874.	1826.	1779.	1732.	1688.
1644.	1601.	1560.	1519.	1480.	1442.	1404.	1368.	1333.	1296.
1265.	1232.	1200.	1169.	1139.	1109.	1080.	1052.	1025.	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	294546.	281984.	191063.	78635.	3107166.
INCHES		7.65	20.75	25.61	42.17
AC-FT		139699.	379203.	468149.	770770.

N02FA321

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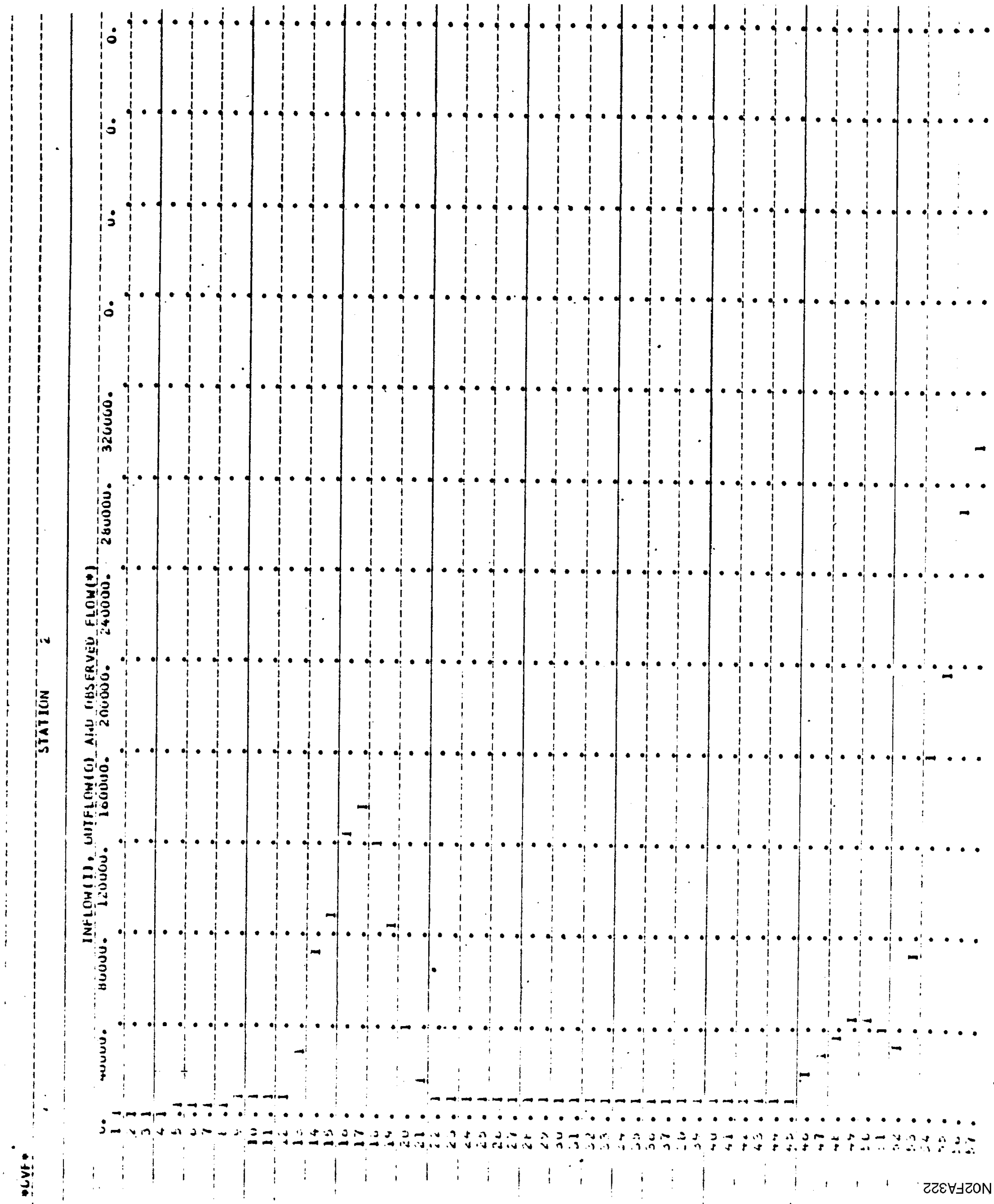

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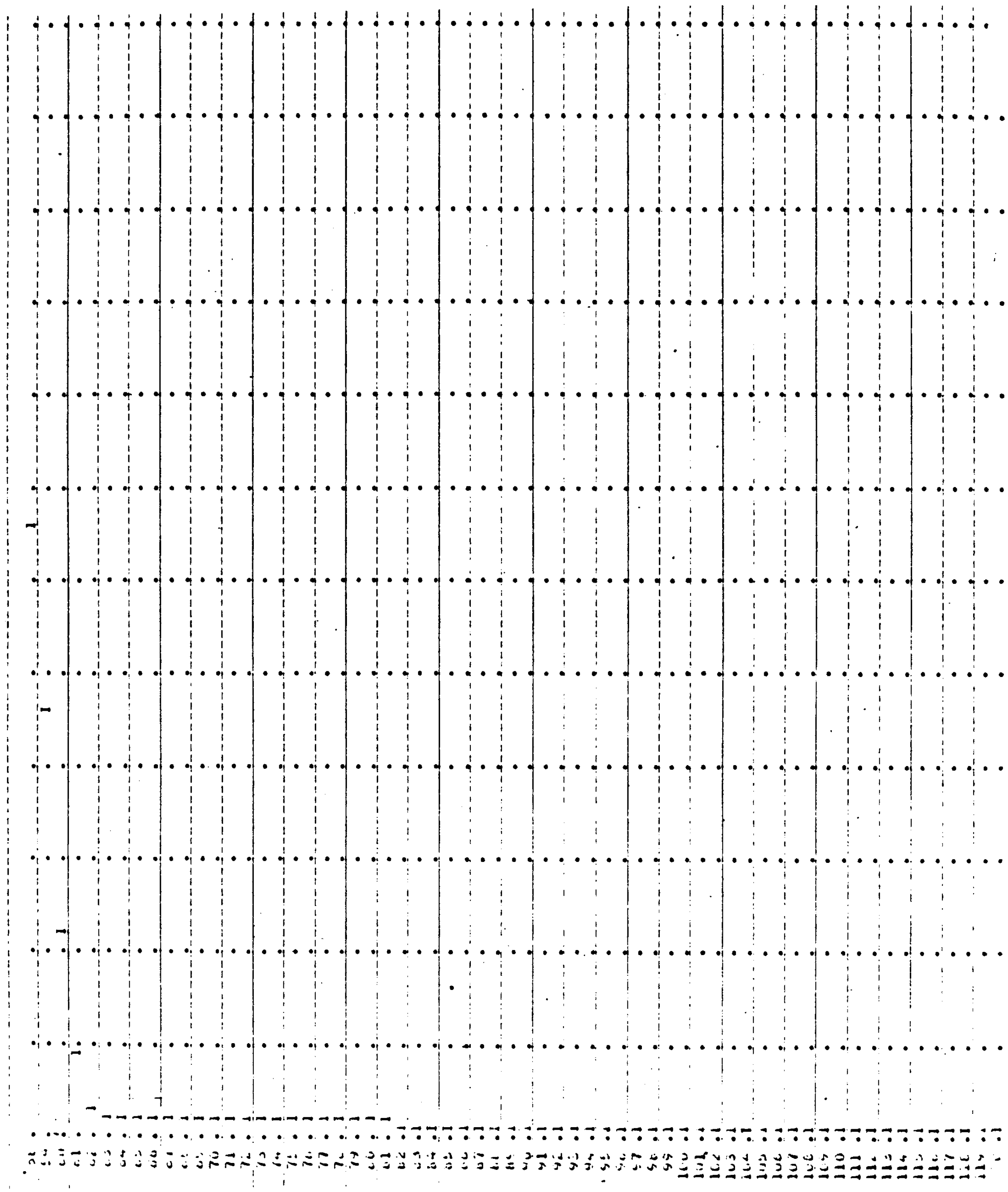

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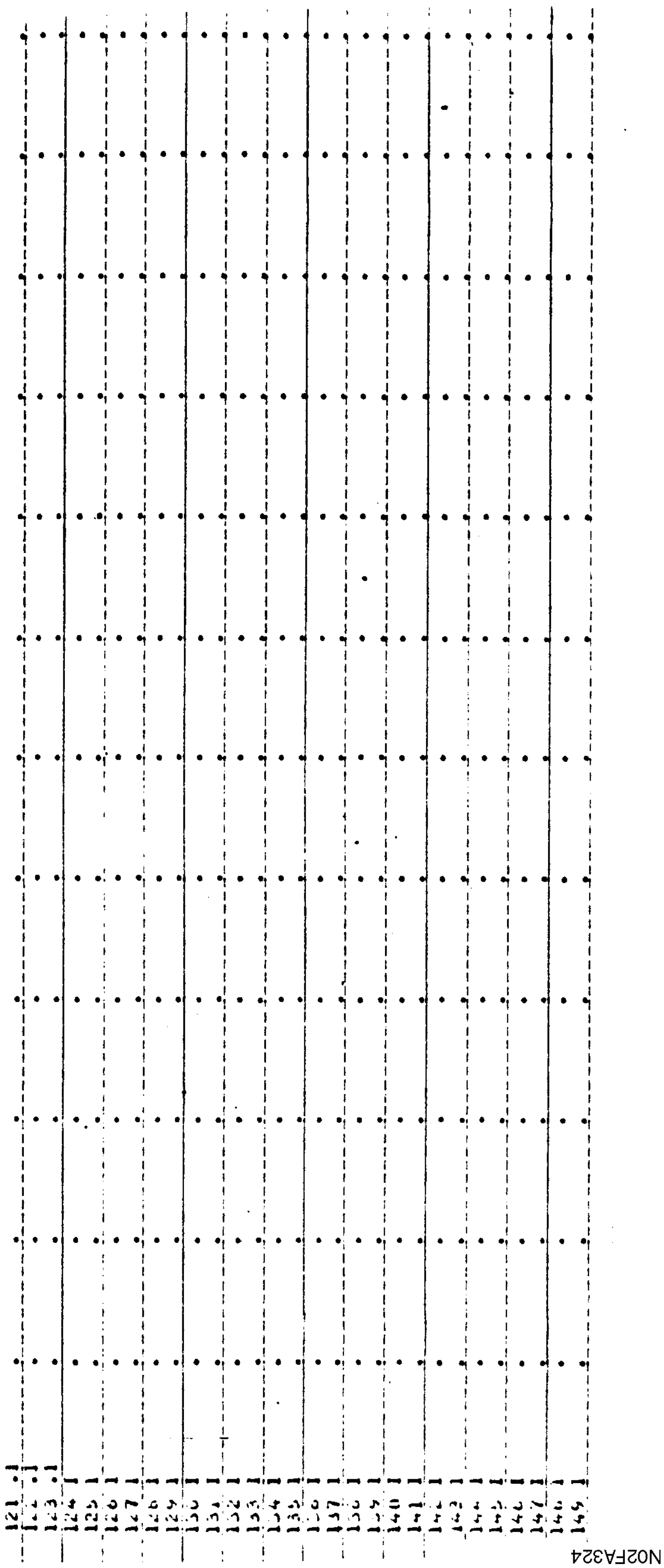

DVN

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HYDROGRAPH ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
3	1	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.0	0.0	0.0	-1.

STORAGE=	1.	15700.	22400.	33200.	93700.	108450.	196900.	0.	0.	0.
OUTFLOW=	40.	16890.	47190.	94380.	116600.	122300.	145590.	0.	0.	0.

TIME	EOP STOR	AVG IN	EOP OUT	
1	615.	464.	464.	
2	614.	460.	464.	
3	626.	517.	472.	
4	650.	575.	488.	
5	664.	1214.	650.	
6	1640.	3960.	1173.	
7	2376.	4397.	1681.	
8	2950.	4197.	2078.	
9	3665.	6083.	2710.	
10	4505.	7267.	3430.	
11	5932.	7925.	4139.	
12	6954.	8616.	4846.	
13	10048.	18394.	6984.	
14	16258.	49190.	25174.	
15	26616.	79369.	66136.	
16	33024.	105727.	95026.	
17	41405.	129449.	97665.	
18	46756.	126786.	100666.	
19	49517.	103626.	100912.	El. 255.2
20	40688.	63537.	97376.	
21	27207.	26648.	66669.	
22	16573.	12982.	26937.	
23	16057.	9761.	12683.	
24	15485.	9508.	10742.	
25	15147.	9262.	10508.	
26	14808.	9022.	10274.	
27	14469.	8788.	10039.	
28	14131.	8561.	9806.	
29	13796.	8339.	9574.	
30	13465.	8123.	9345.	
31	13136.	7913.	9119.	
32	12815.	7708.	8896.	
33	12498.	7508.	8677.	
34	12187.	7314.	8462.	
35	11881.	7124.	8251.	
36	11582.	6940.	8044.	
37	11289.	6760.	7841.	
38	11002.	6585.	7643.	
39	10721.	6414.	7449.	
40	10447.	6248.	7260.	
41	10218.	6259.	7102.	
42	10029.	6273.	6971.	
43	9864.	6248.	6857.	

N02FA325

44	4721.	6226.	6758.	EL 251.0
45	4994.	7953.	6946.	
46	11989.	15683.	6325.	
47	15625.	24248.	10638.	
48	18764.	32217.	28113.	
49	20666.	40972.	36634.	
50	21411.	43709.	42706.	
51	21157.	41051.	41366.	
52	20438.	36457.	37549.	
53	22671.	52290.	49213.	
54	33230.	114367.	94292.	
55	52904.	177706.	102270.	
56	83864.	233461.	114676.	
57	123416.	281984.	126372.	
58	160529.	276666.	136013.	
59	161732.	224322.	141596.	EL. 264.2
60	160792.	137680.	141346.	
61	161910.	62707.	136377.	
62	134855.	23694.	129253.	
63	106420.	10832.	121791.	
64	75709.	9661.	112959.	
65	55240.	9411.	103203.	
66	33082.	9168.	93075.	
67	19605.	8930.	32700.	
68	16089.	8699.	13063.	
69	15258.	8474.	10585.	
70	14726.	8254.	10217.	
71	14229.	8040.	9873.	
72	13763.	7832.	9551.	
73	13324.	7629.	9248.	
74	12909.	7432.	8961.	
75	12516.	7239.	8690.	
76	12142.	7052.	8431.	
77	11785.	6869.	8185.	
78	11444.	6691.	7949.	
79	11118.	6518.	7723.	
80	10804.	6349.	7506.	
81	10502.	6185.	7298.	
82	10212.	6025.	7097.	
83	9931.	5869.	6903.	
84	9660.	5717.	6716.	
85	9398.	5569.	6535.	
86	9145.	5425.	6360.	
87	8899.	5284.	6190.	
88	8661.	5147.	6025.	
89	8430.	5014.	5866.	
90	8206.	4884.	5711.	
91	7988.	4758.	5560.	
92	7777.	4634.	5414.	
93	7571.	4514.	5272.	
94	7372.	4398.	5134.	
95	7177.	4284.	5000.	
96	6989.	4173.	4869.	
97	6805.	4065.	4742.	
98	6626.	3959.	4619.	
99	6452.	3857.	4493.	
100	6283.	3757.	4381.	
101	6118.	3660.	4266.	
102	5957.	3565.	4157.	
103	5801.	3473.	4049.	
104	5649.	3383.	3944.	
105	5501.	3295.	3841.	
106	5357.	3210.	3742.	

N02FA326

107	5216.	3127.	3645.
108	5060.	3046.	3550.
109	4946.	2967.	3456.
110	4817.	2890.	3368.
111	4690.	2815.	3281.
112	4567.	2742.	3196.
113	4448.	2671.	3113.
114	4331.	2602.	3032.
115	4217.	2535.	2954.
116	4106.	2469.	2877.
117	3999.	240[illegible].	280[illegible].
118	3894.	2343.	2730.
119	3791.	2282.	2660.
120	3692.	2223.	2591.
121	3594.	2165.	2524.
122	3500.	2109.	2458.
123	3408.	2055.	2395.
124	3316.	2002.	2332.
125	3231.	1950.	2272.
126	3145.	1899.	2213.
127	3063.	1850.	2156.
128	2982.	1802.	2100.
129	2903.	1756.	2046.
130	2826.	1710.	1993.
131	2752.	1666.	1941.
132	2679.	1623.	1891.
133	2608.	1581.	1842.
134	2539.	1540.	1794.
135	2472.	1500.	1748.
136	2406.	1461.	1702.
137	2343.	1423.	1658.
138	2281.	1386.	1615.
139	2220.	1350.	1574.
140	2161.	1315.	1533.
141	2104.	1281.	1493.
142	2048.	1248.	1454.
143	1993.	1216.	1417.
144	1940.	1184.	1380.
145	1888.	1154.	1344.
146	1836.	1124.	1310.
147	1789.	1095.	1276.
148	1741.	1066.	1243.
149	1695.	1039.	1210.
SUM			3102903.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	141596.	141472.	130927.	77675.	3102903.
INCHES		3.64	14.22	25.37	42.11
AC-FT		70188.	259624.	463629.	769712.

N02FA327

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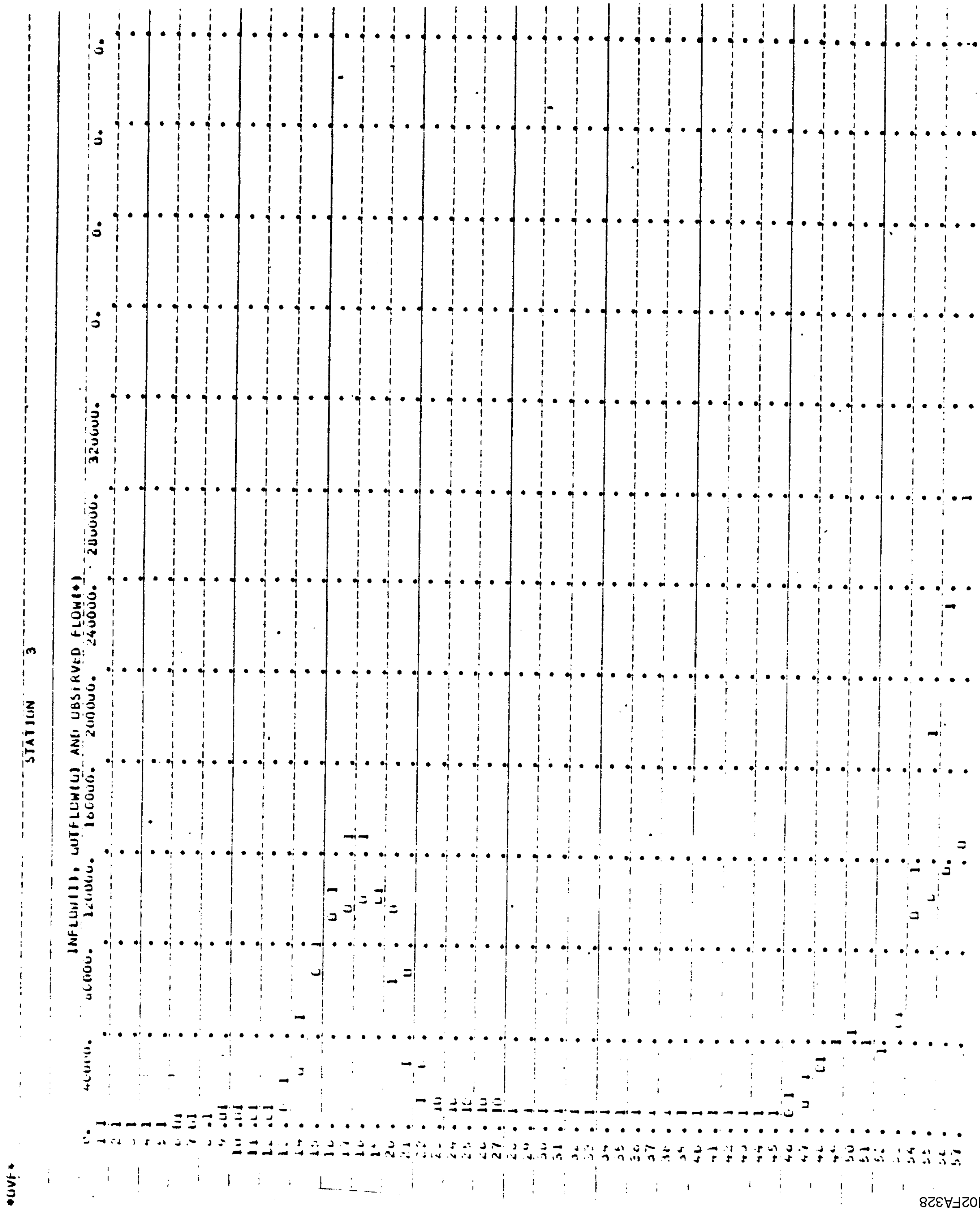

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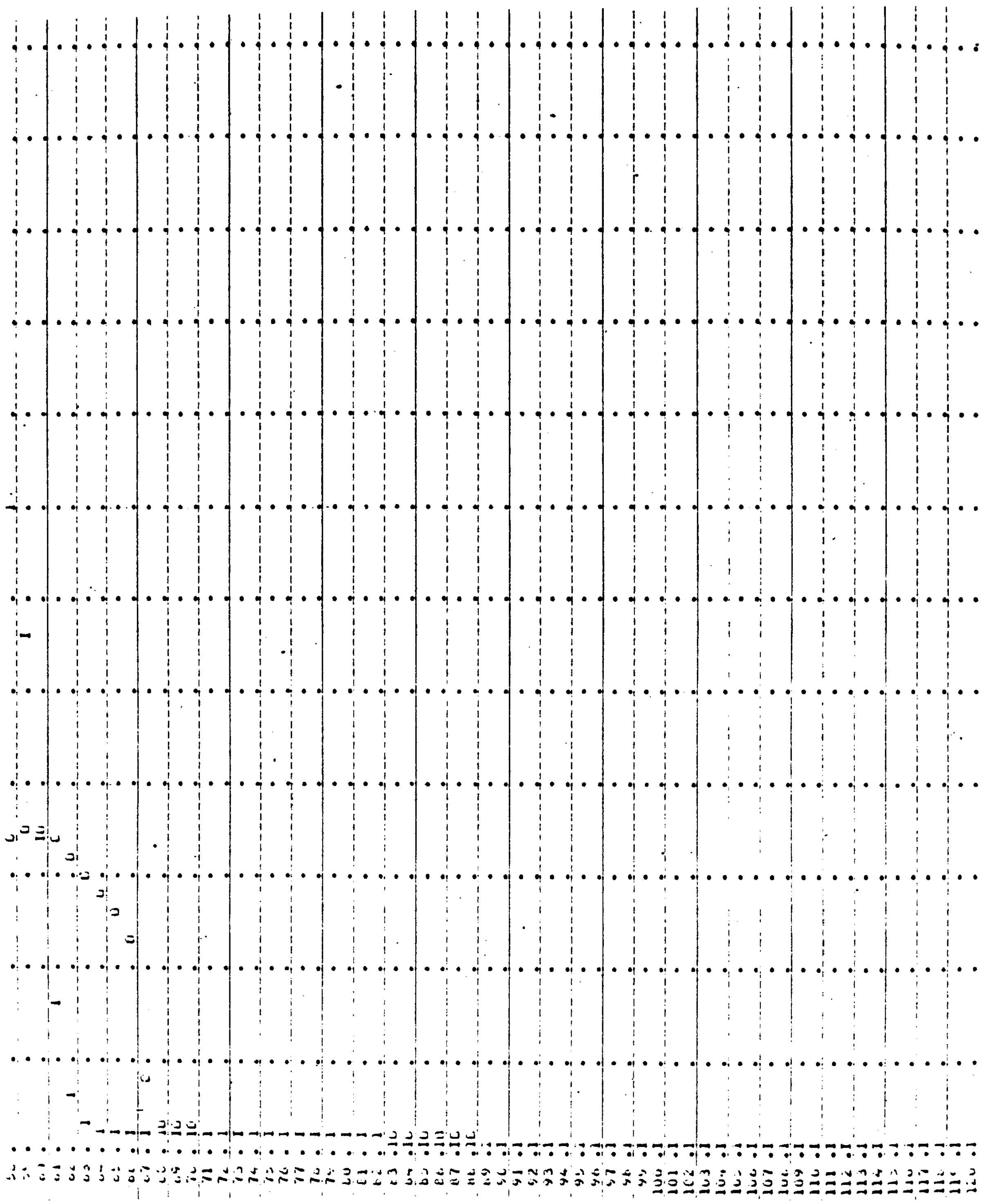

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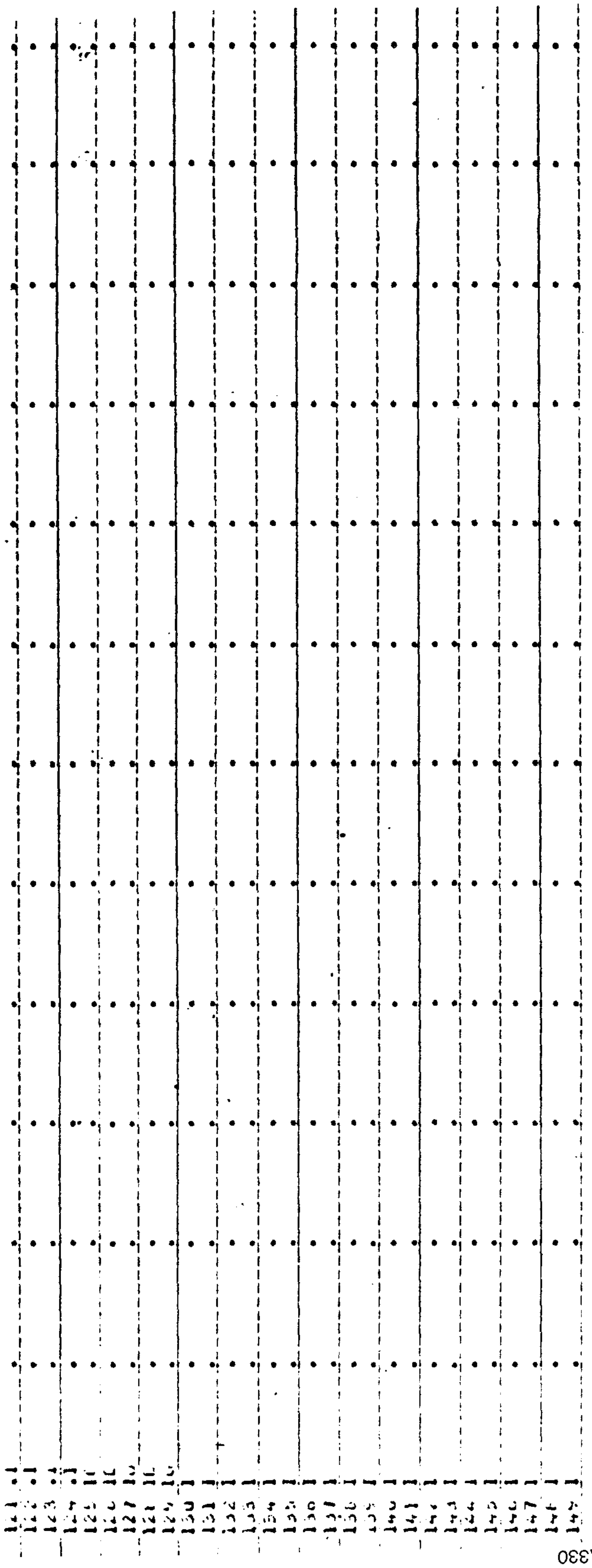

N02FA330

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N02FA331

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	294546.	280393.	180027.	73992.	322.70
ROUTED TO	2	294546.	280393.	180027.	73992.	322.70
HYDROGRAPH AT	2	54997.	41044.	12529.	4845.	20.00
2 COMBINED	2	294546.	281984.	191083.	78655.	342.70
ROUTED TO	3	141596.	141472.	130927.	77075.	342.70

N02FA332

B. Approximate Inflow Analysis, HEC-1 Printout

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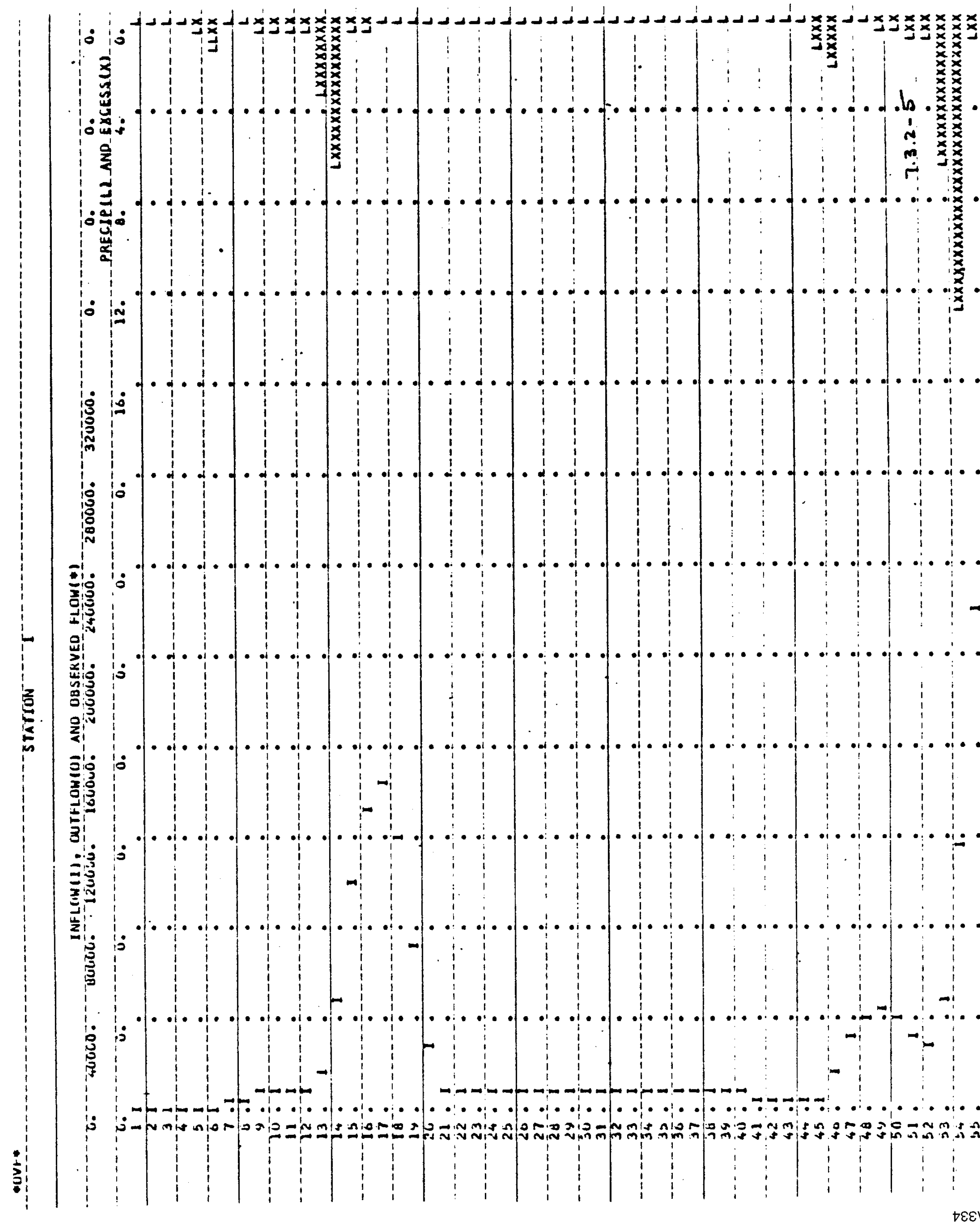

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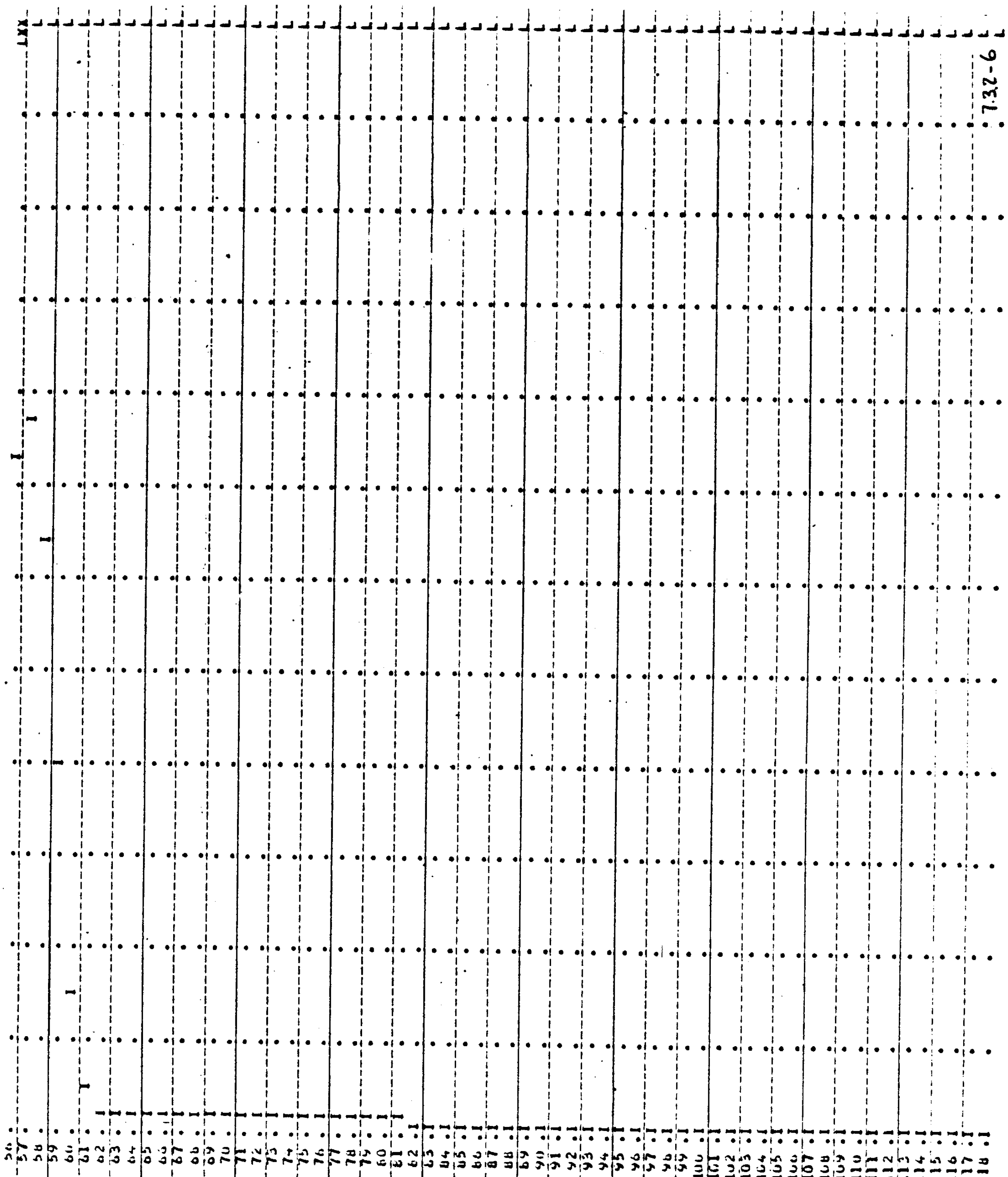

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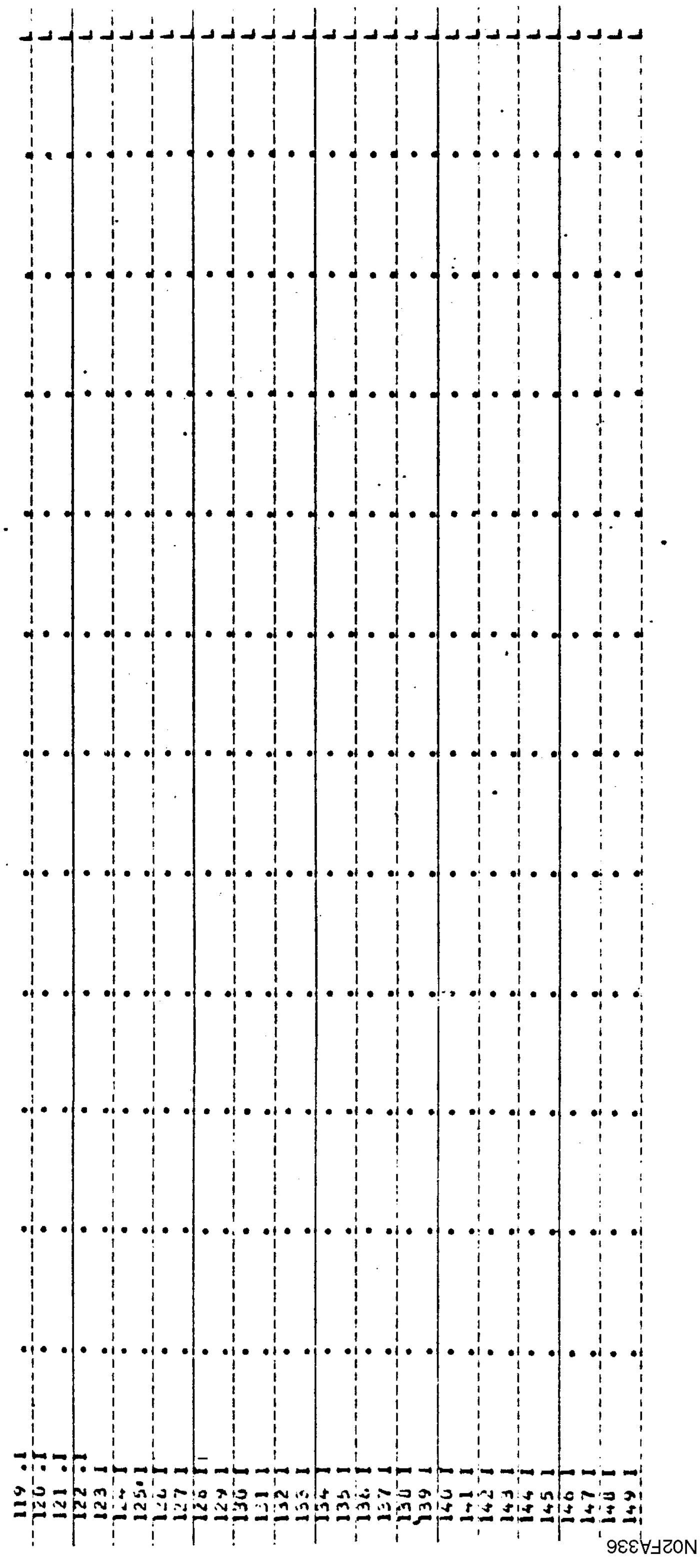
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GVN

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HYDROGRAPH ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	1	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	1	0	0.0	0.0	0.0	0.

ROUTED FLOWS AT 2

292.	285.	277.	270.	263.	1269.	3564.	5408.	6486.	6533.
6419.	6940.	16346.	49828.	98950.	133863.	142312.	118641.	73257.	27560.
9979.	9721.	9469.	9224.	8985.	8752.	8526.	8305.	8090.	7880.
7676.	7477.	7284.	7095.	6911.	6732.	6558.	6388.	6223.	6062.
5905.	5752.	5603.	5458.	5316.	15018.	30107.	40825.	44450.	40610.
32970.	28315.	46989.	117385.	219792.	291840.	307779.	255941.	156371.	60670.
18978.	9864.	9628.	9379.	9136.	8899.	6669.	8444.	8226.	8013.
7805.	7603.	7406.	7214.	7027.	6846.	6668.	6496.	6327.	6164.
6004.	5848.	5697.	5549.	5406.	5266.	5129.	4997.	4867.	4741.
4618.	4499.	4382.	4269.	4158.	4051.	3946.	3843.	3744.	3647.
3553.	3461.	3371.	3284.	3199.	3116.	3035.	2957.	2880.	2805.
2733.	2662.	2593.	2526.	2460.	2397.	2335.	2274.	2215.	2158.
2102.	2046.	1995.	1943.	1893.	1844.	1796.	1749.	1704.	1660.
1617.	1575.	1534.	1495.	1456.	1418.	1381.	1346.	1311.	1277.
1244.	1212.	1180.	1150.	1120.	1091.	1063.	1035.	1008.	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	307779.	299809.	182345.	74262.	2937872.
INCHES		8.64	21.03	25.69	42.34
AC-FT		148743.	361863.	442118.	728774.

N02FA337

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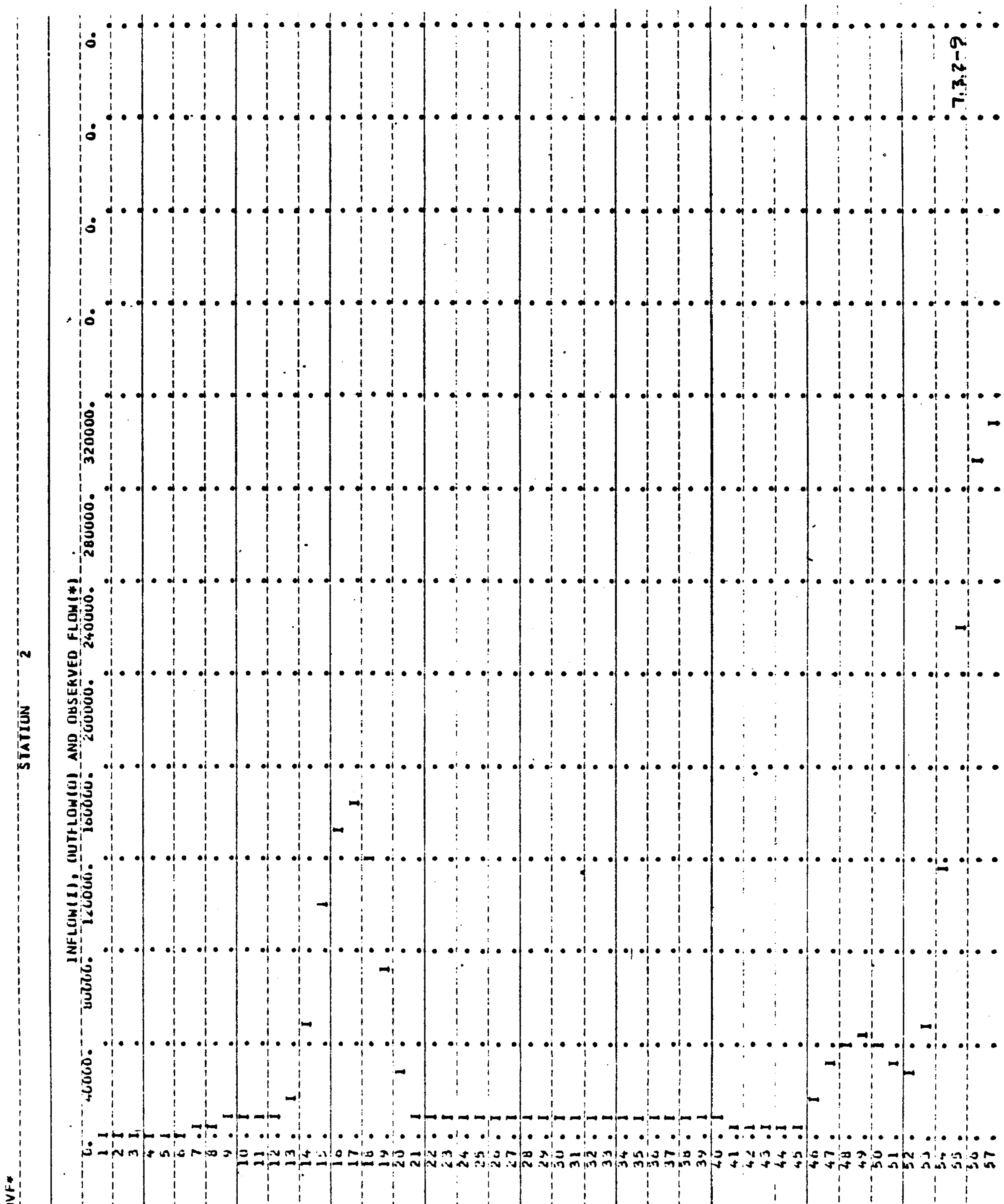

N02FA338

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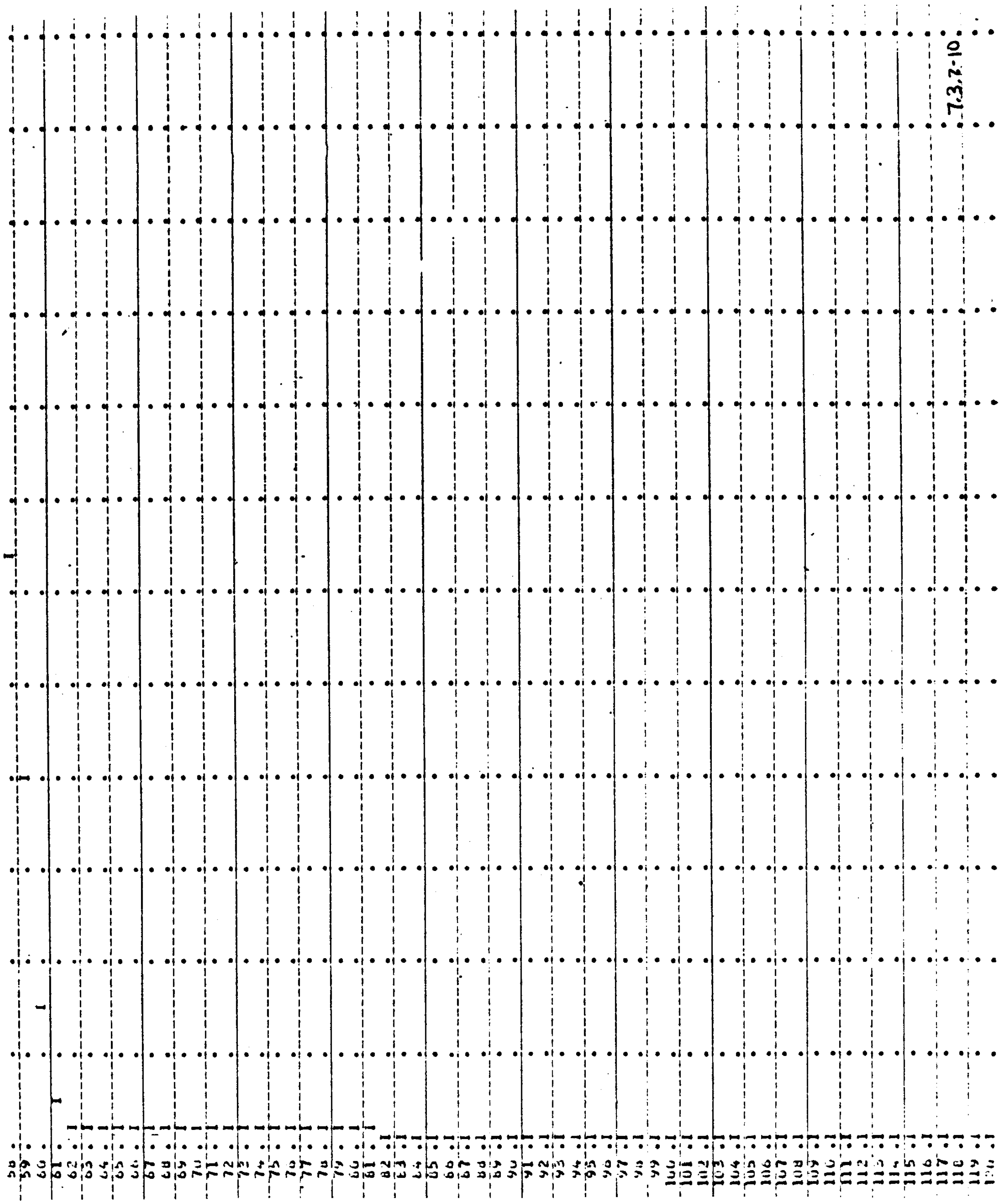

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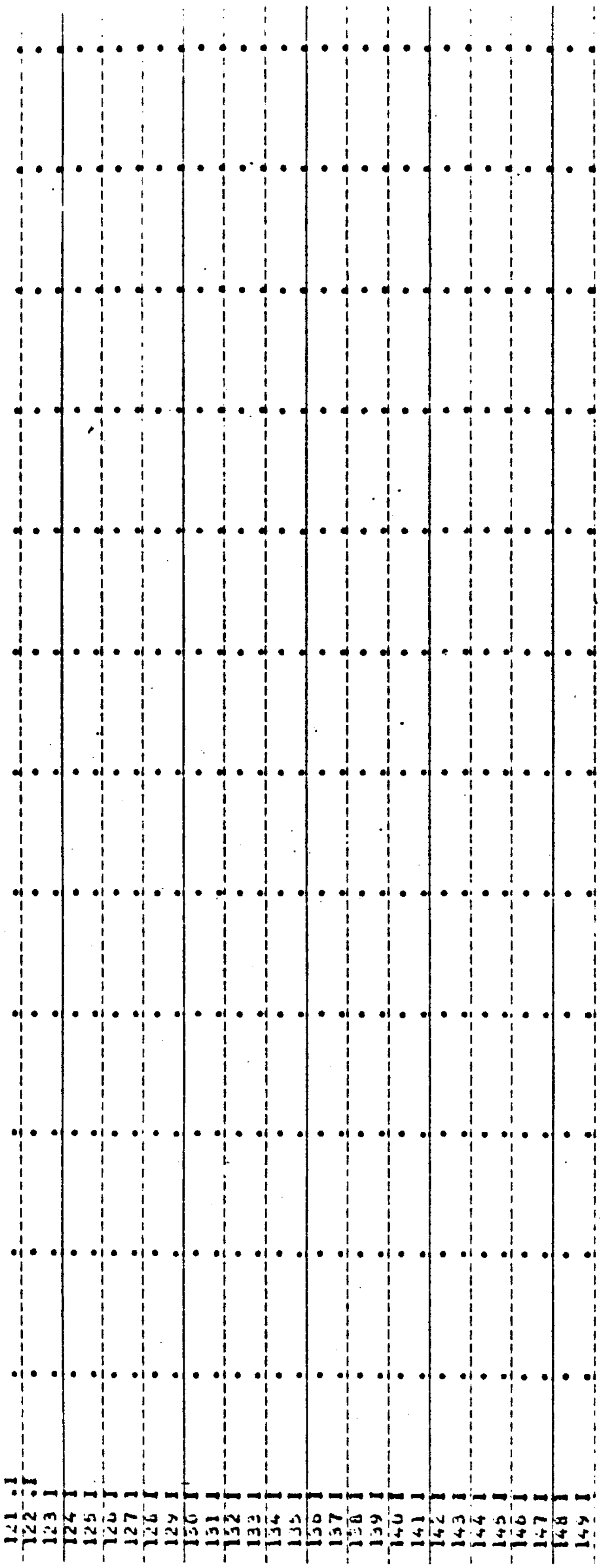

N02FA340

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*OVN*

          **********          **********          **********          **********          **********

                                        SUB-AREA RUNOFF COMPUTATION
                            ISTAQ    ICOMP   IECON   ITAPE    JPLT    JPRT   INAME
                               2        0       0       0       0       0       0

                                            HYDROGRAPH DATA
               IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                   0      -1   20.00     0.0   20.00    1.00     0.0       0       0       0

                                              PRECIP DATA
                                       NP   STORM     DAJ     DAK
                                       56   40.58     0.0     0.0
                                             PRECIP PATTERN
          0.04      0.04      0.07      0.07      0.51      1.02      0.06      0.06      0.25      0.25
          0.44      0.44      3.15      6.40      0.37      0.37      0.0       0.0       0.0       0.0
          0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
          0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
          0.08      0.08      0.14      0.14      1.01      2.04      0.12      0.12      0.50      0.50
          0.87      0.87      6.30     12.79      0.74      0.74

                                               LOSS DATA
              STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
                0.0     0.0    1.00     0.0     0.0    1.00     0.0     0.0     0.0     0.0

                                     GIVEN UNIT GRAPH, NUHGQ=   1
         4300.
                         UNIT GRAPH TOTALS    4300. CFS OR 1.00 INCHES OVER THE AREA

                                              RECESSION DATA
                            STRTQ=    0.0      QRCSN=    0.0     RTIOR= 1.00

                                          END-OF-PERIOD FLOW
                                    TIME   RAIN    EXCS      COMP Q
                                       1   0.04    0.04       172.
                                       2   0.04    0.04       172.
                                       3   0.07    0.07       301.
                                       4   0.07    0.07       301.
                                       5   0.51    0.51      2193.
                                       6   1.02    1.02      4386.
                                       7   0.06    0.06       258.
                                       8   0.06    0.06       258.
                                       9   0.25    0.25      1075.
                                      10   0.25    0.25      1075.
                                      11   0.44    0.44      1892.
                                      12   0.44    0.44      1892.
                                      13   3.15    3.15     13545.
                                      14   6.40    6.40     27520.
                                      15   0.37    0.37      1591.
                                      16   0.37    0.37      1591.
                                      17   0.0     0.0          0.
                                      18   0.0     0.0          0.
                                      19   0.0     0.0          0.
                                      20   0.0     0.0          0.
                                      21   0.0     0.0          0.
                                      22   0.0     0.0          0.
                                      23   0.0     0.0          0.
                                      24   0.0     0.0          0.
                                      25   0.0     0.0          0.
```

N02FA341

26	0.0	0.0	0.
27	0.0	0.0	0.
28	0.0	0.0	0.
29	0.0	0.0	0.
30	0.0	0.0	0.
31	0.0	0.0	0.
32	0.0	0.0	0.
33	0.0	0.0	0.
34	0.0	0.0	0.
35	0.0	0.0	0.
36	0.0	0.0	0.
37	0.0	0.0	0.
38	0.0	0.0	0.
39	0.0	0.0	0.
40	0.0	0.0	0.
41	0.08	0.08	344.
42	0.08	0.08	344.
43	0.14	0.14	602.
44	0.14	0.14	602.
45	1.01	1.01	4343.
46	2.04	2.04	8772.
47	0.12	0.12	516.
48	0.12	0.12	516.
49	0.50	0.50	2150.
50	0.50	0.50	2150.
51	0.87	0.87	3741.
52	0.87	0.87	3741.
53	6.30	6.30	27090.
54	12.79	12.79	54997.
55	0.74	0.74	3182.
56	0.74	0.74	3182.
57	0.0	0.0	0.
58	0.0	0.0	0.
59	0.0	0.0	0.
60	0.0	0.0	0.
61	0.0	0.0	0.
62	0.0	0.0	0.
63	0.0	0.0	0.
64	0.0	0.0	0.
65	0.0	0.0	0.
66	0.0	0.0	0.
67	0.0	0.0	0.
68	0.0	0.0	0.
69	0.0	0.0	0.
70	0.0	0.0	0.
71	0.0	0.0	0.
72	0.0	0.0	0.
73	0.0	0.0	0.
74	0.0	0.0	0.
75	0.0	0.0	0.
76	0.0	0.0	0.
77	0.0	0.0	0.
78	0.0	0.0	0.
79	0.0	0.0	0.
80	0.0	0.0	0.
81	0.0	0.0	0.
82	0.0	0.0	0.
83	0.0	0.0	0.
84	0.0	0.0	0.
85	0.0	0.0	0.
86	0.0	0.0	0.
87	0.0	0.0	0.
88	0.0	0.0	0.

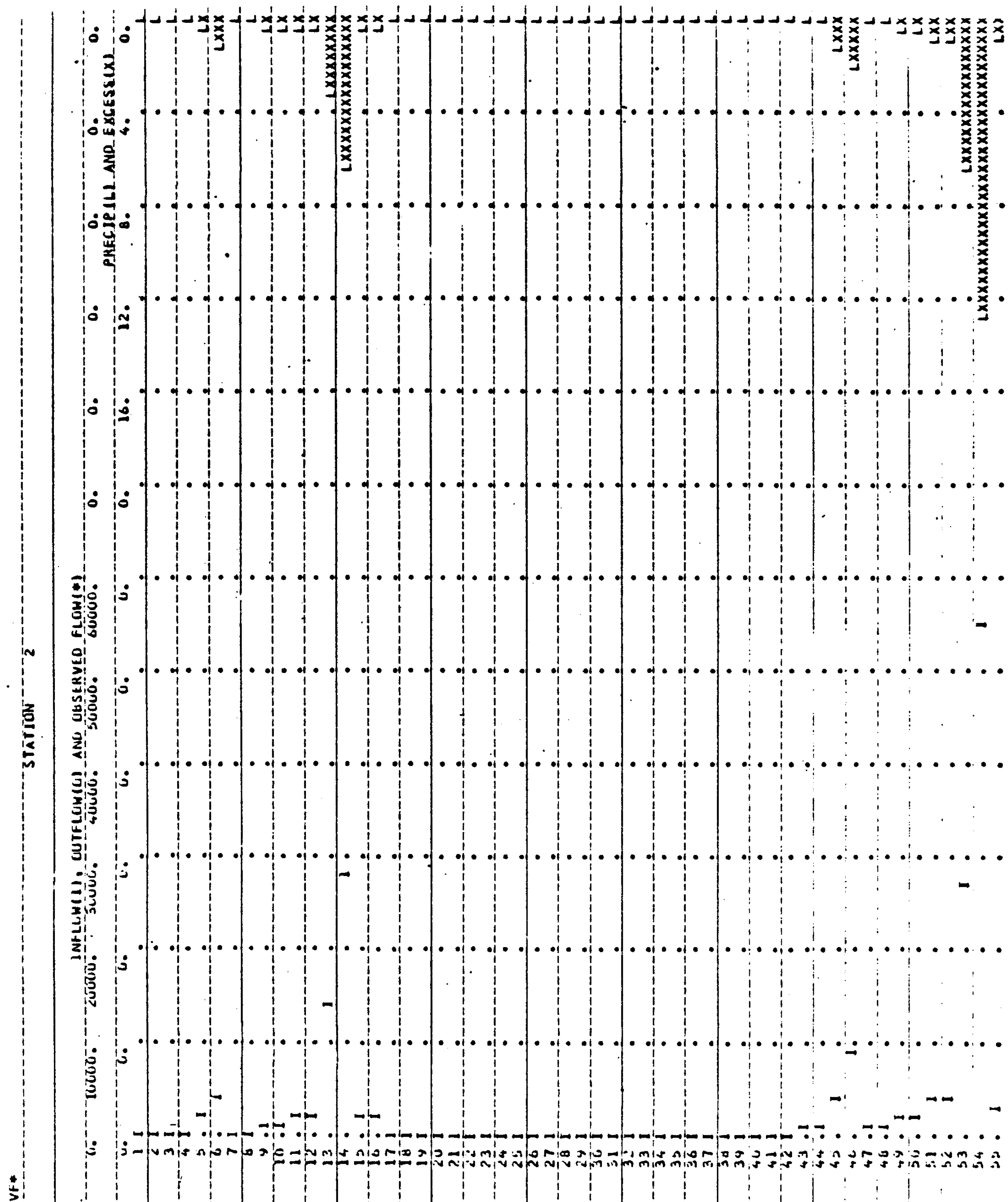
N02FA342

89	0.0	0.0	0.
90	0.0	0.0	0.
91	0.0	0.0	0.
92	0.0	0.0	0.
93	0.0	0.0	0.
94	0.0	0.0	0.
95	0.0	0.0	0.
96	0.0	0.0	0.
97	0.0	0.0	0.
98	0.0	0.0	0.
99	0.0	0.0	0.
100	0.0	0.0	0.
101	0.0	0.0	0.
102	0.0	0.0	0.
103	0.0	0.0	0.
104	0.0	0.0	0.
105	0.0	0.0	0.
106	0.0	0.0	0.
107	0.0	0.0	0.
108	0.0	0.0	0.
109	0.0	0.0	0.
110	0.0	0.0	0.
111	0.0	0.0	0.
112	0.0	0.0	0.
113	0.0	0.0	0.
114	0.0	0.0	0.
115	0.0	0.0	0.
116	0.0	0.0	0.
117	0.0	0.0	0.
118	0.0	0.0	0.
119	0.0	0.0	0.
120	0.0	0.0	0.
121	0.0	0.0	0.
122	0.0	0.0	0.
123	0.0	0.0	0.
124	0.0	0.0	0.
125	0.0	0.0	0.
126	0.0	0.0	0.
127	0.0	0.0	0.
128	0.0	0.0	0.
129	0.0	0.0	0.
130	0.0	0.0	0.
131	0.0	0.0	0.
132	0.0	0.0	0.
133	0.0	0.0	0.
134	0.0	0.0	0.
135	0.0	0.0	0.
136	0.0	0.0	0.
137	0.0	0.0	0.
138	0.0	0.0	0.
139	0.0	0.0	0.
140	0.0	0.0	0.
141	0.0	0.0	0.
142	0.0	0.0	0.
143	0.0	0.0	0.
144	0.0	0.0	0.
145	0.0	0.0	0.
146	0.0	0.0	0.
147	0.0	0.0	0.
148	0.0	0.0	0.
149	0.0	0.0	0.
SUM	40.58	40.58	174494.

N02FA343

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	54997.	41044.	12529.	4845.	174494.
INCHES		19.09	23.31	27.04	40.58
AC-FT		20363.	24864.	28843.	43285.

N02FA344


STATION 2
INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)
PRECIP(L) AND EXCESS(X)

N02FA345

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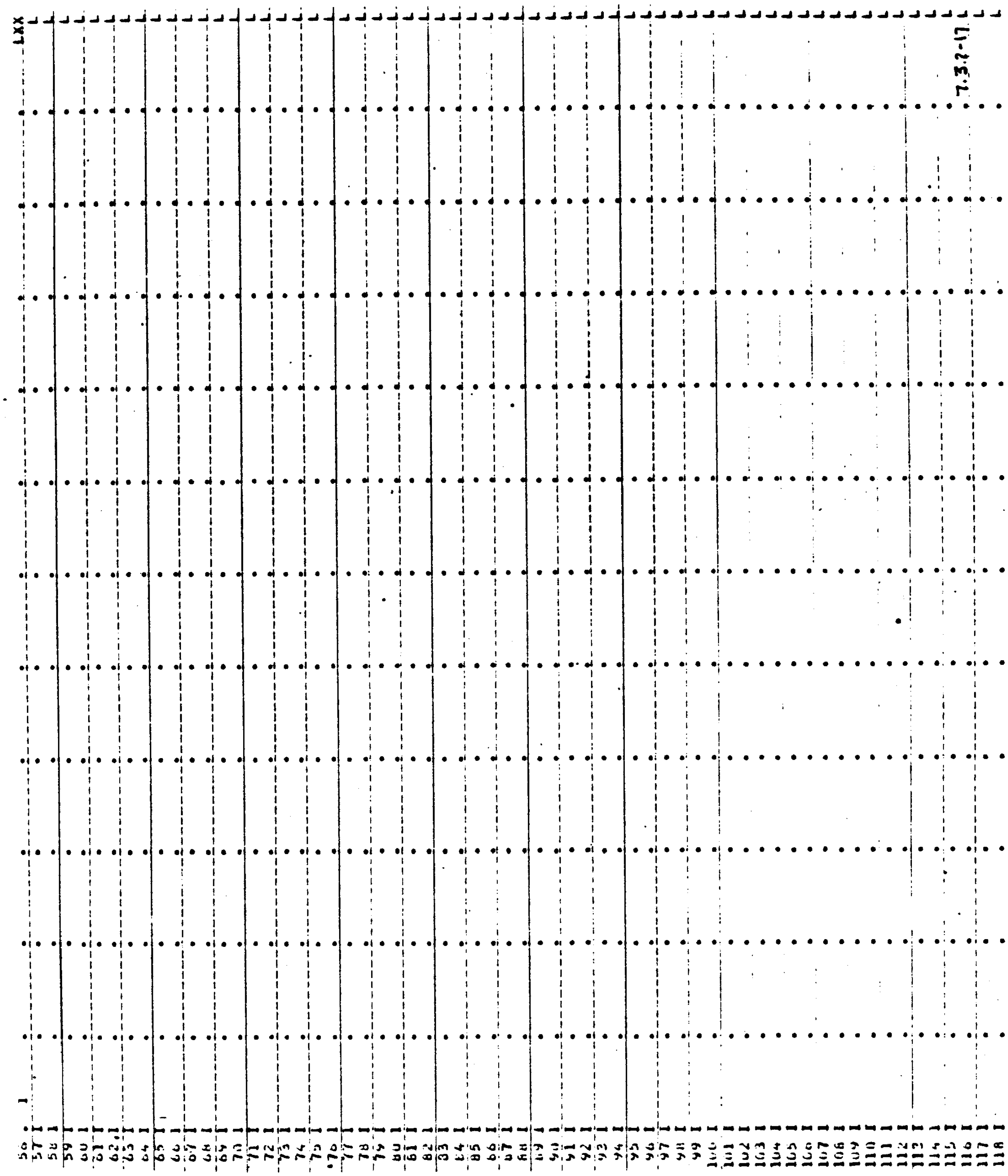

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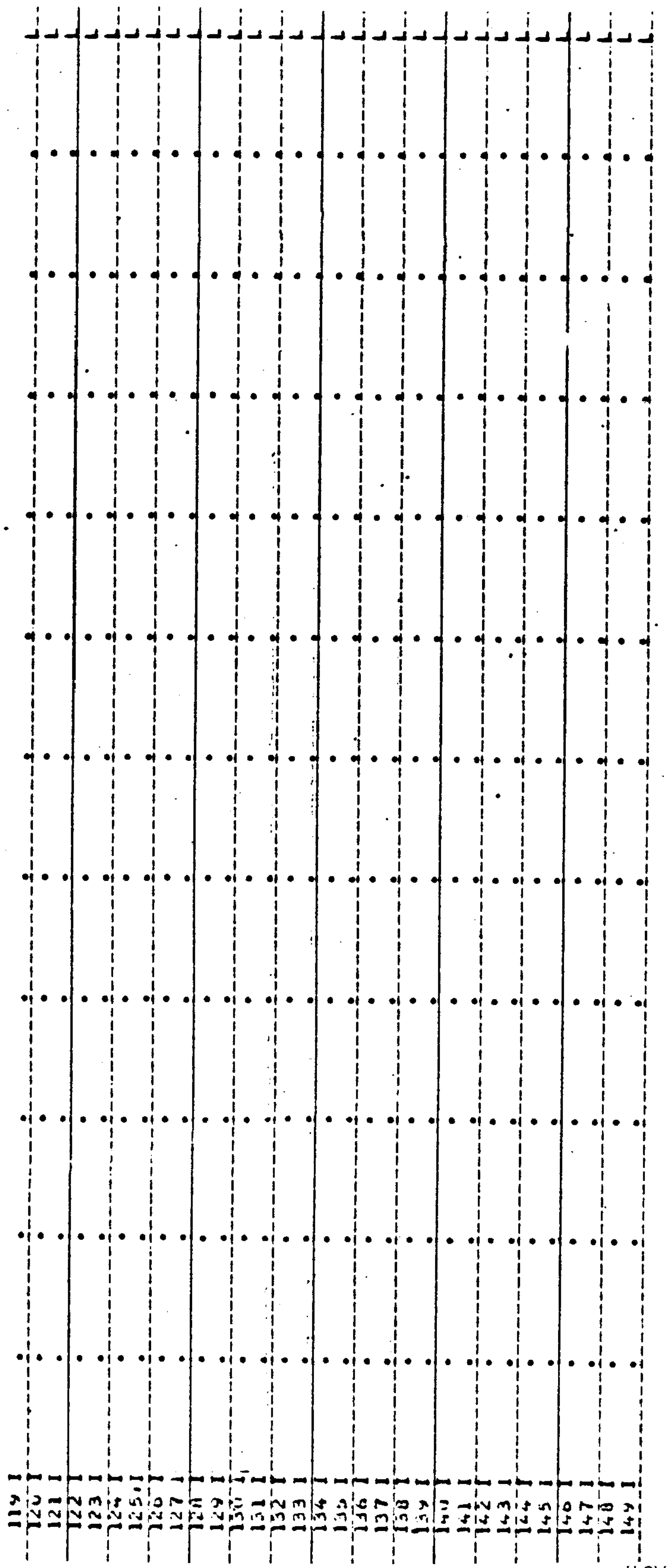

OVN

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	2	0	0	0	0	0

SUM OF 2 HYDROGRAPHS AT 2

464.	457.	576.	571.	2456.	5655.	3822.	5666.	7561.	7606.
8311.	8632.	29691.	77348.	100541.	135454.	142312.	118641.	73257.	27560.
9979.	9721.	9469.	9224.	8985.	8752.	8526.	8305.	8090.	7880.
7676.	7477.	7284.	7095.	6911.	6732.	6558.	6388.	6223.	6062.
6249.	6096.	6205.	6060.	9659.	23790.	30623.	41341.	46600.	42700.
36711.	32056.	74079.	172582.	222974.	295022.	307779.	255941.	158371.	60670.
18978.	9884.	9628.	9379.	9136.	8899.	8669.	8444.	8226.	8013.
7805.	7603.	7406.	7214.	7027.	6846.	6668.	6496.	6327.	6164.
6004.	5848.	5697.	5549.	5406.	5266.	5129.	4997.	4867.	4741.
4618.	4499.	4382.	4269.	4158.	4051.	3946.	3843.	3744.	3647.
3553.	3461.	3371.	3284.	3199.	3116.	3035.	2957.	2880.	2805.
2733.	2662.	2593.	2526.	2460.	2397.	2335.	2274.	2215.	2158.
2102.	2048.	1995.	1943.	1893.	1844.	1796.	1749.	1704.	1660.
1617.	1575.	1534.	1495.	1456.	1418.	1381.	1346.	1311.	1277.
1244.	1212.	1180.	1150.	1120.	1091.	1063.	1035.	1008.	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	307779.	301400.	193401.	78907.	3112365.
INCHES		8.18	21.00	25.70	42.24
AC-FT		149532.	383804.	469770.	772059.

N02FA348

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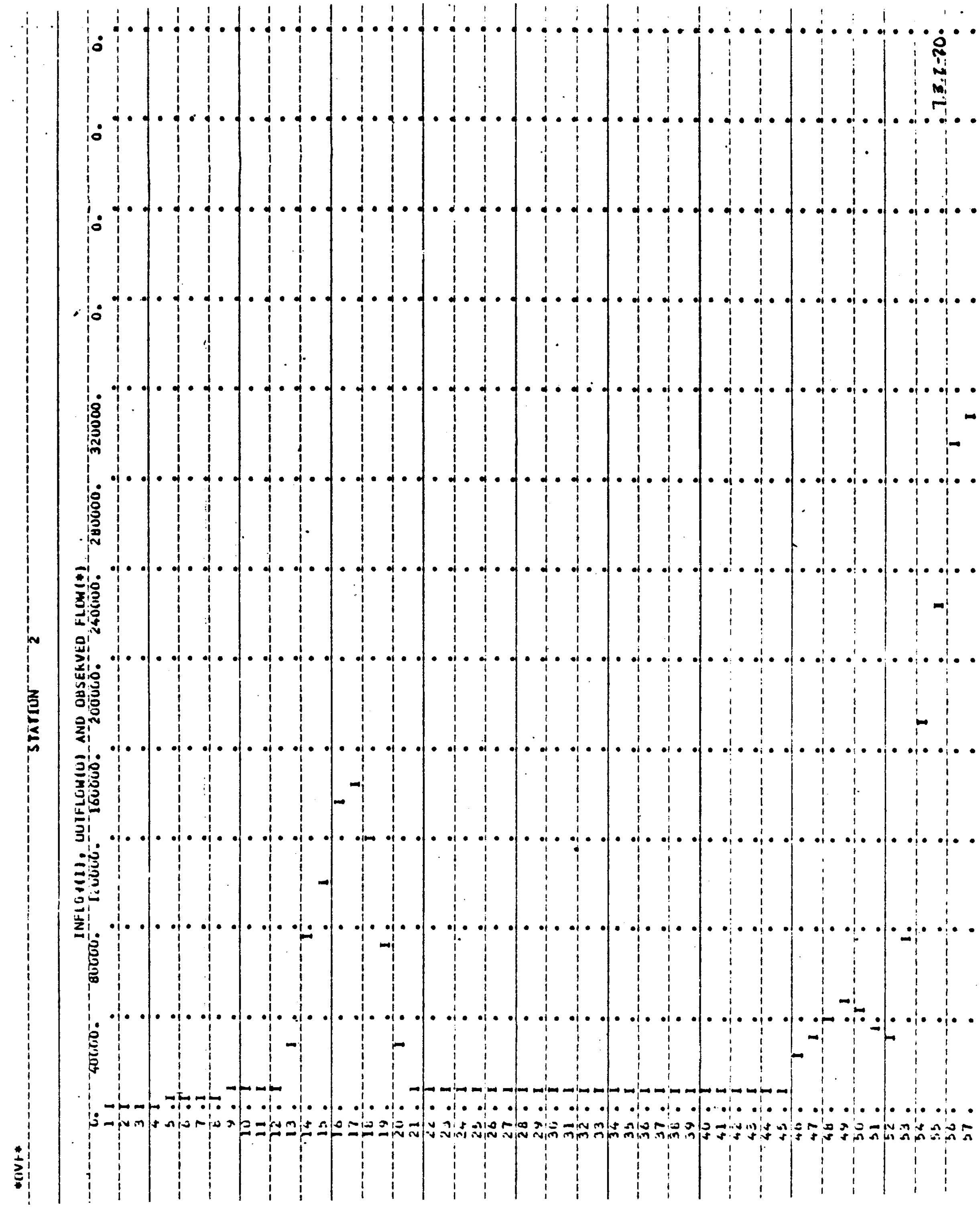

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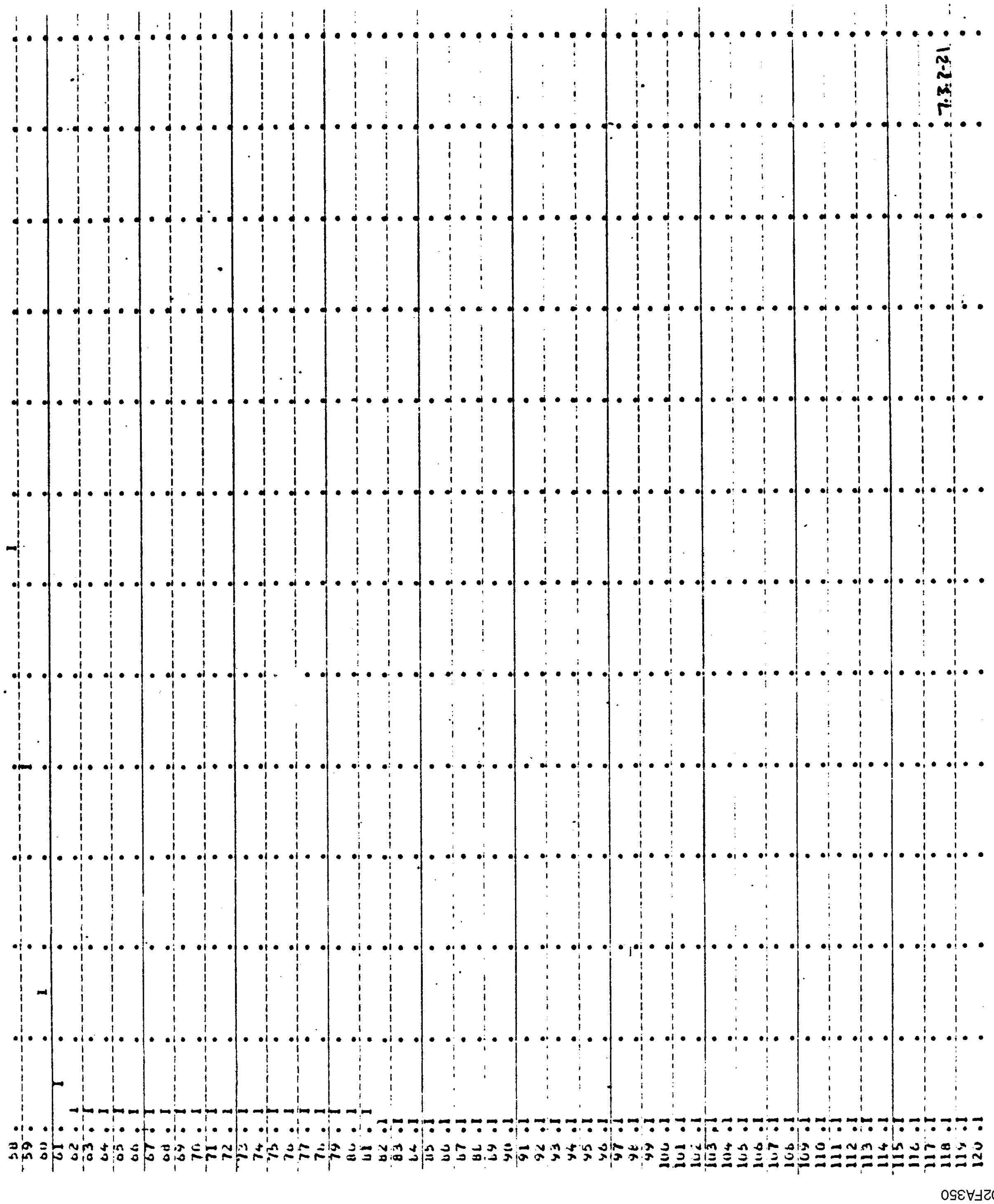

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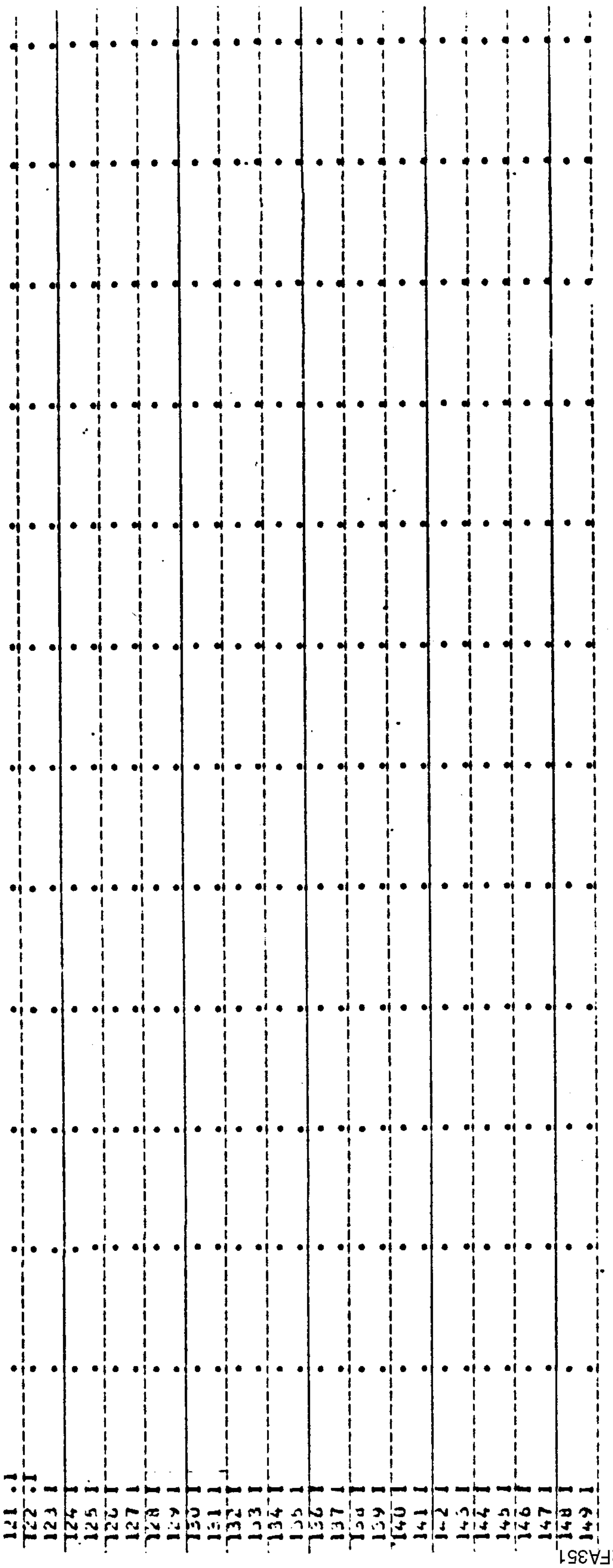

N02FA351

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DVN

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
3	1	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.0	0.0	0.0	-1.

STORAGE=	1.	15700.	22200.	33200.	93700.	108450.	196900.	0.	0.	0.
OUTFLOW=	40.	10890.	47190.	94380.	118600.	122300.	145590.	0.	0.	0.

TIME	EOP STOR	AVG IN	EOP OUT
1	615.	464.	464.
2	614.	460.	464.
3	626.	517.	472.
4	650.	575.	488.
5	884.	1514.	650.
6	1662.	4056.	1188.
7	2472.	4739.	1748.
8	3157.	4744.	2221.
9	4160.	6614.	2914.
10	5226.	7585.	3651.
11	6210.	7960.	4331.
12	7179.	8571.	5001.
13	10458.	19362.	7267.
14	19128.	53619.	30034.
15	28341.	88944.	73535.
16	36611.	117996.	95746.
17	46801.	138883.	99825.
18	54041.	130476.	102723.
19	52441.	95949.	102083.
20	40255.	50408.	97196.
21	25327.	18769.	60603.
22	17594.	9850.	21470.
23	15655.	9595.	11754.
24	15391.	9346.	10677.
25	15032.	9104.	10428.
26	14676.	8869.	10182.
27	14324.	8639.	9939.
28	13976.	8415.	9696.
29	13633.	8197.	9461.
30	13296.	7985.	9228.
31	12965.	7778.	8999.
32	12640.	7577.	8775.
33	12321.	7381.	8555.
34	12009.	7190.	8339.
35	11704.	7003.	8129.
36	11406.	6822.	7922.
37	11114.	6645.	7721.
38	10829.	6473.	7524.
39	10551.	6306.	7332.
40	10280.	6142.	7144.
41	10054.	6155.	6980.
42	9868.	6172.	6859.
43	9706.	6150.	6747.

N02FA352

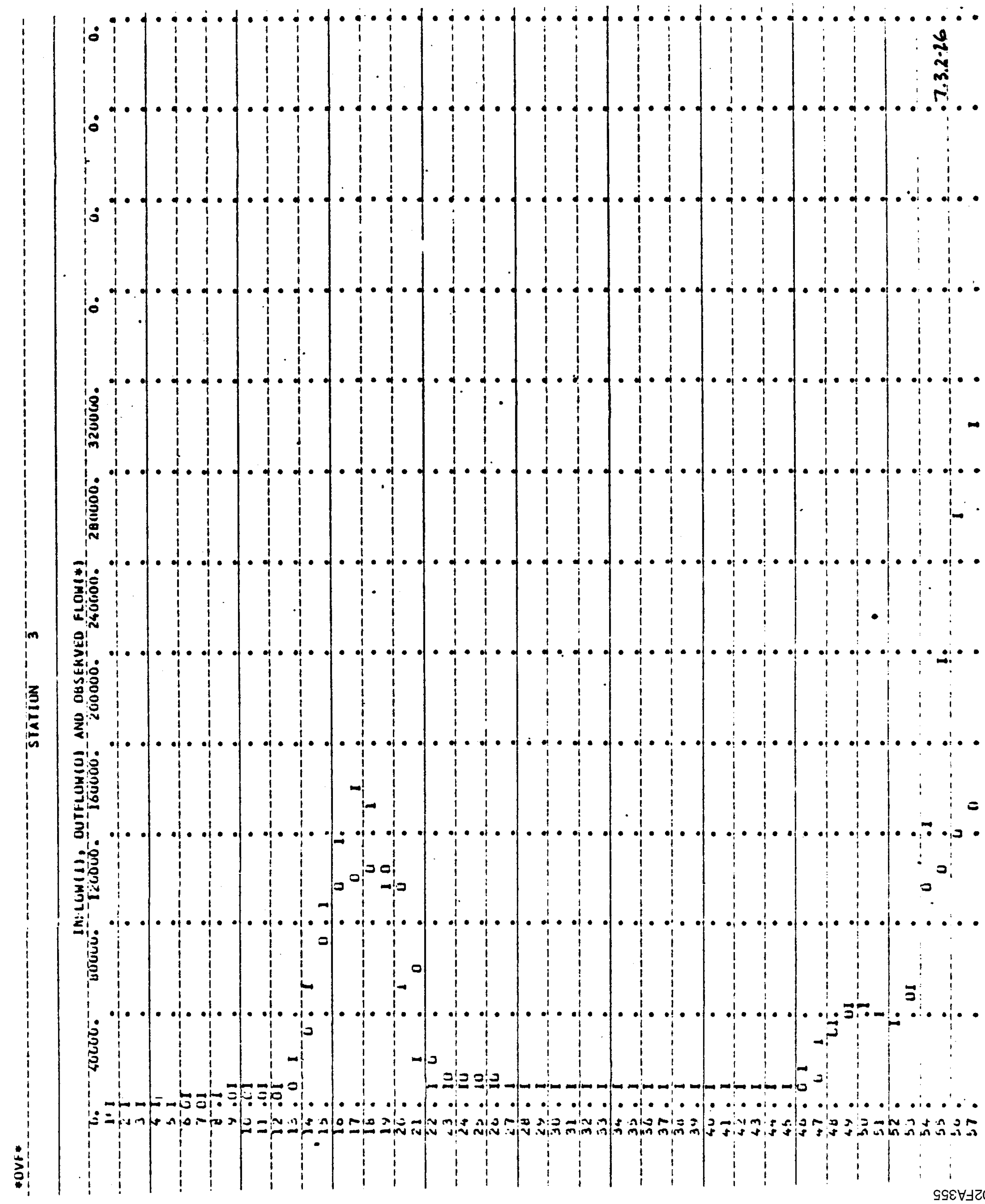
44	9565.	6132.	6650.	
45	9842.	7860.	6841.	
46	12099.	16725.	8401.	
47	16145.	27206.	13374.	
48	19457.	35982.	31871.	
49	21230.	43970.	41770.	
50	21656.	44080.	44151.	
51	21609.	39736.	40539.	
52	20107.	34384.	35503.	
53	22731.	55068.	49468.	
54	35345.	123231.	95239.	
55	59542.	197676.	164926.	
56	95976.	258996.	119171.	
57	139748.	301401.	130541.	
58	176079.	281860.	140108.	
59	192177.	207156.	144346.	EL 264.7
60	183815.	169520.	142145.	
61	159248.	39824.	135676.	
62	120138.	14431.	126011.	
63	101735.	9756.	120616.	
64	75347.	9503.	111253.	
65	51255.	9257.	101608.	
66	30585.	9017.	83163.	
67	18893.	8784.	28722.	
68	15939.	8557.	12223.	
69	15164.	8335.	10533.	
70	14633.	8119.	10152.	
71	14120.	7909.	9798.	
72	13642.	7704.	9468.	
73	13194.	7505.	9158.	
74	12772.	7310.	8866.	
75	12373.	7121.	8591.	
76	11995.	6937.	8330.	
77	11636.	6757.	8081.	
78	11294.	6582.	7845.	
79	10967.	6411.	7619.	
80	10653.	6245.	7402.	
81	10352.	6084.	7194.	
82	10062.	5926.	6994.	
83	9784.	5773.	6801.	
84	9515.	5623.	6615.	
85	9255.	5478.	6436.	
86	9004.	5336.	6262.	
87	8761.	5198.	6094.	
88	8525.	5063.	5931.	
89	8297.	4932.	5774.	
90	8076.	4804.	5621.	
91	7861.	4680.	5472.	
92	7652.	4559.	5328.	
93	7449.	4441.	5188.	
94	7253.	4326.	5052.	
95	7061.	4214.	4919.	
96	6875.	4104.	4791.	
97	6694.	3998.	4666.	
98	6518.	3895.	4544.	
99	6347.	3794.	4426.	
100	6180.	3695.	4310.	
101	6018.	3600.	4196.	
102	5860.	3507.	4089.	
103	5706.	3416.	3983.	
104	5556.	3327.	3879.	
105	5410.	3241.	3779.	
106	5269.	3157.	3681.	

N02FA353

107	5130.	3075.	3585.
108	4996.	2996.	3492.
109	4865.	2918.	3401.
110	4737.	2843.	3313.
111	4613.	2769.	3227.
112	4492.	2697.	3144.
113	4374.	2628.	3062.
114	4259.	2559.	2983.
115	4147.	2493.	2906.
116	4038.	2429.	2830.
117	3932.	2366.	2757.
118	3829.	2304.	2686.
119	3728.	2245.	2616.
120	3630.	2187.	2548.
121	3535.	2130.	2482.
122	3442.	2075.	2418.
123	3351.	2021.	2355.
124	3263.	1969.	2294.
125	3177.	1918.	2235.
126	3093.	1868.	2177.
127	3012.	1820.	2121.
128	2932.	1773.	2066.
129	2855.	1727.	2012.
130	2779.	1682.	1960.
131	2706.	1639.	1909.
132	2634.	1596.	1860.
133	2565.	1555.	1812.
134	2497.	1514.	1765.
135	2431.	1475.	1719.
136	2366.	1437.	1675.
137	2303.	1400.	1631.
138	2242.	1364.	1589.
139	2183.	1328.	1548.
140	2125.	1294.	1508.
141	2068.	1260.	1469.
142	2013.	1228.	1431.
143	1960.	1196.	1394.
144	1907.	1165.	1358.
145	1857.	1135.	1322.
146	1807.	1105.	1288.
147	1759.	1077.	1255.
148	1712.	1049.	1222.
149	1666.	1022.	1191.
SUM			3108218.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	144346.	143245.	132576.	78129.	3108218.
INCHES		3.89	14.39	25.45	42.19
AC-FT		71067.	263097.	465139.	771031.

N02FA354


OVF
STATION 3
INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)
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7.3.2-26
N02FA355

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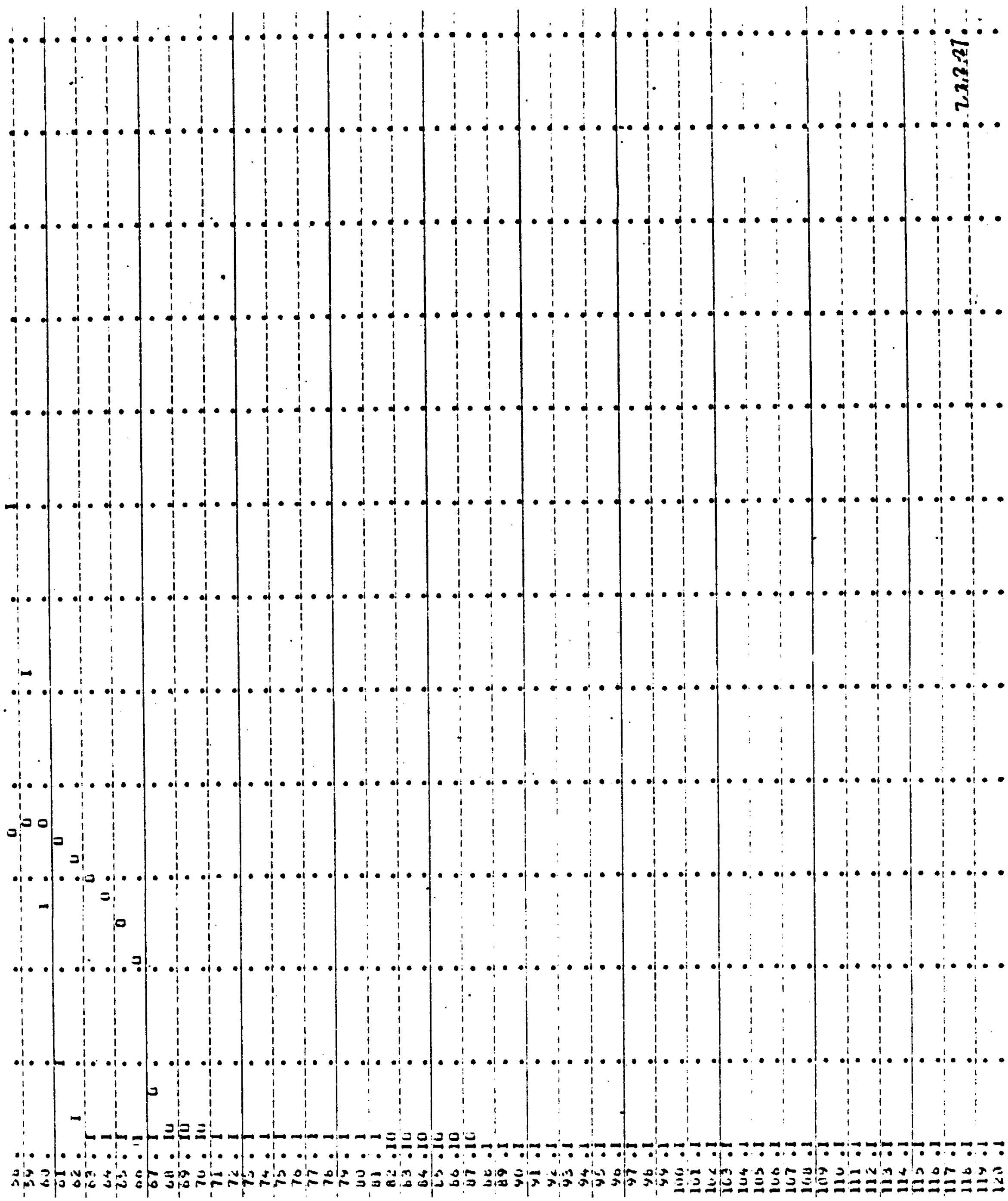

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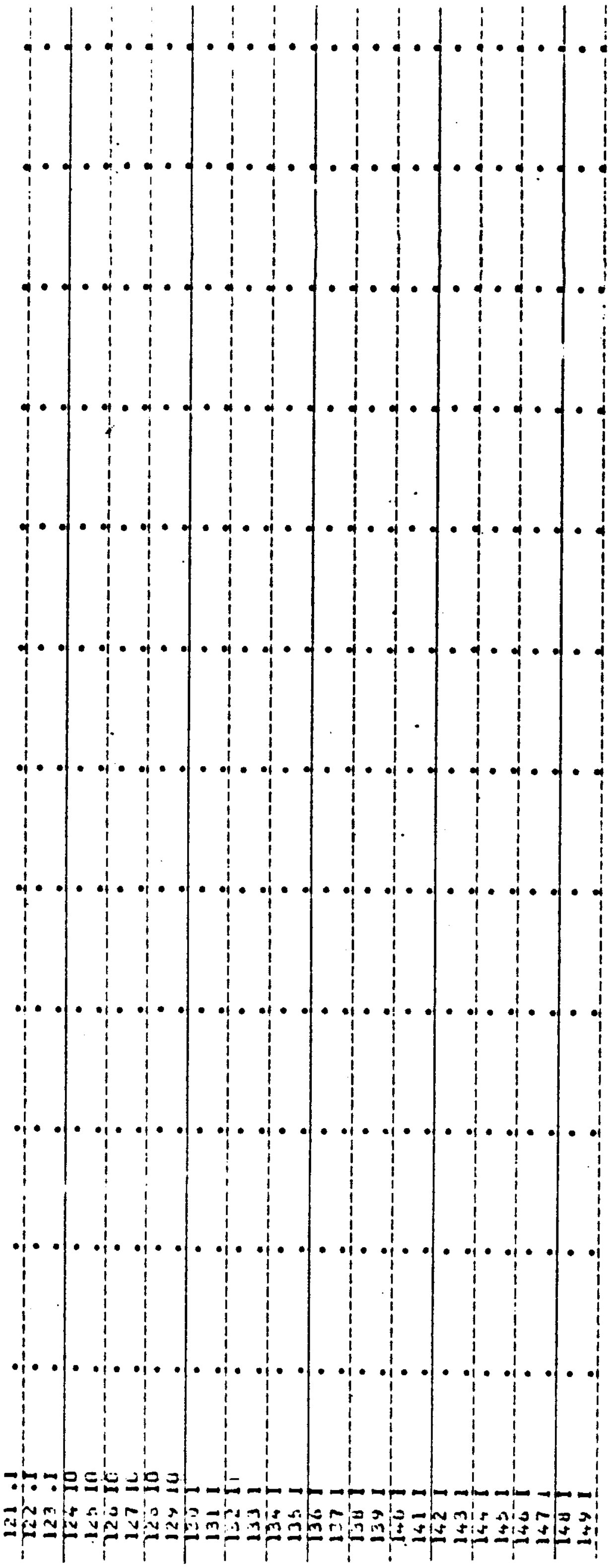

N02FA357

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	307779.	299809.	182345.	74262.	322.70
ROUTED TO	2	307779.	299809.	182345.	74262.	322.70
HYDROGRAPH AT	2	54997.	41044.	12529.	4845.	20.00
2 COMBINED	2	307779.	301400.	193401.	78907.	342.70
ROUTED TO	3	144346.	143245.	132576.	78129.	342.70

N02FA358

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Appendix 2A
Attachment 4[1]
Documentation of Inflow Analysis Program

1. Attachment 4 to Appendix 2A was submitted as Appendix J, Section 7.4 in the original FSAR.

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LAKE ANNA MAIN RESERVOIR INFLOW ESTIMATION

By

F. K. Chou and Y. C. Chang

F. K. Chou
Senior Hydraulic - Environmental Engineer

Y. C. Chang
Supervisor, Hydrological Analysis Group

Y. J. Tsai
Head, Envrionmental Impact Analysis

E. J. Schmidt
Chief, Environmental Engineering Division

N02FA402

Stone & Webster Engineering Corporation
Boston, Massachusetts

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1. PROGRAM SUMMARY

Purpose

To estimate flood inflows to the main reservoir of Lake Anna in Virginia during historical storms.

Method

Lake Anna is divided into two major portions; the main reservoir and the Waste Heat Treatment Facility (WHTF). The WHTF is further subdivided into four component reservoirs. Four dikes separate the main reservoir and the WHTF, and three canals connect the four component reservoirs of the WHTF. Taking into consideration precipitation, reservoir storage, and flood, canal, dike, and spillway flows, the continuity equations for the Lake Anna flow system are derived and solved by Runge-Kutta fourth order method.

Input (IBM punch cards)

Job description

Total hours to be performed

Time step

Canal and dike characteristics

Derived inflows to the WHTF

Recorded main reservoir water levels

Derived spillway flows

Precipitation over the main reservoir and the WHTF

Stage area curves for all reservoirs

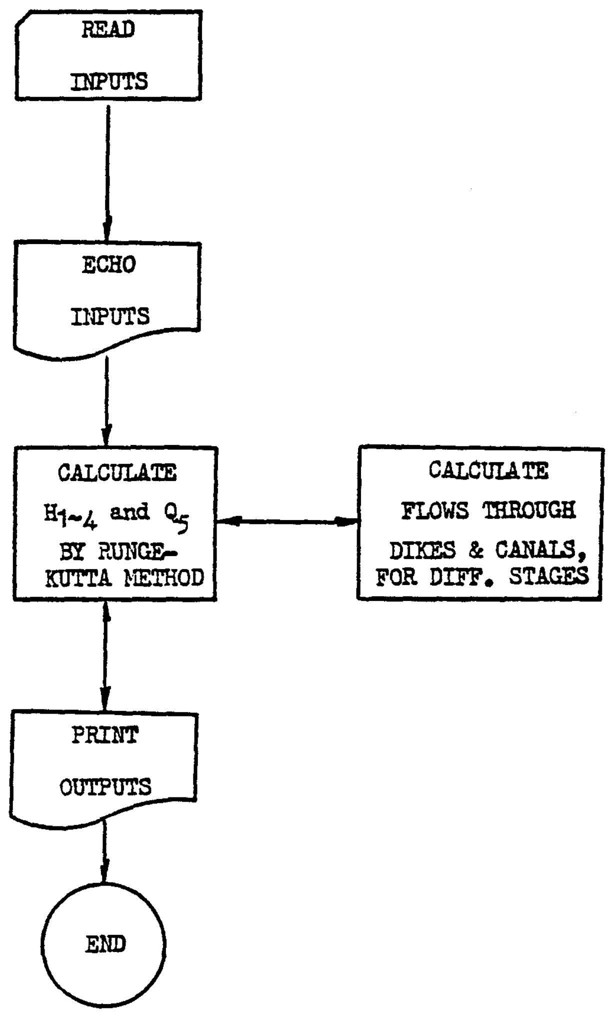
Output

Echo print all inputs

Flows through all canals and dikes

Water levels of all reservoirs and inflows to the main reservoir

BLOCK DIAGRAM



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3. FUNCTIONAL DESCRIPTION - MULTIPLE RESERVOIRS ANALYSIS

Due to the existence of the dikes between the WHTF and the Main Reservoir, and the canals connecting the component reservoirs of the WHTF, a comprehensive approach was taken to simulate the flood flow in Lake Anna.

3.1 General Formulation

Lake Anna is divided into two major portions: the main reservoir and the WHTF. The WHTF is further subdivided into four component reservoirs. Four dikes separate the main reservoir and the WHTF, and three canals connect the four component reservoirs of the WHTF (Figure A). Taking into consideration precipitation, reservoir storage, and canal, dike, spillway, and flood flows, the continuity equations for the Lake Anna flow system can be written as follows:

$$P_1A_1 + Q_1 + C_A + D_1 = C_B + \frac{dH_1}{dt} A_1 \qquad (1)$$

$$P_2A_2 + Q_2 + C_B + D_2 = C_C + \frac{dH_2}{dt} A_2 \qquad (2)$$

$$P_3A_3 + Q_3 + C_C + D_3 = \frac{dH_3}{dt} A_3 \qquad (3)$$

$$P_4A_4 + Q_4 + Q_C + D_4 = C_A + \frac{dH_4}{dt} A_4 \qquad (4)$$

$$P_5A_5 + Q_5 = Q_C + \sum_{i=1}^{4} D_i + Q_S + \frac{dH_5}{dt} A_5 \qquad (5)$$

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where P is the precipitation, in./hr.

A is the surface area, acres

C is the flow through the canal, cfs

D is the flow through the dike, cfs

H is the reservoir surface elevation, ft

Q_C is the cooling water flow through the power plant, cfs

Q_S is the flow through the spillway of the main dam, cfs

The suffix for P, A, C, D, and H identifies the component parts of the WHTF and the main reservoir (Figure A).

Equations 1 through 5 state that the net inflow is balanced by net outflow and reservoir storage change.

For the flow in the canal, the steady-state Manning equation is used

$$C = \frac{1.49}{n} R^{2/3} S^{1/2} A_c \quad (6)$$

where n is the Manning n

R is the hydraulic radius, ft

S is taken as the average slope of the water surface connecting two reservoirs at the ends of the canal

A_c is the cross-sectional area of the canal, ft^2

The cross section of the canals is shown in Figure B. The flows over the dikes are more complicated. There are four dikes between the WHTF and the main reservoir. The cross sections of the dikes are shown in Figures C and D. Dikes I, II, and IV are identical. The crests of the dikes are at 260 ft. The formulae adopted for calculating flows are shown below.

$D_{I,II,IV}$ = for H $\leq$260 ft

$$D_{I,II,IV} = \frac{2}{3}\frac{\sqrt{2g}}{3}\{1 - [0.069(W/h_u - 1 + 2.35 R_e^{0.25})^{0.80} R_e^{-0.20}]\} \qquad (7)$$

$$Lh_u^{3/2}$$

for submergence $\sigma = h_d/h_u \leq 0.85$, H>260 ft

$$D_{I,II,IV} = C_k (L\sigma h_u \sqrt{2gh_u(1 - \sigma)}) \qquad (8)$$

for $\sigma > 0.85$, $H > 260$ ft

where L is dike length, ft

W is dike width, ft

h_u and h_d are the reservoir stages above the crest of the dike for the upstream and downstream reservoir respectively, ft.

R_e is the Reynolds number and is defined as

$$3.8 \times 10^5 \, h_u^{3/2}$$

C_k is the flow factor as the function of the upstream head h_u shown in Figure E.

For calculating the flow through dike III, the flow is divided into 3 components: namely, the flow through the submerged orifices, the flow over the saddle section, and the flow over the broad crest weir (Figure D). Representing the flows by $D_{III,1}$, $D_{III,2}$, and $D_{III,3}$, the flow through dike III becomes

$$D_{III} = D_{III,1} + D_{III,2} + D_{III,3}$$

where $D_{III,2} = 0$ for $H \leq 253.5$ ft

$D_{III,3} = 0$ for $H \leq 260.0$ ft

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The formulae for computing the orifice and broad crest weir flows are as follows

$$D_{III,1} = 8{,}200\ (H_u - H_d)^{1/2} \tag{10}$$

where H_u and H_d are the reservoir stages upstream and downstream of the orifices, respectively, ft

$$D_{III,2} = \frac{2\sqrt{2g}}{3\ 3}\ \{1 - [0.069(W/h_u - 1 + 2.35R_e^{0.25})^{0.80} \tag{11}$$

$$R_e^{-0.20}]\}[bh_u^{3/2} + 0.8\ m(h_u^{5/2} - hu'^{5/2})]$$

for submergence $\sigma \leq 0.85$

and

$$D_{III,2} = C_k\ [350\ \sigma h_u + m\ (\sigma h_u)^2]\sqrt{2gh_u(1 - \sigma)} \tag{12}$$

when $m(\sigma h_u)^2 \leq 2341$

or $$D_{III,2} = C_k\ [1070(\sigma h_u - 6.5) + 4616]\sqrt{2gh_u(1 - \sigma)}$$

when $m(\sigma h_u)^2 > 2341$

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for submergence $\sigma > 0.85$

where $b = 350$ ft, the bottom width of the saddle section

$m = 55.4$, side slope of the saddle section

$hu' = hu - 6.5$ if $hu > 6.5$, $hu' = 0$ if $hu \leq 6.5$

$R_e = 3.8 \times 10^5 (h_u)^{5/2}$ the Reynolds number

h_u is the reservoir stages above the crest of the saddle section, ft

C_k is the flow factor as the function of h_u shown in Figure E.

$D_{III,3}$ is identical to Equations 7 and 8. It should be noted that L used should be the total dike length minus the length of the saddle section and that h_u and h_d are related to dike crest 260 ft.

Since the maximum flood stages of the historical storms are all below 253.5 ft, none of the formulations for flow over the dike were actually used for the derivation of inflows to the reservoir.

The outflows through the spillway were calculated using the stage records and the gate opening records for the respective storms.

With the supplement of Equations 6 through 12, Equations 1 through 5 still contain more unknowns than the available equations. The problem

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is overcome by using the synthesized flows to the WHTF component reservoirs. Since the drainage area of the WHTF is only about 10 percent of the entire Lake Anna drainage area, and the precipitation for historical storms is known, the flows can be generated utilizing the synthetic unit hydrograph parameters for the subdrainage basin of the WHTF, with little sacrifice of accuracy. With the known generated flows to the WHTF, Equations 1 through 12 provide a complete set of equations for flood simulation in Lake Anna

3.2 Formulation for estimating inflows to main reservoir using historical storm data

During the historical storms, the precipitation and main reservoir water level are known. The flow through the spillway can be generated from the recorded gate opening and lake level data. The flows into the component reservoirs can be generated using the precipitation data and synthetic unit hydrograph parameters. Equations 1 through 5 can be arranged as follows:

$$\frac{dH_1}{dt} = P_1 + (Q_1 + C_A + D_1 - C_B)/A_1 \quad (13)$$

$$\frac{dH_2}{dt} = P_2 + (Q_2 + C_B + D_2 - C_C)/A_2 \quad (14)$$

$$\frac{dH_3}{dt} = P_3 + (Q_3 + C_C + D_3)/A_3 \quad (15)$$

$$\frac{dH_4}{dt} = P_4 + (Q_4 + Q_C + D_4)/A_4 \quad (16)$$

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$$Q_5 = Qc + \sum_{i=1}^{4} D_i + Q_s + (\frac{dH5}{dt} - P_5)A_5 \qquad (17)$$

Equations 13 through 16, in conjunction with Equations 6 through 12, can be solved for H_1, H_2, H_3, and H_4. Q_5 can be obtained by Equation 17. The solution will give the required information on the main reservoir inflow and additional information on the water levels in the WHTF.

3.3 Numerical Solutions to the Simultaneous Ordinary Differential Equations

For solving the simultaneous ordinary differential equations, Runge-Kutta fourth-order method is used. The method has algorithms:

$$h_{i+1} = h_i + \frac{\Delta t}{6} (k_1 + 2k_2 + 2k_3 + k_4) \qquad (18)$$

where $k_1 = f\ (t_i, h_i)$

$$k_2 = f\ (t_i + \frac{\Delta t}{2}, h_i + \frac{k_1}{2})$$

$$k_3 = f\ (t_i + \frac{\Delta t}{2}, h_i + \frac{k_2}{2})$$

$$k_4 = f\ (t_i + \Delta t,\ h_i + k_3)$$

The k value is the approximate of the derivative at various points on the integration interval $t_i \leq t \leq t_{i+1}$. Equations 13 through 16 are solved by the Runge-Kutta method. Equation 17 is used to generate the inflows using recorded main reservoir flood levels, spillway flows, and calculated flows through dikes.

3.4 Program Description

The program basically consists of three sections: input, model simulation, and output. The input section reads in available data. For flow, water stage, spillway discharge, and precipitation data, the values are read in at DT interval. In the simulation section, water elevations in the four component reservoirs of the WHTF are calculated TW times in each DT step using Runge-Kutta fourth order method. In each sub-step, the flows through canals and dikes, also the instantaneous reservoir areas, are calculated as required by Runge-Kutta algorithm. The inflows to the main reservoir are calculated every DT step. The flows through canals and dikes are printed out every DT step. The resulting reservoir elevations in the WHTF and inflows to the main reservoir are stored every DT step and printed out at the end of calculations. Additional outputs for the main reservoir inflows are punched on cards to facilitate optimization of the main reservoir drainage basin unit hydrograph parameters by HEC-1 program.

4. OPERATING INSTRUCTIONS

4.1 Input

The input data formats and descriptions are shown in the attached IBM coding sheets. The descriptions can be used as dictionary of important variables.

Since the data from the four storms available for Lake Anna since its closure are at one hour intervals, DT of one hour was selected for all four storms. In each DT step, TW calculations were performed. In general, TW of 60, i.e., time step of one minute, was observed to yield reasonable results. A further increase in TW does not yield any significant difference on inflows to the main reservoir.

4.2 Sample Problem

The June, 1972, storm was used as the sample problem. The sample problem includes inputs, source listing and outputs as shown in the attached sheets.

5. REFERENCES

1. Rouse, H., "Elementary Mechanics of Fluids" Wiley, 1962.

2. James, M. L., G. M. Smith, and J. C. Wolford, "Applied Numerical Methods" International, 1967.

3. "HEC-1 Flood Hydrograph Package" Hydrologic Engineering Center, U.S. Army Corps of Engineers, January, 1973.

4. Chou, V. T., Handbook of Applied Hydrology McGraw-Hill, 1964.

5. King, H. W., and E. F. Brater, Handbook of Hydraulics, McGraw-Hill, 1963.

6. Henderson, F. M., Open Channel Flow, Macmillan, 1966.

7. Hall, G. W., "Discharge Characteristics of Broad-Crested Wiers using Boundary Layer Theory," Proc. Inst. of Civil Engineers, Vol. 22, June 1962.

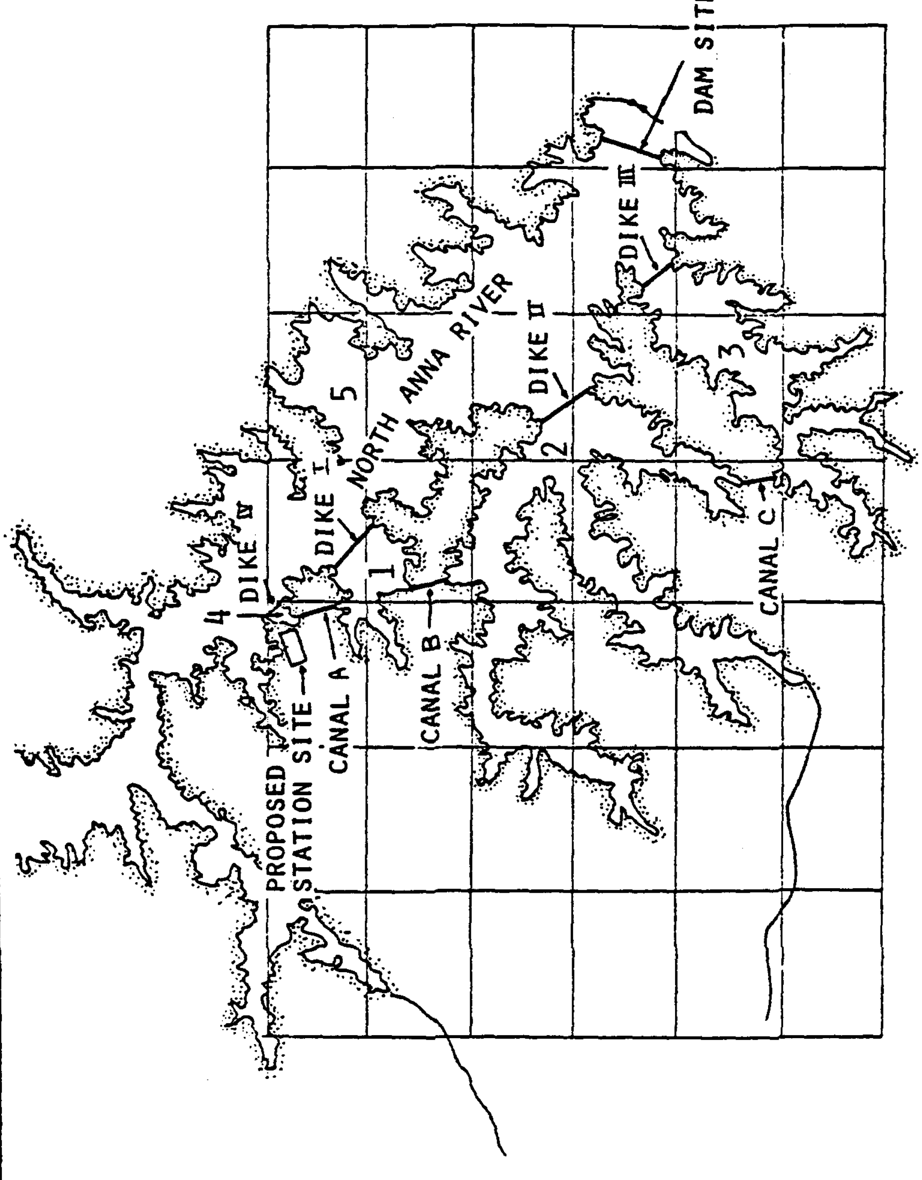

FIGURE A
LAKE ANNA LAYOUT

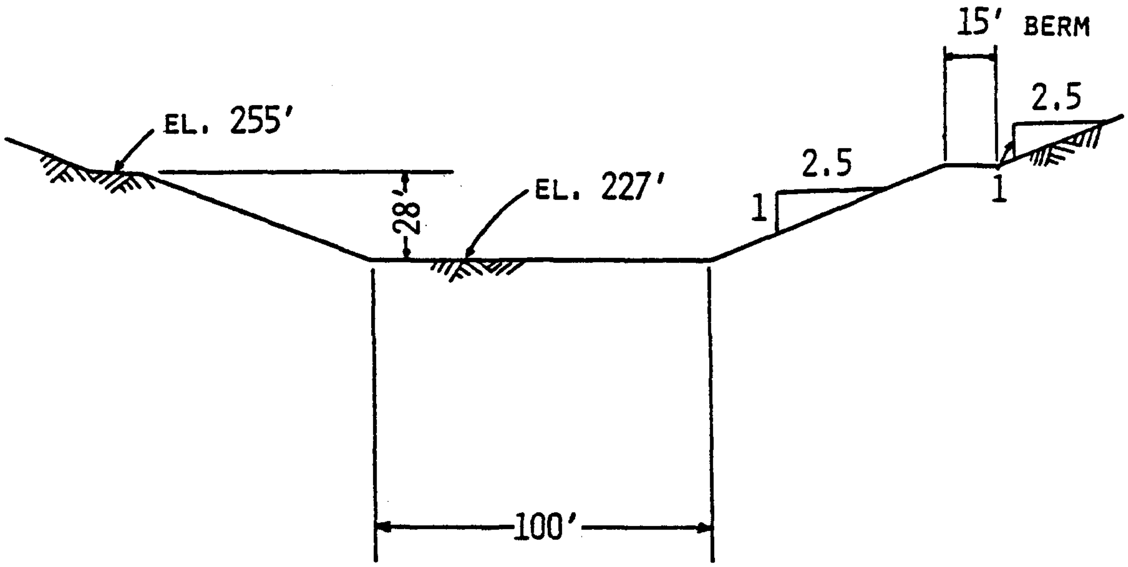

FIGURE B
CROSS SECTION OF CANAL

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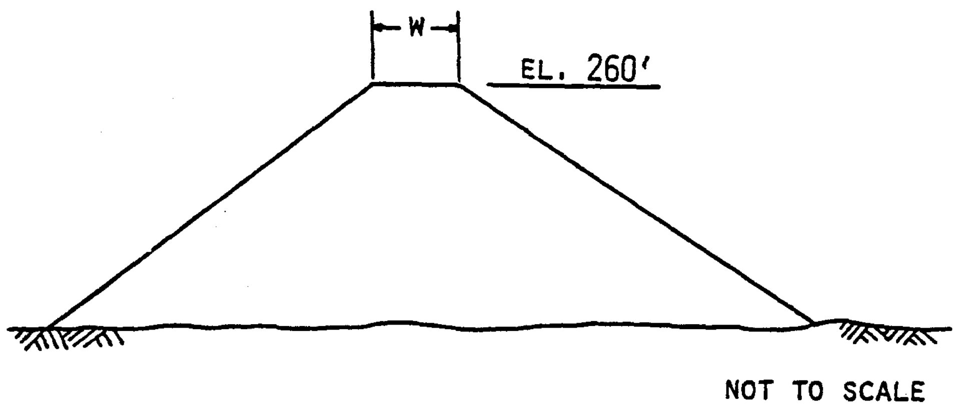

W = 20' FOR DIKE I & II

= 25' FOR DIKE IV

L = LENGTH OF DIKE

= 3890' FOR DIKE I

= 3740' FOR DIKE II

= 400' FOR DIKE IV

FIGURE C

CROSS SECTION OF DIKE I, II, IV

N02FA421

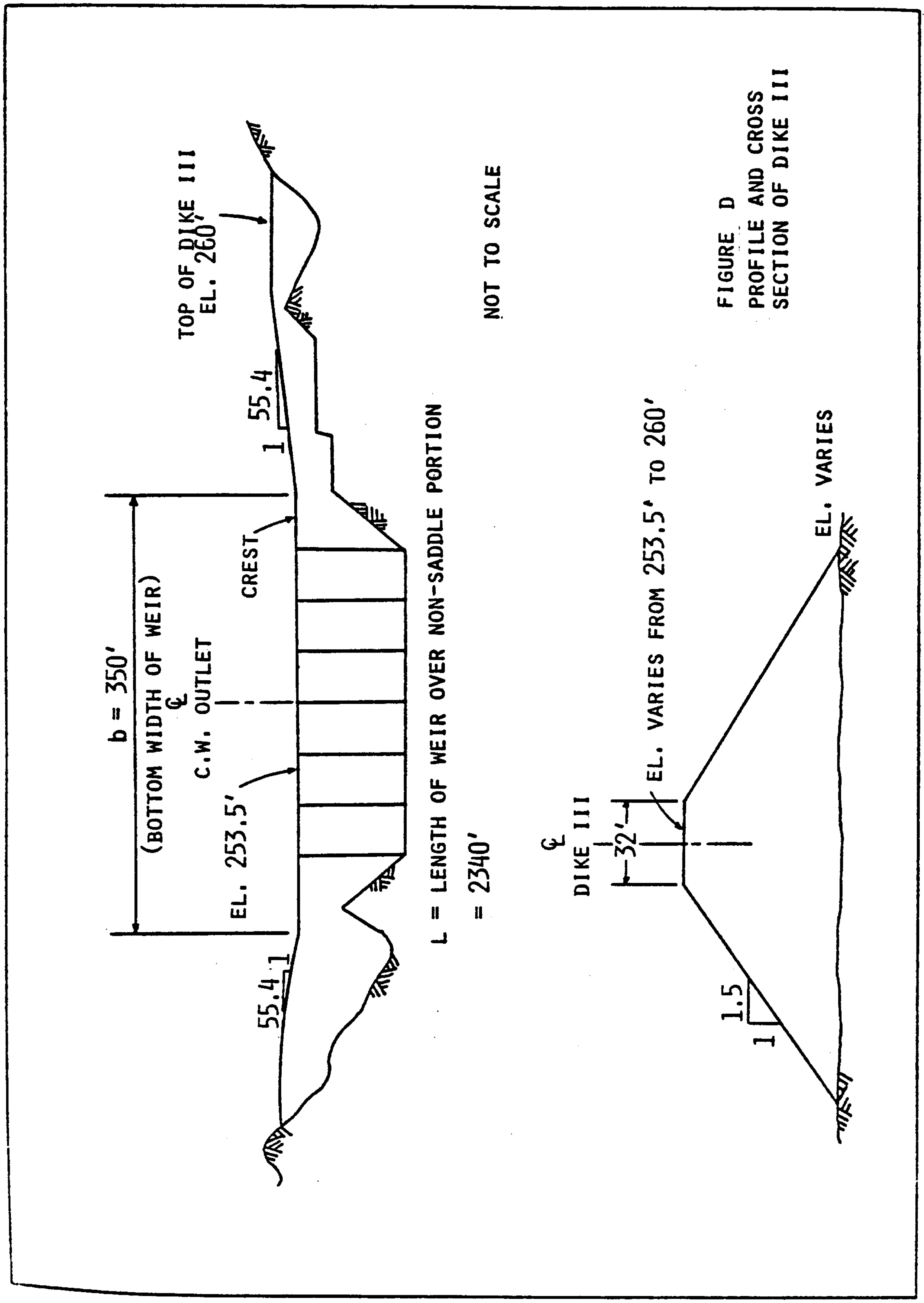

FIGURE D
PROFILE AND CROSS SECTION OF DIKE III

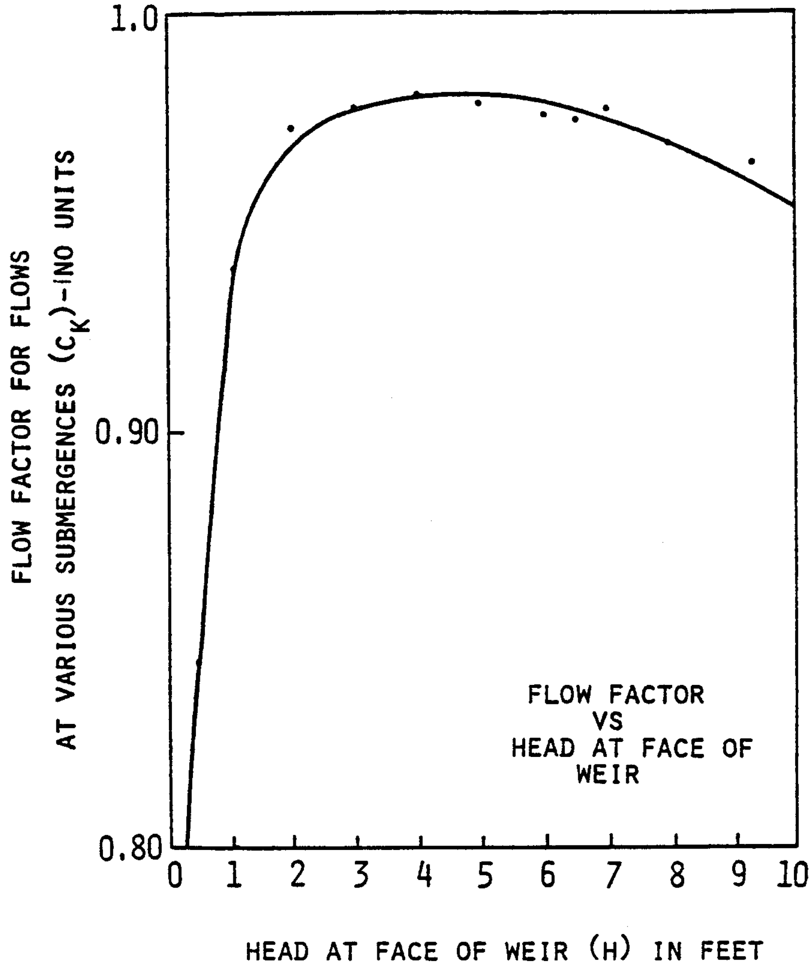

FIGURE E
FLOW FACTOR

N02FA423

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AUTHOR | PROGRAM NAME *Lake Anna Main Reservoir Inflow Estimation* | PROGRAM NUMBER | DATE | PAGE 1 OF 2

STATEMENT NO. | CONT | FORTRAN STATEMENT → | IDENTIFICATION

```
I10
ICASE
 NUMBER ØF CASES TØ BE PERFØRMED

20A4
TIT(I),I=1,20
 JØB IDENTIFICATIØN CARD NØ.1

20A4
TI1(I),I=1,20
 JØB IDENTIFICATIØN CARD NØ.2

20A4
TI2(I),I=1,20
 JØB IDENTIFICATIØN CARD NØ.3

I10
JMAX
 TØTAL NUMBER ØF STEPS TØ BE USED IN THE CALCULATIØN

    F10.2      F10.2      F10.2      F10.2      F10.2      F10.2
DT         HI         QC         AN         HSAD       TW
 DT   -  TIME STEP IN HR.
 HI   -  INITIAL WATER LEVEL IN FT.
 QC   -  PLANT CØØLING WATER DISCHARGE IN CFS
 AN   -  MANNING CØEFFICIENT
 HSAD -  SADDLE PØINT ELEVATIØN FØR DIKE NØ.3 IN FT.
 TW   -  TIME STEPS WITHIN AN HR.
```

N02FA424

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AUTHOR | PROGRAM NAME | PROGRAM NUMBER | DATE | PAGE 2 OF 4

STATEMENT NO. | CONT | FORTRAN STATEMENT | IDENTIFICATION

```
4F10.2
HD(I), I=1,4
 HD - DIKE ELEVATIONS FOR DIKE 1,2,3,AND 4 ABOVE WHICH BROAD CREST WEIR FLOWS
      WOULD OCCUR IN FT.

4F10.2
DL(I), I=1,4
 DL - DIKE LENGTHS FOR DIKE 1,2,3,AND 4 IN FT.

4F10.2
WL(I), I=1,4
 WL - DIKE WIDTHS FOR DIKE 1,2,3,AND 4 IN FT.

3F10.2
HCA(I), I=1,3
 HCA - CANAL BOTTOM LEVELS FOR CANAL 1,2,AND 3 IN FT.

3F10.2
HCT(I), I=1,3
 HCT - CANAL ELEVATIONS FOR BERM SECTIONS FOR CANAL 1,2,AND 3 IN FT.

3F10.2
AL(I), I=1,3
 AL - CANAL LENGTHS FOR CANAL 1,2,AND 3 IN FT.
```

N02FA425

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AUTHOR | PROGRAM NAME | PROGRAM NUMBER | DATE | PAGE 3 OF 4

```
8F10.2
.......
.......
8F10.2
((Q(I,J),J=1,JMAX),I=1,4)
 Q - INFLOWS TO THE COMPONENT RESERVOIRS OF THE WHTF IN CFS

8F10.2
(HR(J),J=1,JMAX)
 HR - RECORDED MAIN RESERVOIR STAGES IN FT.

8F10.2
(QS(J),J=1,JMAX)
 QS - GENERATED MAIN RESERVOIR SPILLWAY OUTFLOWS BY RECORDED RESERVOIR STAGES
      AND GATE OPENING IN CFS

8F10.2
(QPR(J),J=1,JMAX)
 QPR - PRECIPITATION ON MAIN RESERVOIR IN IN/HR

8F10.2
(QP(1,J),J=1,JMAX)
 QP(1,J) - PRECIPITATION ON COMPONENT RESERVOIR NO. 1 IN IN/HR
           IN THE PROGRAM, THE PRECIPITATION ON ALL COMPONENT RESERVOIRS OF
           THE WHTF ARE MADE IDENTICAL
```

N02FA426

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AUTHOR	PROGRAM NAME	PROGRAM NUMBER	DATE	PAGE 4 OF 4
				IDENTIFICATION

STATEMENT NO. | CONT | FORTRAN STATEMENT →

5 SETS —

```
I10
NF(I)
 NF  -  NUMBER OF DATA POINTS USED ON ELEV. VS AREA CURVE
8F10.2
SF10.2
A(I,J),J=1,2*NF(I)
 A  -  ELEV. AND AREA ALTERNATELY FOR POINTS DEFINING ELEV. VS AREA CURVE
       ELEV. IN FT.  AREA IN ACRE
I10
NG(I)
 NG(I) - NUMBER OF DATA POINTS OF FLOW FACTOR CURVE FOR FLOW OVER THE DIKE
8F10.2
CF10.12
G(I,J),J=1,2*NG(I)
G(I,J) - HEAD AND FLOW FACTOR ALTERNATLLY FOR DIKE FLOW FACTOR CURVE
         HEAD IN FT.  FLOW FACTOR DIMENSIONLESS.
```

N02FA427

INPUT SAMPLE

```
 1
** LAKE INFLOW COMPUTATION **
   **  JUNE 72 STORM, UNSMOOTHED STAGE DATA **
   ** NORMAL DIKE DISCHARGE, NORMAL LAKE $ WHTF AREA **
   120
   1.0     232.50     0.0       .03      253.5     240.
 260.0     260.0    260.0     260.0
3890.0    3740.0   2340.0     400.0
  20.0      20.0     32.0      25.0
 227.0     227.0    227.0
 255.0     255.0    255.0
3910.0    3000.0   4310.0
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
    0.        1.       2.        1.        1.        0.        0.        1.
    1.        1.       0.        0.        0.        0.        0.        2.
    3.       16.      30.       70.      295.      663.      836.      792.
  696.      538.     395.      316.      243.      191.      167.      140.
   91.       49.      28.       17.        9.        4.        2.        1.
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
    0.        0.       0.       10.       17.       11.        5.       12.
   29.       31.      18.        6.        4.       13.       21.       13.
    6.        3.       1.        1.        0.        0.        0.        0.
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
    0.        0.       0.        0.        0.        0.       10.       17.
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
    0.       10.      19.       14.        9.        5.        3.        8.
   12.        9.       5.        3.        2.        1.        1.       16.
   26.      129.     242.      576.     2387.     5401.     7129.     7298.
 6883.     5717.    4566.     3779.     3028.     2467.     2121.     1777.
 1294.      862.     589.      406.      266.      174.      113.       73.
   47.       31.      20.       12.        8.        5.        3.        2.
    1.        0.       0.       75.      136.      100.       64.      114.
  249.      275.     191.      119.       72.      134.      189.      137.
   87.       53.      35.       21.       14.        9.        6.        4.
    3.        2.       1.        1.        0.        0.        0.        0.
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
   0.0       0.0      0.0       0.0       0.0       0.0      77.      138.
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
    0.        5.       9.        7.        3.        2.        1.        3.
    5.        4.       2.        1.        0.        0.        0.        7.
   14.       61.     117.      272.     1129.     2603.     3418.     3338.
 2966.     2365.    1767.     1410.     1100.      868.      750.      630.
  428.      242.     142.       89.       49.       24.       12.        5.
    3.        1.       0.        0.        0.        0.        0.        0.
    0.        0.       0.       35.       67.       48.       24.       48.
  115.      130.      82.       41.       20.       52.       85.       59.
   29.       15.       7.        4.        2.        1.        0.        0.
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
   0.0       0.0      0.0       0.0       0.0       0.0       0.0       0.0
```

N02FA428

0.0	0.0	0.0	0.0	0.0	0.0	36.	69.
232.50	232.50	232.50	232.50	232.50	232.50	232.50	232.50
232.50	232.50	232.50	232.50	232.50	232.50	232.50	232.50
232.50	232.50	232.50	232.50	232.50	232.50	232.50	232.50
232.50	232.50	232.50	232.50	232.50	232.50	232.50	232.50
232.50	232.50	232.52	232.55	232.60	232.65	233.08	233.50
234.00	234.50	234.98	235.45	235.92	236.40	236.88	237.35
237.72	238.10	238.50	238.90	239.00	239.00	239.00	239.00
239.00	239.00	238.94	238.87	238.80	238.75	238.75	238.75
238.75	238.75	238.75	238.75	238.75	238.75	238.75	238.75
238.78	238.81	238.84	238.87	238.90	238.90	238.90	238.90
238.90	238.90	238.90	238.90	239.00	239.00	239.00	239.10
239.20	239.40	239.40	239.40	239.50	239.40	239.40	239.40
239.40	239.40	239.30	239.40	239.30	239.40	239.40	239.30
239.30	239.30	239.30	239.30	239.35	239.40	239.40	239.40
239.40	239.45	239.45	239.45	239.45	239.45	239.45	239.45
225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00
225.00	225.00	247.00	247.00	232.00	227.00	228.00	225.00
225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00
225.00	227.00	227.00	225.00	225.00	225.00	227.00	227.00
227.00	228.00	227.00	227.00	227.00	227.00	227.00	227.00
227.00	227.00	225.00	227.00	228.00	228.00	230.00	230.00
1744.00	7433.00	22654.00	2997[illegible].00	31334.00	31334.00	31334.00	31334.00
31334.00	23125.00	23125.00	22940.00	19143.00	16590.00	12850.00	10578.00
9317.00	7634.00	6860.00	4135.00	4135.00	230.00	230.00	230.00
230.00	230.00	230.00	230.00	230.00	230.00	230.00	230.00
230.00	230.00	230.00	230.00	230.00	230.00	230.00	230.00
230.00	230.00	230.00	230.00	230.00	230.00	230.00	230.00
230.00	230.00	230.00	230.00	230.00	230.00	230.00	230.00
230.00	230.00	230.00	230.00	230.00	230.00	230.00	230.00
230.00	230.00	230.00	230.00	230.00	230.00	230.00	230.00
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.03	0.0	0.0	0.07
0.0	0.13	0.07	0.09	0.0	0.03	0.0	0.07
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07
0.0	0.13	0.07	0.31	1.02	1.14	0.66	0.66
0.51	0.36	0.58	0.34	0.23	0.25	0.26	0.12
0.05	0.08	0.10	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.07	0.0	0.03	0.03	0.07
0.09	0.0	0.03	0.00	0.0	0.09	0.0	0.0

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0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.07	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.08
0.0	0.16	0.08	0.09	0.0	0.01	0.0	0.08
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.08
0.0	0.16	0.08	0.33	1.13	1.34	0.78	0.78
0.57	0.24	0.38	0.23	0.19	0.19	0.20	0.10
0.02	0.03	0.04	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.08	0.0	0.01	0.01	0.08
0.09	0.0	0.01	0.0	0.0	0.09	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.08	0.0
10							
190.00	0.0	200.00	6.1	210.00	20.4	220.00	44.2
230.00	85.0	240.00	'142.8	250.00	231.2	255.00	318.2
260.00	374.0	270.00	573.9				
10							
190.00	0.0	200.00	55.3	210.00	184.2	220.00	399.1
230.00	767.5	240.00	1289.4	250.00	2087.6	255.00	2873.5
260.00	3377.0	270.00	5102.2				
10							
190.00	0.	200.00	28.1	210.00	93.6	220.00	202.8
230.00	390.0	240.00	655.2	250.00	1060.8	255.00	1460.2
260.00	1716.0	270.00	2633.3				
10							
190.00	0.0	200.00	.5	210.00	1.8	220.00	3.9
230.00	7.5	240.00	12.6	250.00	20.4	255.00	28.1
260.00	33.0	270.00	50.6				
10							
180.00	0.	190.00	280.0	200.00	960.0	210.00	2100.0
220.00	3500.0	230.00	5010.0	240.00	6950.0	250.00	9540.0
260.00	12150.0	270.00	15310.0				
15							
.00	.000	.20	.000	.50	.845	1.00	.940
1.50	.961	2.00	.970	3.00	.978	4.00	.981
5.00	.981	6.00	.979	7.00	.975	8.00	.970
9.00	.962	10.00	.955	15.00	.900		

N02FA430

SOURCE LISTING

```
C
C  NORTH ANNA POWER STATION FLOOD STUDY
C    EFFECTS OF DIFFERENT WATER LEVELS BETWEEN LAKE ANNA AND WHTF
C
      EXTERNAL DERIV4
      COMMON /B/DT,T,QC,TW
      COMMON/CK/HD(4),QD(4),QE(4),NG(5),G(5,30),HSAD,  DL(4),WL(4)
      COMMON/D/Q(4,200),QP(4,200),H(4,200),NF(5),A(5,30)
      COMMON /EE/E(10)
      COMMON/FK/HCA(3),HCT(3),AL(3),AN,QCA(3)
      COMMON/HH/HR(200)
      COMMON ISW
      DIMENSION QR(200),QPR(200),QS(200)
      DIMENSION TIT(20),TI1(20),TI2(20)
C  REAL IN NUMBER OF CASES TO BE PERFORMED
      READ(5,1)ICASE
    1 FORMAT(3I10)
C  READ IN JOB IDENTIFICATION CARD NO. 1
      READ(5,30)(TIT(I),I=1,20)
   30 FORMAT(20A4)
      WRITE(6,31)(TIT(I),I=1,20)
    2 FORMAT(1H0,'CASE ',I3)
   31 FORMAT(1H1,20A4)
   32 FORMAT(//20A4)
      DO 1000 II=1,ICASE
      WRITE(6,2)II
C  READ IN JOB IDENTIFICATION CARD NO. 2
      READ(5,30)(TI1(I),I=1,20)
      WRITE(6,32) (TI1(I),I=1,20)
C  READ IN JOB IDENTIFICATION CARD NO. 3
      READ(5,30)(TI2(I),I=1,20)
      WRITE(6,32) (TI2(I),I=1,20)
C  READ IN TOTAL NUMBER OF DT'S TO BE COMPUTED
      READ(5,1)JMAX
C  READ IN TIMESTEP,INITIAL WATER LEVEL,PLANT COOLING WATER DISCHARGE,
C  MANNING COEFFICIENT,SADDLE POINT ELEVATION FOR DIKE 3,NUMBER OF STEPS WITHIN
C  TIME STEP DT
      READ(5,3)DT,HI,QC,AN,HSAD,TW
    3 FORMAT(6F10.2)
      WRITE(6,4)DT,HI,QC,AN,HSAD,TW
    4 FORMAT(///,3X,'DT(HR.)',3X,'HI(FT)',4X,'QC(CFS)',8X,'N',
     113X,'HSADDLE(FT)',2X,'TW(STEP)',//6F10.2)
C  READ IN DIKE CHARACTERISTICS
      READ(5,3)(HD(I),I=1,4)
      READ(5,3) (DL(I),I=1,4)
      READ(5,3) (WL(I),I=1,4)
C  READ IN CANAL CHARACTERISTICS
      READ(5,3)(HCA(I),I=1,3)
      READ(5,3)(HCT(I),I=1,3)
      READ(5,3)(AL(I),I=1,3)
      WRITE(6,63)
   63 FORMAT(18X,'DIKE ELE',7X,'DIKE WIDTH',5X,'DIKE LENGTH'
     1/20X,'(FT)',11X,'(FT)',11X,'(FT)')
      WRITE(6,60)(I,HD(I),WL(I),DL(I),I=1,4)
   60 FORMAT(5X,I5,5X,F10.2,5X,F10.2,5X,F10.2)
      WRITE(6,64)
```

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   64 FORMAT(18X,'CANAL ELE 1',4X,'CANAL ELE 2',4X,'CANAL LENGTH'
     1/20X,'(FT)',11X,'(FT)',11X,'(FT)')
      WRITE(6,60)(I,HCA(I),HCT(I),AL(I),I=1,3)
C     READ IN INFLOWS TO THE WHTF COMPONENT RESERVOIRS
      READ(5,3)((Q(I,J),J=1,JMAX),I=1,4)
C     READ IN RECORDED LAKE STAGE
      READ(5,3)(HR(J),J=1,JMAX)
C     READ IN RECORDED SPILLWAY DISCHARGE
      READ(5,3)(QS(J),J=1,JMAX)
C     READ IN PRECIPITATION ON MAIN RESERVOIR
      READ(5,3)(QPR(J),J=1,JMAX)
C     READ IN PRECIPITATION ON THE WHTF COMPONENT RESERVOIR
      READ(5,3)(QP(1,J),J=1,JMAX)
      WRITE(6,5)
    5 FORMAT(///,9X,'Q1(CFS)',3X,'Q2(CFS)',3X,'Q3(CFS)',3X,'Q4(CFS)',3X,
     1'HR(FT)',4X,'QS(CFS)',3X,'QPR(IN/HR)',2X,'QP(IN/HR)')
      WRITE(6,6)(J,(Q(I,J),I=1,4),HR(J),QS(J),QPR(J),QP(1,J),J=1,JMAX)
    6 FORMAT(1X,I4,  6F10.2,2F10.4)
    7 FORMAT(//,2X,'ELEV VS AREA FOR AREA ',I1//4(3X,'ELEV',6X,'AREA',3X
     1)/4(4X,'FT',7X,'ACRE',3X))
C     READ IN ELEVATION VERSUS AREA RELATIONSHIP
      DO 101 I=1,5
      READ(5,1)NF(I)
      NF(I)=2*NF(I)
      NFF=NF(I)
      READ(5,3)(A(I,J),J=1,NFF)
      DO 76 J=2,NFF,2
      A(I,J)=1.0*A(I,J)
   76 CONTINUE
      WRITE(6,7)I
      WRITE(6,3)(A(I,J),J=1,NFF)
  101 NF(I)=NF(I)-3
   16 FORMAT(//,2X,'FLOW FACTOR FOR FLOW OVER THE DIKES',
     1//4(3X,'HEAD',3X,'FLOW FACTOR')
     2//4(5X,'FT',        14X))
C     READ IN FLOW FACTOR CURVE FOR FLOW OVER THE DIKES
      DO 20 I=1,1
      READ(5,1)NG(I)
      NG(I)=2*NG(I)
      NGG=NG(I)
      READ(5,3)(G(I,J),J=1,NGG)
      WRITE(6,16)
      WRITE(6,3) (G(I,J),J=1,NGG)
      NG(I)=NG(I)-3
   20 CONTINUE
      T=DT
      DTT=1/DT/3600.
      DO 102 J=1,JMAX
      DO 102 I=2,4
  102 QP(I,J)=QP(1,J)
      DO 103 I=1,4
  103 H(I,1)=HI
      QR(1)=0.
      WRITE(6,11)
   11 FORMAT(//,2X,'FLOW THROUGH THE DIKES AND CANALS',//
     1(10X,'DIKE 1',4X,'DIKE 2',4X,'DIKE 3',4X,'DIKE 4',
```

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```
     23X,'CANAL A',3X,'CANAL B',3X,'CANAL C')//
     3(10X,'(CFS)',6(5X,'(CFS)')))
      DO 111 I=1,4
  111 E(I)=H(I,1)
      IW=TW
      ISW=0
C  TO COMPUTE THE WATER LEVELS AT THE WHTF COMPONENT RESERVOIRS USING
C  RUNGE KUTTA FOURTH ORDER EQUATIONS
      DO 110 J=2,JMAX
      DO 113 IJ=1,IW
      CALL RUNGS(DERIV4,4)
  113 T=T+DT/TW
      DO 15 I=1,4
C  TO COMPUTE THE FLOW THROUGH THE DIKES
      CALL QDF(HR(J),E(I),I)
      IF(I.EQ.4) GO TO 15
      L=I-1
      IF(L.LE.0) L=4
C  TO COMPUTE THE FLOW THROUGH THE CANALS
      CALL QCF(E(L),E(I),I)
   15 CONTINUE
      CALL LININT(NF(5),HR(J),A,ARR,5)
      WRITE(6,8)J,(QD(I),I=1,4),(QCA(I),I=1,3)
    8 FORMAT(I5,7F10.2)
C  TO COMPUTE THE INFLOW TO THE MAIN RESERVOIR
      QR(J)=QC+QS(J)+QD(1)+QD(2)+QD(3)+QD(4)+(HR(J)-HR(J-1))*
     1DTT*ARR*43560.-QPR(J)*ARR*43560./3600./12
      DO 112 I=1,4
  112 H(I,J)=E(I)
      IF(ISW.EQ.1) GO TO 77
  110 CONTINUE
   77 IF(ISW.EQ.1) JMAX=J
      WRITE(6,12)
      WRITE(6,9)(J,(H(I,J),I=1,4),HR(J),QR(J),J=1,JMAX)
   12 FORMAT(///,9X,'H1',8X,'H2',8X,'H3',8X,'H4',8X,'HR',8X,'QR'//
     1(9X,'FT',4(8X,'FT'),8X,'CFS'/))
    9 FORMAT(I5,6F10.2)
      WRITE(7,32) (TI1(I),I=1,20)
      WRITE(7,32) (TI2(I),I=1,20)
      WRITE(7,99)(QR(J),J=1,JMAX)
   99 FORMAT(10F8.0)
 1000 CONTINUE
      STOP
      END
```

N02FA433

```
      SUBROUTINE  RUNGS (DERIVE,NE)
C  THE PURPOSE OF THIS SUBROUTINE IS TO SOLVE THE SIMULTANEOUS EQUATIONS
C  USING RUNGE KUTTA ALGORITHM
      COMMON /AA/EP(10)
      DIMENSION W1(10),W2(10),W3(10),W4(10),Z(10)
      COMMON /B/DT,T,OC,TW
      COMMON /EE/E(10)
      CALL DERIVE (E,-1)
      DO 2 I=1,NE
      W1(I)=DT*EP(I)*3600./TW
    2 Z(I)=E(I)+W1(I)*0.5
      CALL DERIVE (Z,0)
      DO 3 I=1,NE
      W2(I)=DT*EP(I)*3600./TW
    3 Z(I)=E(I)+W2(I)*0.5
      CALL DERIVE (Z,0)
      DO 4 I=1,NE
      W3(I)=DT*EP(I)*3600./TW
    4 Z(I)=E(I)+W3(I)
      CALL DERIVE (Z,1)
      DO 5 I=1,NE
      W4(I)=DT*EP(I)*3600./TW
    5 E(I)=E(I)+(2.*(W2(I)+W3(I))+W1(I)+W4(I))/6.
      RETURN
      END
```

N02FA434

```
      SUBROUTINE DERIV4 (E,K)
C     THIS SUBROUTINE IS TO EVALUATE THE DERIVATIVE TERM IN THE EQUATION
      DIMENSION E(10),AR(5),QR(5),QPR(5)
      DIMENSION DQ(4)
      COMMON /AA/EP(10)
      COMMON /B/DT,T,CC,TW
      COMMON/LK/HD(4),QD(4),QE(4),NG(5),G(5,30),HSAD,  DL(4),WL(4)
      COMMON/C/Q(4,200),QP(4,200),H(4,200),NF(5),A(5,30)
      COMMON/FK/HCA(3),HCT(3),AL(3),AN,QCA(3)
      COMMON/HH/HR(200)
      IT=T/DT+.0001
      DO 99 I=1,4
      DHR=HR(IT+1)-HR(IT)
      DQ(I)=Q(I,IT+1)-Q(I,IT)
   99 CONTINUE
      TINC1=T/DT-IT
      TINC2=TINC1+1/TW
      IF(K)1,2,3
    1 DO 100 I=1,4
      QR(I)=Q(I,IT)+TINC1*DQ(I)
  100 QPR(I)=QP(I,IT)
      HRR=HR(IT)+TINC1*DHR
      GO TO 4
    2 DO 101 I=1,4
      QR(I)=(Q(I,IT)+Q(I,IT+1)+(TINC1+TINC2)*DQ(I))*.5
  101 QPR(I)=QP(I,IT)
      HRR=(HR(IT)+HR(IT+1)+(TINC1+TINC2)*DHR)*.5
      GO TO 4
    3 DO 102 I=1,4
      QR(I)=Q(I,IT)+TINC2*DQ(I)
  102 QPR(I)=QP(I,IT)
      HRR=HR(IT)+TINC2*DHR
    4 CONTINUE
      DO 103 I=1,4
      CALL QDF(HRR,E(I),I)
      IF(I.EQ.4) GO TO 103
      L=I-1
      IF(L.LE.0) L=4
      CALL QCF(E(L),E(I),I)
  103 CALL LININT(NF(I),E(I),A,AR(I),I)
      EP(1)=(QR(1)+QD(1)+QCA(1)-QCA(2))/AR(1)/43560.+QPR(1)/3600./12.
      EP(2)=(QR(2)+QD(2)+QCA(2)-QCA(3))/AR(2)/43560.+QPR(2)/3600./12.
      EP(3)=(QR(3)+QD(3)+QCA(3)       )/AR(3)/43560.+QPR(3)/3600./12.
      EP(4)=(QR(4)+QD(4)+QC     -QCA(1))/AR(4)/43560.+QPR(4)/3600./12.
      RETURN
      END
```

N02FA435

```
      SUBROUTINE LININT(N ,X,F,FF,I)
C     THIS SUBROUTINE IS A LINEAR INTERPOLATION
      DIMENSION F(5,30)
      COMMON ISW
      DO 2 K=1,N,2
      IF(X.GE.F(I,K).AND.X.LE.F(1,K+2)) GO TO 3
    2 CONTINUE
      NO=N+3
      WRITE(6,4) I,NO,X
      WRITE(6,5)(F(I,J),J=1,NO)
    4 FORMAT(/8X,'I',8X,'NO',9X,'X'//2(5X,I5),F10.2//)
    5 FORMAT(8(2X,F10.2))
      ISW=1
      RETURN
    3 X1=F(I,K)
      X2=F(I,K+2)
      Y1=F(I,K+1)
      Y2=F(I,K+3)
      FF=Y1+(X-X1)*(Y2-Y1)/(X2-X1)
      RETURN
      END
```

N02FA436

```
      SUBROUTINE QDF(HR,H,I)
C     THIS SUBROUTINE IS TO COMPUTE THE FLOW THROUGH THE DIKES
      COMMON/CK/HD(4),QD(4),QE(4),NG(5),G(5,30),HSAD,  DL(4),WL(4)
      DLH=HR-H
      DLHS=ABS(DLH)
      QE(I)=0.
      QD(I)=0.
      HMA=HR
      IF(HR.LT.H)HMA=H
      HMI=H
      IF(HR.LT.H)HMI=HR
      IF(I.EQ.3) QD(I)=8200.0*DLHS**.5
      IF(HR.LE.HD(I).AND.H.LE.HD(I)) GO TO 1
      HMAX=HMA-HD(I)
      HMIN=HMI-HD(I)
      IF(HMIN.LT.0.) HMIN=0.
      HRAT=HMIN/HMAX
      IF(HRAT.GT.0.85) GO TO 2
      RE=3.80*10.0**5*HMAX**1.5
      C=1.0-(0.069*(WL(I)/HMAX-1.0+2.35*RE**0.25)**0.80*RE**(-0.20))
      CD=0.667*(0.667*32.2)**0.5*C
      QE(I)=QE(I)+CD*DL(I)*HMAX**1.5
      GO TO 1
    2 CALL LININT(NG(1),HMAX,G,CKH,1)
      QE(I)=CKH*DL(I)*HMAX*HRAT*(2.0*32.2*HMAX*(1.0-HRAT))**0.5
    1 IF(I.NE.3) GO TO 9
      IF(HR.LE.HSAD.AND.H.LE.HSAD) GO TO 9
      HMAX=HMA-HSAD
      HMIN=HMI-HSAD
      IF(HMIN.LT.0.) HMIN=0.
      HRAT=HMIN/HMAX
      IF(HRAT.GT.0.85) GO TO 4
      RE=3.80*10.0**5*HMAX**1.5
      C=1.0-(0.069*(WL(I)/HMAX-1.0+2.35*RE**0.25)**0.80*RE**(-0.20))
      CD=0.667*(0.667*32.2)**0.5*C
      IF(HMAX.LE.6.5)H1=0.
      IF(HMAX.GT.6.5)H1=HMAX-6.5
      QE(I)=QE(I)+CD*(350.0*HMAX**1.5+0.8*55.4*(HMAX**2.5-H1**2.5))
      GO TO 9
    4 CONTINUE
      SIGH=HRAT*HMAX
      PAR=55.4*SIGH**2
      CALL LININT(NG(1),HMAX,G,CKH,1)
      IF(PAR.GT.2341.0) GO TO 8
      QE(I)=QE(I)+CKH*(350.0*SIGH+PAR)*(2.0*32.2*HMAX*(1.0-HRAT))**0.5
      GO TO 9
    8 QE(I)=QE(I)+CKH*(1070.0*(SIGH- 6.5)+4616.0)*(2.0*32.2*HMAX*
     1(1.0-HRAT))**0.5
    9 QD(I)=QD(I)+QE(I)
      IF(HR.LT.H) QD(I)=-QD(I)
      RETURN
      END
```

N02FA437

```
      SUBROUTINE QCF(HU,HD,I)
C     THIS SUBROUTINE IS TO COMPUTE THE FLOW THROUGH THE CANALS
      COMMON/FK/HCA(3),HCT(3),AL(3),AN,QCA(3)
      DLH=HU-HD
      DLHS=ABS(DLH)
      S=DLHS/AL(I)
      H=(HU+HD)/2.
      IF(H.GT.HCT(I)) GO TO 1
      IF(H.GT.HCA(I)) GO TO 2
      QCA(I)=0.
      GO TO 4
    1 A=4760.+270.*(H-HCT(I))+2.5*(H-HCT(I))**2
      P=280.78+5.385*(H-HCT(I))
      GO TO 3
    2 A=(100.+2.5*(H-HCA(I)))*(H-HCA(I))
      P=100.+5.385*(H-HCA(I))
    3 R=A/P
      QCA(I)=1.486*R**(2./3.)*S**0.5*A/AN
      IF(DLH.LT.0.) QCA(I)=-QCA(I)
    4 RETURN
      END
```

N02FA438

** LAKE INFLOW COMPUTATION **

OUTPUT SAMPLE

CASE 1

** JUNE 72 STORM, UNSMOOTHED STAGE DATA **

** NORMAL DIKE DISCHARGE, NORMAL LAKE $ WHTF AREA **

DT(HR.)	HI(FT)	QC(CFS)	N	HSADDLE(FT)	TW(STEP)
1.00	232.50	0.0	0.03	253.50	240.00

	DIKE ELE (FT)	DIKE WIDTH (FT)	DIKE LENGTH (FT)
1	260.00	20.00	3890.00
2	260.00	20.00	3740.00
3	260.00	32.00	2340.00
4	260.00	25.00	400.00

	CANAL ELE 1 (FT)	CANAL ELE 2 (FT)	CANAL LENGTH (FT)
1	227.00	255.00	3910.00
2	227.00	255.00	3000.00
3	227.00	255.00	4310.00

	Q1(CFS)	Q2(CFS)	Q3(CFS)	Q4(CFS)	HR(FT)	QS(CFS)	QPR(IN/HR)	QP(IN/HR)
1	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
2	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
3	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
4	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
5	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
6	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
7	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
8	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
9	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
10	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
11	0.0	0.0	0.0	0.0	232.50	247.00	0.0	0.0
12	0.0	0.0	0.0	0.0	232.50	247.00	0.0	0.0
13	0.0	0.0	0.0	0.0	232.50	232.00	0.0300	0.0100
14	0.0	0.0	0.0	0.0	232.50	227.00	0.0	0.0
15	0.0	0.0	0.0	0.0	232.50	228.00	0.0	0.0
16	0.0	0.0	0.0	0.0	232.50	225.00	0.0700	0.0800
17	0.0	0.0	0.0	0.0	232.50	225.00	0.0	0.0
18	1.00	10.00	5.00	0.0	232.50	225.00	0.1300	0.1600
19	2.00	19.00	9.00	0.0	232.50	225.00	0.0700	0.0800
20	1.00	14.00	7.00	0.0	232.50	225.00	0.0900	0.0900
21	1.00	9.00	3.00	0.0	232.50	225.00	0.0	0.0
22	0.0	5.00	2.00	0.0	232.50	225.00	0.0300	0.0100
23	0.0	3.00	1.00	0.0	232.50	225.00	0.0	0.0
24	1.00	8.00	3.00	0.0	232.50	225.00	0.0700	0.0800
25	1.00	12.00	5.00	0.0	232.50	225.00	0.0	0.0
26	1.00	9.00	4.00	0.0	232.50	227.00	0.0	0.0
27	0.0	5.00	2.00	0.0	232.50	227.00	0.0	0.0
28	0.0	3.00	1.00	0.0	232.50	225.00	0.0	0.0
29	0.0	2.00	0.0	0.0	232.50	225.00	0.0	0.0
30	0.0	1.00	0.0	0.0	232.50	225.00	0.0	0.0
31	0.0	1.00	0.0	0.0	232.50	227.00	0.0	0.0
32	[illegible].00	16.00	7.00	0.0	232.50	227.00	0.0700	0.0800

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34	16.00	129.00	61.00	0.0	232.50	228.00	0.1200	0.1600
35	30.00	242.00	117.00	0.0	232.52	227.00	0.0700	0.0800
36	70.00	576.00	272.00	0.0	232.55	227.00	0.3100	0.3300
37	295.00	2387.00	1129.00	0.0	232.60	227.00	1.0200	1.1300
38	663.00	5401.00	2603.00	0.0	232.65	227.00	1.1400	1.3400
39	836.00	7129.00	3418.00	0.0	233.08	227.00	0.6600	0.7800
40	792.00	7298.00	3338.00	0.0	233.50	227.00	0.6600	0.7800
41	698.00	6883.00	2986.00	0.0	234.00	227.00	0.5100	0.5700
42	538.00	5717.00	2365.00	0.0	234.50	227.00	0.3600	0.2400
43	395.00	4566.00	1767.00	0.0	234.98	225.00	0.5800	0.3800
44	316.00	3779.00	1410.00	0.0	235.45	227.00	0.3400	0.2300
45	243.00	3028.00	1100.00	0.0	235.92	228.00	0.2300	0.1900
46	191.00	2467.00	868.00	0.0	236.40	228.00	0.2300	0.1900
47	167.00	2121.00	750.00	0.0	236.68	230.00	0.2600	0.2000
48	140.00	1777.00	630.00	0.0	237.35	230.00	0.1200	0.1000
49	91.00	1294.00	428.00	0.0	237.72	1744.00	0.0500	0.0200
50	49.00	862.00	242.00	0.0	238.10	7433.00	0.0800	0.0300
51	28.00	569.00	142.00	0.0	238.50	22654.00	0.1000	0.0400
52	17.00	406.00	89.00	0.0	238.90	29473.00	0.0	0.0
53	9.00	266.00	49.00	0.0	239.00	31334.00	0.0	0.0
54	4.00	174.00	24.00	0.0	239.00	31334.00	0.0	0.0
55	2.00	113.00	12.00	0.0	239.00	31334.00	0.0	0.0
56	1.00	73.00	5.00	0.0	239.00	31334.00	0.0	0.0
57	0.0	47.00	3.00	0.0	239.00	31334.00	0.0	0.0
58	0.0	31.00	1.00	0.0	239.00	23125.00	0.0	0.0
59	0.0	20.00	0.0	0.0	238.94	23125.00	0.0	0.0
60	0.0	12.00	0.0	0.0	238.87	22940.00	0.0	0.0
61	0.0	8.00	0.0	0.0	238.80	19143.00	0.0	0.0
62	0.0	5.00	0.0	0.0	238.75	16590.00	0.0	0.0
63	0.0	3.00	0.0	0.0	238.75	12850.00	0.0	0.0
64	0.0	2.00	0.0	0.0	238.75	10578.00	0.0	0.0
65	0.0	1.00	0.0	0.0	238.75	9317.00	0.0	0.0
66	0.0	0.0	0.0	0.0	238.75	7634.00	0.0	0.0
67	0.0	0.0	0.0	0.0	238.75	6860.00	0.0	0.0
68	10.00	75.00	35.00	0.0	238.75	4135.00	0.0700	0.0800
69	17.00	136.00	67.00	0.0	238.75	4135.00	0.0	0.0
70	11.00	100.00	48.00	0.0	238.75	230.00	0.0300	0.0100
71	5.00	64.00	24.00	0.0	238.75	230.00	0.0300	0.0100
72	12.00	114.00	48.00	0.0	238.75	230.00	0.0700	0.0800
73	29.00	249.00	115.00	0.0	238.78	230.00	0.0900	0.0900
74	31.00	275.00	130.00	0.0	238.81	230.00	0.0	0.0
75	18.00	191.00	82.00	0.0	238.84	230.00	0.0300	0.0100
76	8.00	119.00	41.00	0.0	238.87	230.00	0.0	0.0
77	4.00	72.00	20.00	0.0	238.90	230.00	0.0	0.0
78	13.00	134.00	52.00	0.0	238.90	230.00	0.0900	0.0900
79	21.00	189.00	85.00	0.0	238.90	230.00	0.0	0.0
80	13.00	137.00	59.00	0.0	238.90	230.00	0.0	0.0
81	6.00	87.00	29.00	0.0	238.90	230.00	0.0	0.0
82	3.00	53.00	15.00	0.0	238.90	230.00	0.0	0.0
83	1.00	33.00	7.00	0.0	238.90	230.00	0.0	0.0
84	1.00	21.00	4.00	0.0	238.90	230.00	0.0	0.0
85	0.0	14.00	2.00	0.0	234.00	230.00	0.0	0.0
86	0.0	9.00	1.00	0.0	239.00	230.00	0.0	0.0
87	0.0	6.00	0.0	0.0	239.00	230.00	0.0	0.0
88	0.0	4.00	0.0	0.0	239.10	230.00	0.0	0.0
89	0.0	3.00	0.0	0.0	239.20	230.00	0.0	0.0
90	0.0	2.00	0.0	0.0	239.40	230.00	0.0	0.0
91	0.0	1.00	0.0	0.0	239.40	230.00	0.0	0.0
92	0.0	1.00	0.0	0.0	239.40	230.00	0.0	0.0
93	0.0	0.0	0.0	0.0	239.50	230.00	0.0	0.0
94	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
95	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0

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97	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
98	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
99	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
100	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
101	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
102	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
103	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
104	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
105	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
106	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
107	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
108	0.0	0.0	0.0	0.0	239.30	230.00	0.0	0.0
109	0.0	0.0	0.0	0.0	239.35	230.00	0.0	0.0
110	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
111	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
112	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
113	0.0	0.0	0.0	0.0	239.40	230.00	0.0	0.0
114	0.0	0.0	0.0	0.0	239.45	230.00	0.0	0.0
115	0.0	0.0	0.0	0.0	239.45	230.00	0.0	0.0
116	0.0	0.0	0.0	0.0	239.45	230.00	0.0	0.0
117	0.0	0.0	0.0	0.0	239.45	230.00	0.0	0.0
118	0.0	0.0	0.0	0.0	239.45	230.00	0.0	0.0
119	10.00	77.00	36.00	0.0	239.45	230.00	0.0700	0.0800
120	17.00	138.00	69.00	0.0	239.45	230.00	0.0	0.0

ELEV VS AREA FOR AREA 1

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	6.10	210.00	20.40	220.00	44.20
230.00	85.00	240.00	142.80	250.00	231.20	255.00	318.20
260.00	374.00	270.00	573.90				

ELEV VS AREA FOR AREA 2

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	55.30	210.00	184.20	220.00	399.10
230.00	767.50	240.00	1289.40	250.00	2087.60	255.00	2873.50
260.00	3377.00	270.00	5182.20				

ELEV VS AREA FOR AREA 3

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	28.10	210.00	93.60	220.00	202.80
230.00	390.00	240.00	655.20	250.00	1060.80	255.00	1460.20
260.00	1716.00	270.00	2633.30				

ELEV VS AREA FOR AREA 4

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
190.00	0.0	200.00	0.50	210.00	1.80	220.00	3.90
230.00	7.50	240.00	12.60	250.00	20.40	255.00	28.10
260.00	33.00	270.00	50.60				

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ELEV VS AREA FOR AREA 5

ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE	ELEV FT	AREA ACRE
180.00	0.0	190.00	280.00	200.00	960.00	210.00	2100.00
220.00	3500.00	230.00	5010.00	240.00	6950.00	250.00	9540.00
260.00	12150.00	270.00	15310.00				

FLOW FACTOR FOR FLOW OVER THE DIKES

HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR	HEAD FT	FLOW FACTOR
0.0	0.0	0.20	0.0	0.50	0.84	1.00	0.94
1.50	0.96	2.00	0.97	3.00	0.98	4.00	0.98
5.00	0.98	6.00	0.98	7.00	0.97	8.00	0.97
9.00	0.96	10.00	0.95	15.00	0.90		

FLOW THROUGH THE DIKES AND CANALS

	DIKE 1 (CFS)	DIKE 2 (CFS)	DIKE 3 (CFS)	DIKE 4 (CFS)	CANAL A (CFS)	CANAL B (CFS)	CANAL C (CFS)
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	−55.48	0.0	−21.42	12.63	39.06
18	0.0	0.0	0.0	0.0	−22.12	8.93	9.12
19	0.0	0.0	−169.49	0.0	−20.73	16.73	105.17
20	0.0	0.0	−139.62	0.0	−20.72	16.73	96.33
21	0.0	0.0	−139.62	0.0	−19.97	15.49	96.33
22	0.0	0.0	0.0	0.0	−22.12	6.31	5.27
23	0.0	0.0	0.0	0.0	−22.12	6.31	5.27
24	0.0	0.0	0.0	0.0	−22.12	6.31	5.27
25	0.0	0.0	−78.46	0.0	−20.70	12.63	52.68
26	0.0	0.0	0.0	0.0	−22.12	8.93	10.53
27	0.0	0.0	0.0	0.0	−22.12	6.31	5.27
28	0.0	0.0	0.0	0.0	−22.12	8.93	0.0
29	0.0	0.0	0.0	0.0	−22.12	8.93	0.0
30	0.0	0.0	0.0	0.0	−22.12	8.93	0.0
31	0.0	0.0	0.0	0.0	−22.12	8.93	0.0
32	0.0	0.0	0.0	0.0	−22.12	8.93	0.0
33	0.0	0.0	−106.24	0.0	−20.71	12.64	73.01
34	0.0	0.0	−150.24	0.0	−22.83	15.49	93.99
35	0.0	0.0	−798.21	0.0	−24.99	15.63	94.55
36	0.0	0.0	−995.03	0.0	−29.44	20.45	162.43
37	0.0	0.0	−1858.92	0.0	−35.00	59.73	491.46
38	0	0.0	−3562.96	0.0	−54.54	116.32	10[illegible]51
39	.0	0.0	−4263.77	0.0	−69.61	110.27	13[illegible].94

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41	0.0	0.0	-4220.11	0.0	-41.38	71.84	1875.18
42	0.0	0.0	-4067.47	0.0	-15.86	57.24	1880.17
43	0.0	0.0	-3808.49	0.0	23.66	33.06	1619.45
44	0.0	0.0	-3452.84	0.0	41.09	-31.63	1093.99
45	0.0	0.0	-2252.46	0.0	22.40	-146.92	-386.27
46	0.0	0.0	1297.56	0.0	23.53	-223.76	-1243.10
47	0.0	0.0	2437.32	0.0	24.79	-275.43	-1881.19
48	0.0	0.0	3245.29	0.0	39.90	-318.05	-2379.36
49	0.0	0.0	3621.37	0.0	65.22	-348.00	-2700.26
50	0.0	0.0	4214.39	0.0	80.90	-372.97	-3020.99
51	0.0	0.0	4812.15	0.0	89.49	-400.76	-3379.77
52	0.0	0.0	5326.05	0.0	98.41	-430.98	-3738.85
53	0.0	0.0	4674.37	0.0	118.37	-423.23	-3711.34
54	0.0	0.0	3913.59	0.0	137.29	-384.68	-3362.31
55	0.0	0.0	3325.70	0.0	160.23	-331.42	-2898.47
56	0.0	0.0	2763.24	0.0	179.10	-279.51	-2399.16
57	0.0	0.0	2188.70	0.0	196.60	-230.74	-1888.06
58	0.0	0.0	1601.56	0.0	213.77	-201.71	-1370.61
59	0.0	0.0	927.25	0.0	239.15	-54.60	216.52
60	0.0	0.0	-532.14	0.0	240.82	94.10	760.71
61	0.0	0.0	-814.12	0.0	238.92	110.46	934.87
62	0.0	0.0	-770.75	0.0	235.07	109.54	866.44
63	0.0	0.0	-290.06	0.0	229.16	-23.78	260.90
64	0.0	0.0	32.03	0.0	225.20	-85.69	19.83
65	0.0	0.0	32.03	0.0	225.20	-85.69	19.83
66	0.0	0.0	32.03	0.0	225.20	-85.69	0.0
67	0.0	0.0	32.03	0.0	225.20	-85.69	0.0
68	0.0	0.0	-71.62	0.0	225.21	-75.16	56.08
69	0.0	0.0	-323.50	0.0	226.29	-47.56	224.42
70	0.0	0.0	-143.25	0.0	225.23	-71.31	101.11
71	0.0	0.0	-96.09	0.0	225.21	-78.83	74.19
72	0.0	0.0	-132.07	0.0	225.23	-71.31	99.15
73	0.0	0.0	-645.41	0.0	220.51	-114.58	-182.71
74	0.0	0.0	-750.52	0.0	223.60	-104.67	-111.55
75	0.0	0.0	-478.33	0.0	225.38	-120.48	-249.52
76	0.0	0.0	-258.24	0.0	227.24	-123.34	-340.22
77	0.0	0.0	175.44	0.0	227.14	-126.18	-427.62
78	0.0	0.0	-132.07	0.0	234.30	-72.94	111.10
79	0.0	0.0	-396.20	0.0	234.46	-42.14	277.52
80	0.0	0.0	-175.44	0.0	234.31	-72.95	134.56
81	0.0	0.0	-78.46	0.0	234.28	-84.22	78.56
82	0.0	0.0	0.0	0.0	234.28	-67.66	49.68
83	0.0	0.0	45.30	0.0	235.24	-90.96	35.13
84	0.0	0.0	55.48	0.0	234.27	-87.65	28.68
85	0.0	0.0	1002.22	0.0	221.79	-173.08	-1042.59
86	0.0	0.0	548.29	0.0	233.41	-127.99	-463.93
87	0.0	0.0	78.46	0.0	239.76	-98.71	-50.43
88	0.0	0.0	1025.00	0.0	228.25	-175.67	-1054.68
89	0.0	0.0	1401.71	0.0	228.47	-194.40	-1285.81
90	0.0	0.0	2325.96	0.0	223.96	-233.17	-1843.49
91	0.0	0.0	1618.45	0.0	239.11	-207.94	-1366.59
92	0.0	0.0	949.15	0.0	251.86	-162.55	-834.58
93	0.0	0.0	1339.96	0.0	249.92	-194.77	-1241.61
94	0.0	0.0	-478.33	0.0	272.07	87.05	715.43
95	0.0	0.0	64.06	0.0	266.39	-101.36	21.83
96	0.0	0.0	64.06	0.0	266.39	-101.36	21.83
97	0.0	0.0	64.06	0.0	266.39	-101.36	21.83
98	0.0	0.0	64.06	0.0	266.39	-101.36	21.83
99	0.0	0.0	-1016.96	0.0	271.33	124.64	1057.00
100	0.0	0.0	746.40	0.0	252.02	-160.56	-871.07
101	0.0	0.0	-817.27	0.0	268.89	113.07	933.13
102	0.0	0.0	849.28	0.0	250.77	-166.63	-932.76
103	0.0	0.0	398.79	0.0	261.10	-138.37	[illegible]

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104	0.0	0.0	-986.75	0.0	271.24	124.60	1036.66
105	0.0	0.0	-436.85	0.0	262.85	25.82	381.63
106	0.0	0.0	55.48	0.0	260.59	-99.90	21.52
107	0.0	0.0	55.48	0.0	260.59	-99.90	21.52
108	0.0	0.0	55.48	0.0	260.59	-99.90	21.52
109	0.0	0.0	531.18	0.0	250.67	-148.82	-695.83
110	0.0	0.0	689.23	0.0	253.25	-154.21	-796.10
111	0.0	0.0	262.19	0.0	263.32	-128.17	-196.47
112	0.0	0.0	106.24	0.0	266.38	-107.90	-57.77
113	0.0	0.0	106.24	0.0	266.38	-107.90	-57.77
114	0.0	0.0	547.35	0.0	258.46	-153.26	-701.17
115	0.0	0.0	150.24	0.0	269.28	-117.87	-116.37
116	0.0	0.0	96.09	0.0	269.30	-108.68	-58.19
117	0.0	0.0	96.09	0.0	269.30	-108.68	-58.19
118	0.0	0.0	96.09	0.0	269.30	-108.68	-58.19
119	0.0	0.0	-64.06	0.0	269.32	-91.32	58.19
120	0.0	0.0	-326.66	0.0	270.43	-64.60	227.58

	H1 FT	H2 FT	H3 FT	H4 FT	HR FT	QR CFS
1	232.50	232.50	232.50	232.50	232.50	0.0
2	232.50	232.50	232.50	232.50	232.50	225.00
3	232.50	232.50	232.50	232.50	232.50	225.00
4	232.50	232.50	232.50	232.50	232.50	225.00
5	232.50	232.50	232.50	232.50	232.50	225.00
6	232.50	232.50	232.50	232.50	232.50	225.00
7	232.50	232.50	232.50	232.50	232.50	225.00
8	232.50	232.50	232.50	232.50	232.50	225.00
9	232.50	232.50	232.50	232.50	232.50	225.00
10	232.50	232.50	232.50	232.50	232.50	225.00
11	232.50	232.50	232.50	232.50	232.50	247.00
12	232.50	232.50	232.50	232.50	232.50	247.00
13	232.50	232.50	232.50	232.50	232.50	65.78
14	232.50	232.50	232.50	232.50	232.50	227.00
15	232.50	232.50	232.50	232.50	232.50	228.00
16	232.50	232.50	232.50	232.50	232.50	-162.85
17	232.50	232.50	232.50	232.50	232.50	169.52
18	232.50	232.50	232.50	232.50	232.50	-495.30
19	232.51	232.51	232.50	232.51	232.50	-332.35
20	232.51	232.51	232.50	232.51	232.50	-413.29
21	232,51	232.51	232.50	232.51	232.50	85.38
22	232.50	232.50	232.50	232.50	232.50	58.78
23	232.50	232.50	232.50	232.50	232.50	225.00
24	232.50	232.50	232.50	232.50	232.50	-162.85
25	232.50	232.50	232.50	232.50	232.50	146.54
26	232.50	232.50	232.50	232.50	232.50	227.00
27	232.50	232.50	232.50	232.50	232.50	227.00
28	232.50	232.50	232.50	232.50	232.50	225.00
29	232.50	232.50	232.50	232.50	232.50	225.00
30	232.50	232.50	232.50	232.50	232.50	225.00
31	232.50	232.50	232.50	232.50	232.50	227.00
32	232.50	232.50	232.50	232.50	232.50	-160.85
33	232.50	232.50	232.50	232.50	232.50	120.76
34	232.51	232.51	232.50	232.51	232.50	-642.54
35	232.53	232.53	232.53	232.53	232.52	370.65
36	232.58	232.58	232.56	232.58	232.55	-490.59
37	[illegible].77	232.77	232.65	232.77	232.60	-3967.06
38	[illegible].24	233.24	232.84	233.24	232.65	-6343.62
39	233.85	233.85	233.35	[illegible]	233.08	21406.82

N02FA444

40	234.41	234.41	233.77	234.41	233.50	21090.33
41	234.90	234.90	234.26	234.90	234.00	28036.72
42	235.28	235.28	234.75	235.28	234.50	29616.13
43	235.53	235.53	235.20	235.53	234.98	27630.44
44	235.76	235.76	235.63	235.76	235.45	29198.87
45	235.98	235.98	236.00	235.98	235.92	31570.61
46	236.23	236.24	236.37	236.23	236.40	36384.64
47	236.51	236.52	236.79	236.51	236.88	37853.70
48	236.80	236.80	237.19	236.80	237.35	39297.55
49	237.07	237.07	237.52	237.07	237.72	34171.74
50	237.32	237.32	237.84	237.32	238.10	41378.11
51	237.56	237.57	238.16	237.56	238.50	59024.98
52	237.82	237.82	238.48	237.82	238.90	67903.63
53	238.07	238.07	238.68	238.07	239.00	44183.62
54	238.30	238.30	238.77	238.30	239.00	35247.58
55	238.50	238.50	238.84	238.50	239.00	34659.70
56	238.66	238.66	238.89	238.66	239.00	34097.24
57	238.79	238.80	238.93	238.79	239.00	33522.70
58	238.89	238.89	238.96	238.89	239.00	24726.56
59	238.93	238.93	238.93	238.93	238.94	19154.80
60	238.90	238.90	238.87	238.90	238.87	16707.54
61	238.84	238.84	238.81	238.85	238.80	12638.82
62	238.79	238.79	238.76	238.79	238.75	11762.20
63	238.75	238.75	238.75	238.76	238.75	12559.94
64	238.75	238.75	238.75	238.75	238.75	10610.03
65	238.75	238.75	238.75	238.75	238.75	9349.03
66	238.75	238.75	238.75	238.75	238.75	7666.03
67	238.75	238.75	238.75	238.75	238.75	6892.03
68	238.75	238.75	238.75	238.75	238.75	3589.94
69	238.75	238.75	238.75	238.76	238.75	3811.50
70	238.75	238.75	238.75	238.75	238.75	-116.15
71	238.75	238.75	238.75	238.75	238.75	-69.00
72	238.75	238.75	238.75	238.75	238.75	-375.51
73	238.78	238.78	238.79	238.79	238.78	1412.19
74	238.82	238.82	238.82	238.82	238.81	1918.43
75	238.84	238.84	238.84	238.84	238.84	1989.30
76	238.87	238.87	238.87	238.87	238.87	2414.93
77	238.89	238.89	238.90	238.89	238.90	2850.73
78	238.90	238.90	238.90	238.90	238.90	-513.41
79	238.91	238.91	238.90	238.91	238.90	-166.20
80	238.90	238.90	238.90	238.90	238.90	54.56
81	238.90	238.90	238.90	238.90	238.90	151.54
82	238.90	238.90	238.90	238.90	238.90	230.00
83	238.90	238.90	238.90	238.90	238.90	275.30
84	238.90	238.90	238.90	238.90	238.90	285.48
85	238.94	238.95	238.99	238.95	239.00	9407.47
86	238.99	238.99	239.00	238.99	239.00	778.29
87	239.00	239.00	239.00	239.00	239.00	308.46
88	239.04	239.05	239.08	239.05	239.10	9452.46
89	239.11	239.11	239.17	239.11	239.20	9853.91
90	239.21	239.21	239.32	239.21	239.40	19093.00
91	239.30	239.30	239.36	239.30	239.40	1848.45
92	239.36	239.36	239.39	239.36	239.40	1229.15
93	239.42	239.42	239.47	239.43	239.50	9862.59
94	239.42	239.42	239.40	239.42	239.40	-8517.48
95	239.40	239.40	239.40	239.40	239.40	294.06
96	239.40	239.40	239.40	239.40	239.40	294.06
97	239.40	239.40	239.40	239.40	239.40	294.06
98	239.40	239.40	239.40	239.40	239.40	294.06
99	239.35	239.35	239.32	239.35	239.30	-9032.63
100	239.37	239.37	239.39	239.37	239.40	9245.55
101	239.34	239.34	239.31	239.34	239.30	-8832.94

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103	239.39	239.39	239.40	239.40	239.40	628.79
104	239.35	239.35	239.31	239.35	239.30	-9002.42
105	239.31	239.31	239.30	239.31	239.30	-206.85
106	239.30	239.30	239.30	239.30	239.30	285.48
107	239.30	239.30	239.30	239.30	239.30	285.48
108	239.30	239.30	239.30	239.30	239.30	285.48
109	239.33	239.33	239.35	239.33	239.35	4889.88
110	239.37	239.37	239.39	239.37	239.40	5053.80
111	239.40	239.40	239.40	239.40	239.40	492.19
112	239.40	239.40	239.40	239.40	239.40	336.24
113	239.40	239.40	239.40	239.40	239.40	336.24
114	239.43	239.43	239.45	239.43	239.45	4917.79
115	239.45	239.45	239.45	239.45	239.45	380.24
116	239.45	239.45	239.45	239.45	239.45	326.09
117	239.45	239.45	239.45	239.45	239.45	326.09
118	239.45	239.45	239.45	239.45	239.45	326.09
119	239.45	239.45	239.45	239.45	239.45	-317.08
120	239.45	239.45	239.45	239.46	239.45	-96.66

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Appendix 2B[1]
Seismic Survey of the North Anna Power Station, Virginia Electric and Power Company
Prepared for Stone & Webster Engineering Corporation by Weston Geophysical Engineers, Inc.

1. Appendix 2B was submitted as Appendix A in the original FSAR.

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SEISMIC SURVEY
NORTH ANNA POWER STATION

INTRODUCTION

Seismic surveys throughout the area of the North Anna Power Station took place during the period of May 1 to November 14, 1968.

The general site plan is shown on Sheet 1 of the accompanying drawings. This drawing and all other location data and topographic elevation data were provided us by the Engineers. Specific location plans are shown on Sheets 2 and 3.

The seismic refraction technique was used for all measurements. A field procedure of continuous line profiling with crosslines for checking and expanding the coverage was used wherever possible.

PURPOSE

The objectives of the study were to determine depths to rock and general information concerning overburden and weathered rock conditions. These data are used by the Engineers to further evaluate the site, for site selection or elimination, for general design considerations, and to determine quantities of excavation.

RESULTS

Depths to rock are shown on the profile sections which accompany this report. Rock is designated by a V_3 symbol.

The seismic velocity for hard, relatively unweathered rock is approximately 13,000 to 16,000 ft./sec. Nearly all measurements were similar to one of these two values. Therefore, the rock velocity symbol is shown as V_{3a} or V_{3b}.

Materials above the rock surface are designated by V_1 and V_2 symbols corresponding to a low velocity surface layer and an intermediate velocity layer. These designations were subdivided into V_{1a} , V_{1b} , and V_{2a} , V_{2b} , and V_{2c} to better distinguish the measured values shown on the legend of each profile section.

Profile Data and Stationing

Seismic subsurface profile data for each line of investigation were prepared and drawn on the topographic profiles provided by the Engineers.

The stationing of each line was designated by the Engineers on the profile sections and also staked in the field.

Discussion of Velocities and Identifications

Throughout the area of this survey, residual materials exist at or very close to the ground surface. Original rock structure can be seen in shallow

excavations such as pits and nearby road cuts. In order to identify the various velocities values and correlate them with materials, we have relied on both local geological inspections and experience with similar conditions in other parts of this geologic province.

Of the three velocity ranges that are noted, the V_2 layer is the only one that presents some difficulty for identification. Weathered rock and saturated soils correspond in some instances to the same range of velocities, namely 4,000 to 6,000 ft./sec. Generally speaking, the specific value of 5,000 ft./sec. is usually indicative of saturated soils; the values above and below 5,000 ft./sec. value are probably weathered rock.

Boring Correlations

A number of borings have been drilled at various locations of this project. These have verified the seismic profile results with rather close correlation in most instances. It is to be expected that in this area of deep and sometimes erratic weathering localized zones of softer or harder material will exist and be undetected by a seismic survey. These conditions would readily account for differences between seismic and boring results.

The borings have indicated that the V_2 velocity layer can be either a soil material or a weathered rock material. Wherever it is a soil material, it usually occurs at or just below the water level noted on the log. For the most part, however, the V_2 layer appears to be mostly weathered rock material throughout the area of this survey.

DISCUSSION OF RESULTS

The coverage of this survey was expanded and intensified in the area of Crosslines 30+00, 33+00 and 36+00 based on the first indications of relatively shallow rock conditions there.

Outside of this area, rock is weathered to greater depths and lower elevations.

The measured velocity of some of the rock at the station site is 10,000 ± ft./sec. It is designated by a V_{3a} - symbol to distinguish it from the higher values of approximately 13,000 to 16,000 ft./sec. Wherever this value was measured, the rock probably contains a slight amount of weathering.

When the plant site is excavated, blasting should be anticipated for all of the V_3 materials. The V_2 material will probably require heavy equipment; localized hard zones within the V_2 layer might require some blasting for excavation.

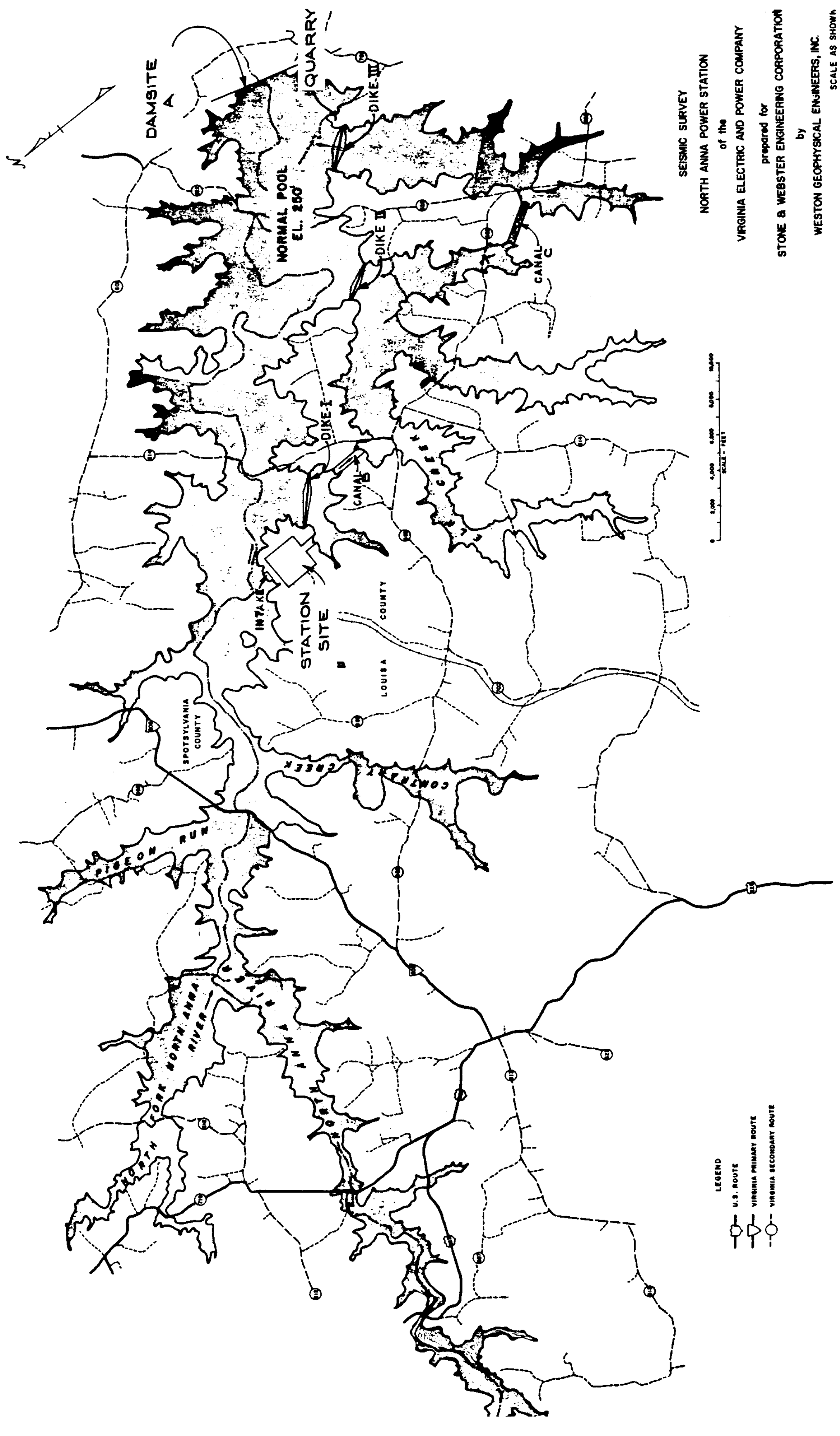
SUMMARY OF RESULTS

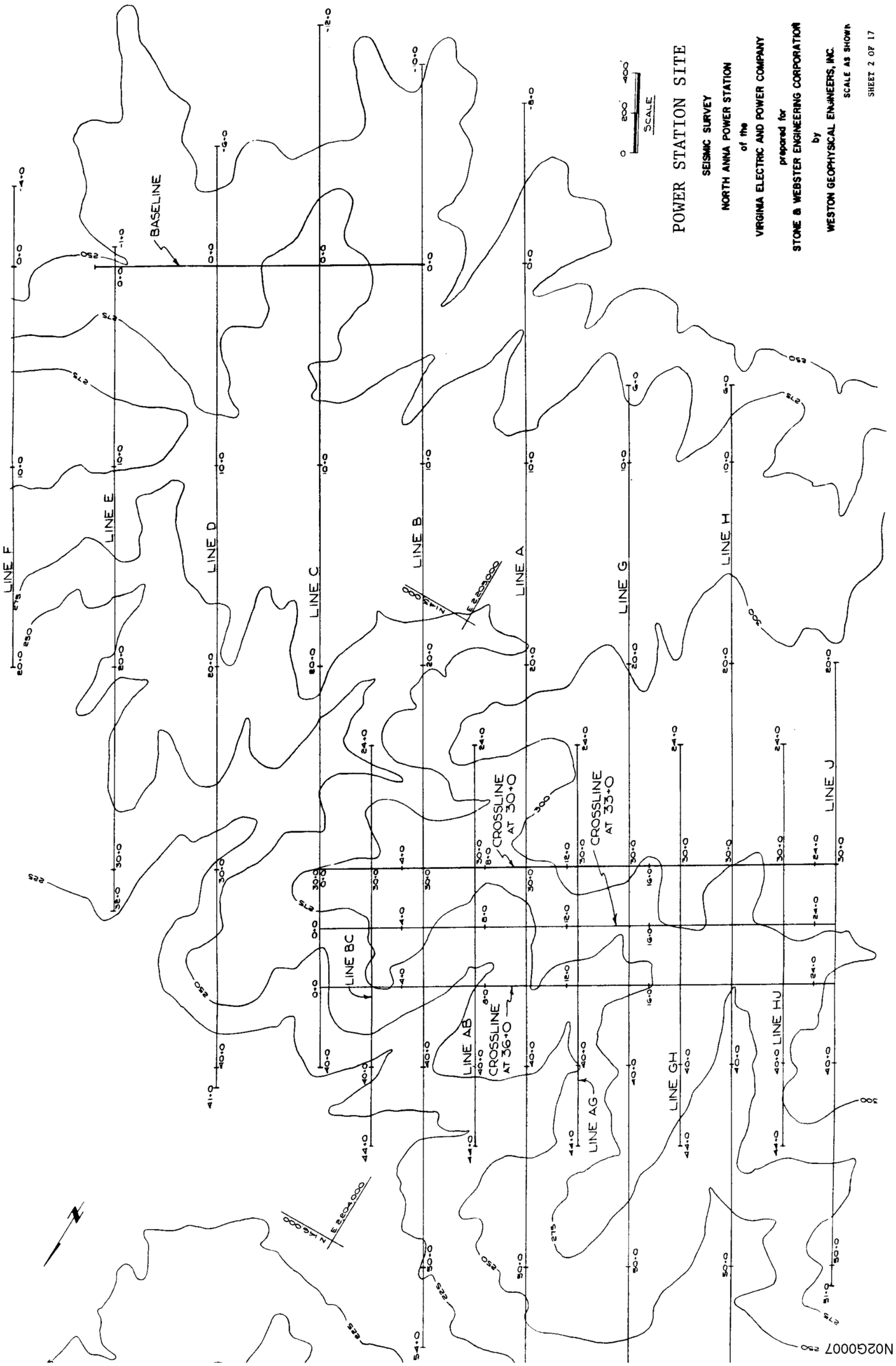
Throughout much of the area of this project, rock is weathered to a depth that generally coincides with the elevation of the present river channel. A few locations contain zones of deeper weathering; in a few other locations, more resistant rock exists at higher elevations than the river level. The

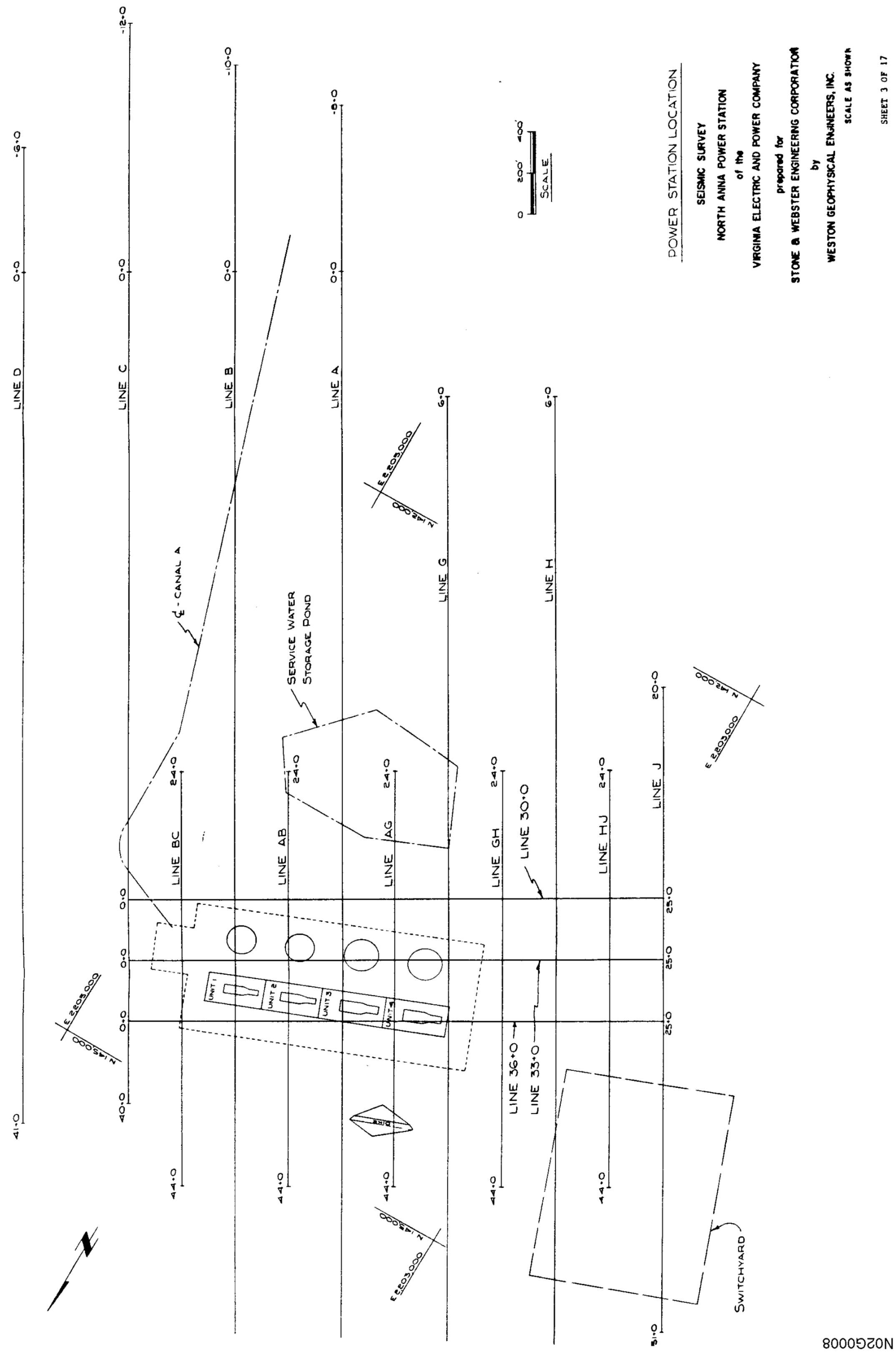
selected plant site is a position where rock was detected at somewhat higher elevations than in surrounding positions.

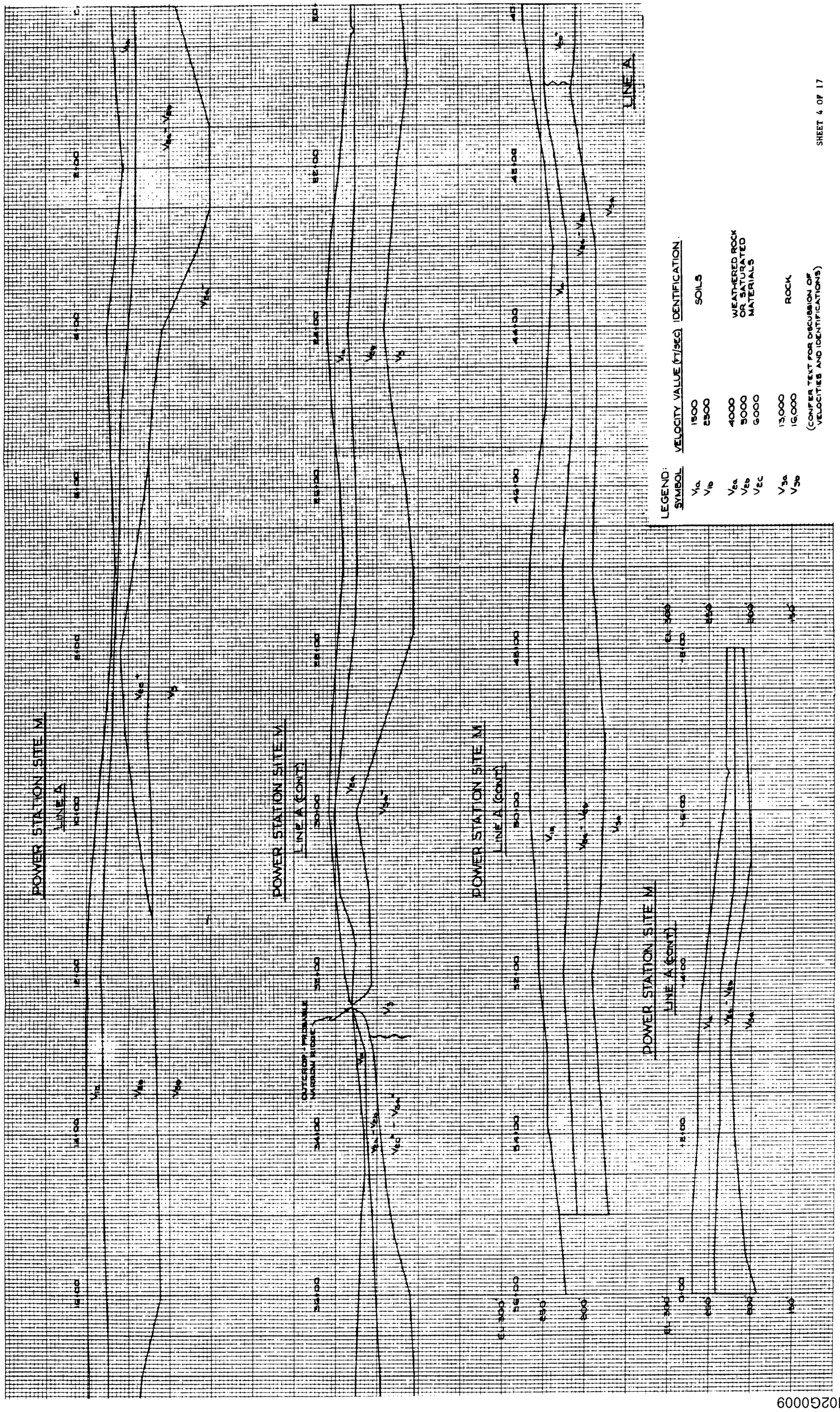
The materials above the rock surface are weathered rock and residual soil in most instances.

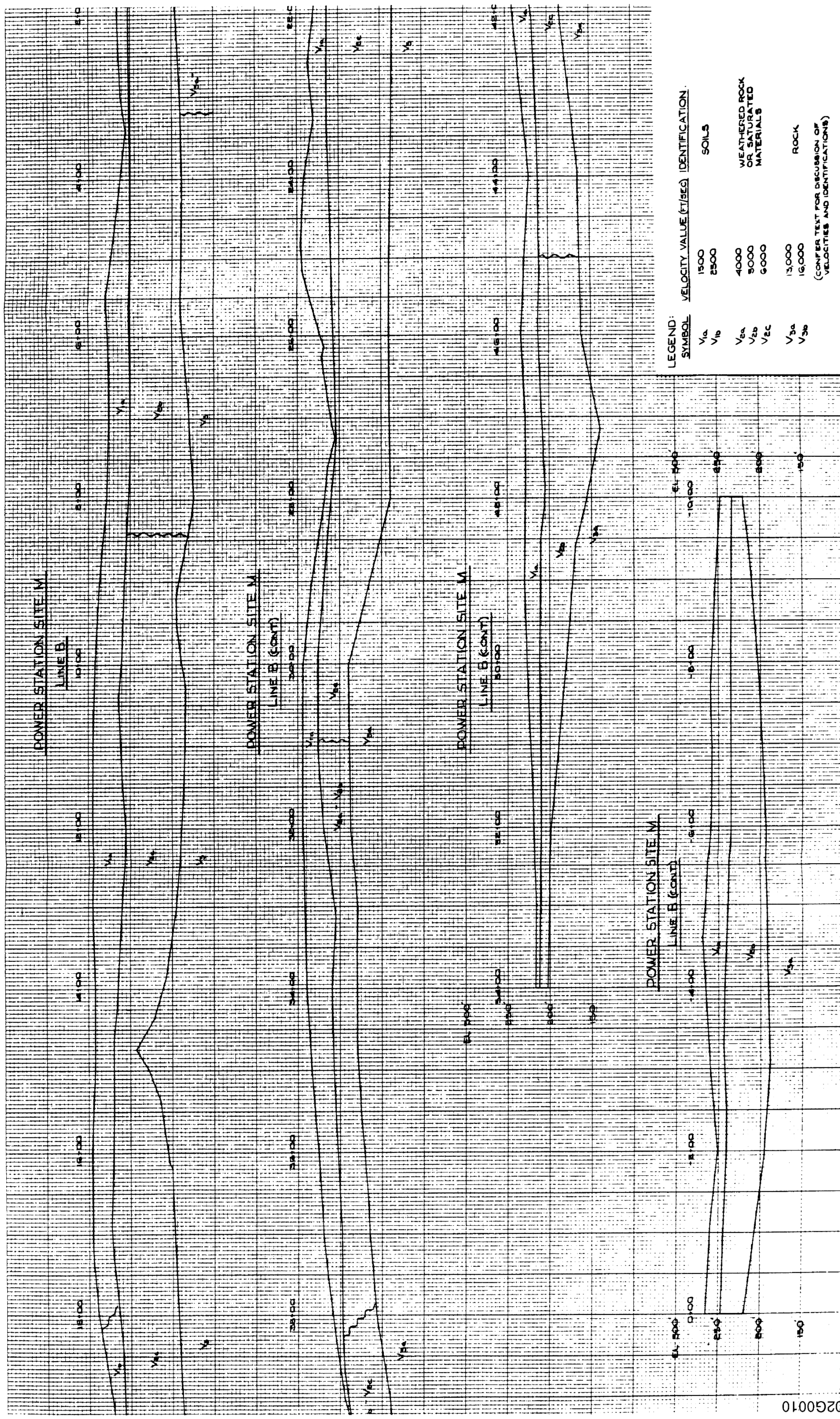
Borings drilled throughout the areas of this seismic survey coverage verified the seismic survey findings.

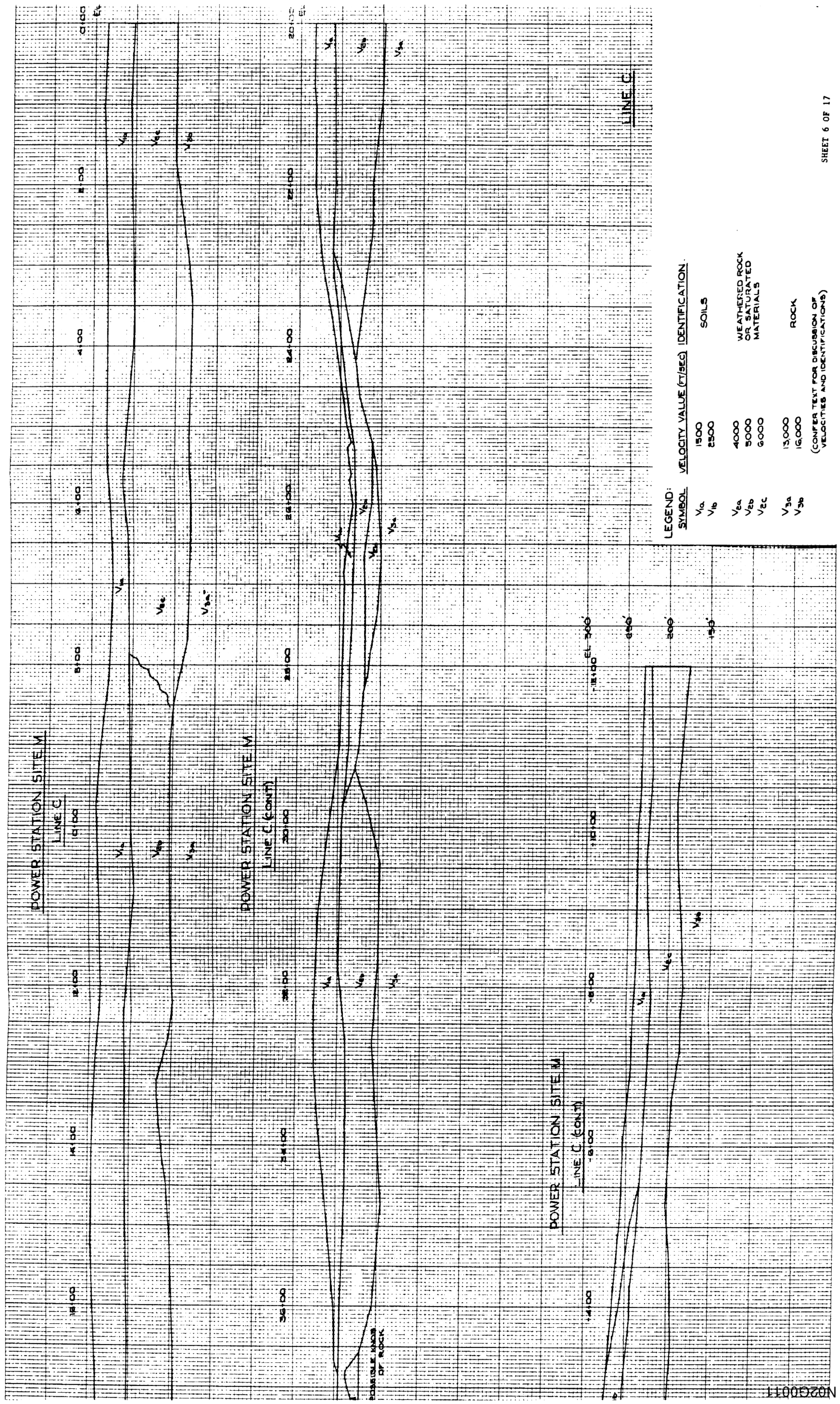

DAMSITE A
QUARRY
DIKE III
NORMAL POOL EL. 250'
DIKE II
CANAL C
DIKE I
CANAL
INTAKE
STATION SITE
LOUISA COUNTY
SPOTSYLVANIA COUNTY
CONTRARY CREEK
PIGEON RUN
NORTH ANNA RIVER
NORTH FORK NORTH ANNA RIVER
SEISMIC SURVEY
NORTH ANNA POWER STATION
of the
VIRGINIA ELECTRIC AND POWER COMPANY
prepared for
STONE & WEBSTER ENGINEERING CORPORATION
by
WESTON GEOPHYSICAL ENGINEERS, INC.
SCALE AS SHOWN
LEGEND
U.S. ROUTE
VIRGINIA PRIMARY ROUTE
VIRGINIA SECONDARY ROUTE

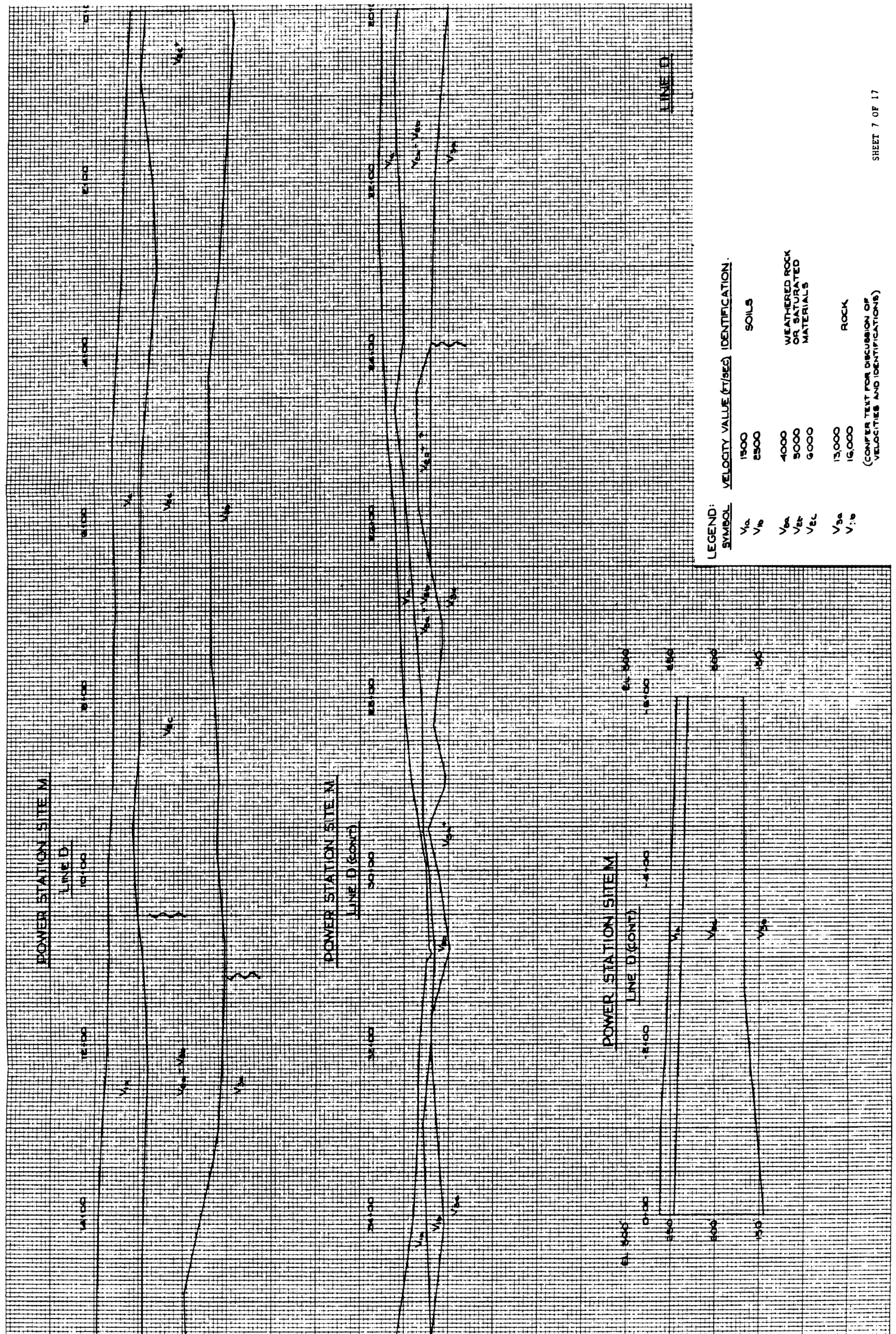

POWER STATION SITE
SEISMIC SURVEY
NORTH ANNA POWER STATION
of the
VIRGINIA ELECTRIC AND POWER COMPANY
prepared for
STONE & WEBSTER ENGINEERING CORPORATION
by
WESTON GEOPHYSICAL ENGINEERS, INC.
SCALE AS SHOWN
SHEET 2 OF 17
SCALE
BASELINE
LINE F
LINE E
LINE D
LINE C
LINE B
LINE A
LINE G
LINE H
LINE J
LINE BC
LINE AB
LINE AG
LINE GH
LINE HJ
CROSSLINE AT 30+0
CROSSLINE AT 33+0
CROSSLINE AT 36+0
N02G0007


POWER STATION LOCATION
SEISMIC SURVEY
NORTH ANNA POWER STATION
of the
VIRGINIA ELECTRIC AND POWER COMPANY
prepared for
STONE & WEBSTER ENGINEERING CORPORATION
by
WESTON GEOPHYSICAL ENGINEERS, INC.
SCALE AS SHOWN
SHEET 3 OF 17
SCALE
LINE D
LINE C
LINE B
LINE A
LINE G
LINE H
LINE BC
LINE AB
LINE AG
LINE GH
LINE HJ
LINE J
LINE 30+0
LINE 36+0
LINE 33+0
SERVICE WATER STORAGE POND
SWITCHYARD
UNIT 1
UNIT 2
UNIT 3
UNIT 4
N02G0008


POWER STATION SITE M
LINE A
POWER STATION SITE M
LINE A (CON'T)
POWER STATION SITE M
LINE A (CON'T)
POWER STATION SITE M
LINE A (CON'T)
OUTCROP - PROBABLE
NARROW RIDGE
LINE A
LEGEND:
SYMBOL
VELOCITY VALUE (FT/SEC)
IDENTIFICATION
V1a 1500
V1b 2500 SOILS
V2a 4000
V2b 5000 WEATHERED ROCK OR SATURATED MATERIALS
V2c 6000
V3a 13,000
V3b 16,000 ROCK
(CONFER TEXT FOR DISCUSSION OF VELOCITIES AND IDENTIFICATIONS)
SHEET 4 OF 17
N02G0009


POWER STATION SITE M
LINE B
POWER STATION SITE M
LINE B (CONT)
POWER STATION SITE M
LINE B (CONT)
POWER STATION SITE M
LINE B (CONT)
LEGEND:
SYMBOL VELOCITY VALUE (FT/SEC) IDENTIFICATION
V1a 1500 SOILS
V1b 2500
V2a 4000 WEATHERED ROCK OR SATURATED MATERIALS
V2b 5000
V2c 6000
V3a 13,000 ROCK
V3b 16,000
(CONFER TEXT FOR DISCUSSION OF VELOCITIES AND IDENTIFICATIONS)
N02G0010


POWER STATION SITE M
LINE C
POWER STATION SITE M
LINE C (CONT)
POWER STATION SITE M
LINE C (CONT)
LINE C
LEGEND:
SYMBOL VELOCITY VALUE (FT/SEC) IDENTIFICATION
V1a 1500 SOILS
V1b 2500
V2a 4000 WEATHERED ROCK OR SATURATED MATERIALS
V2b 5000
V2c 6000
V3a 13,000 ROCK
V3b 16,000
(CONFER TEXT FOR DISCUSSION OF VELOCITIES AND IDENTIFICATIONS)
POSSIBLE KNOB OF ROCK
SHEET 6 OF 17
N02G0011


POWER STATION SITE M
LINE D
POWER STATION SITE M
LINE D (CONT)
POWER STATION SITE M
LINE D (CONT)
LINE D
LEGEND:
SYMBOL VELOCITY VALUE (FT/SEC) IDENTIFICATION.
V1a 1500 SOILS
V1b 2500
V2a 4000 WEATHERED ROCK OR SATURATED MATERIALS
V2b 5000
V2c 6000
V3a 13,000 ROCK
V3b 16,000
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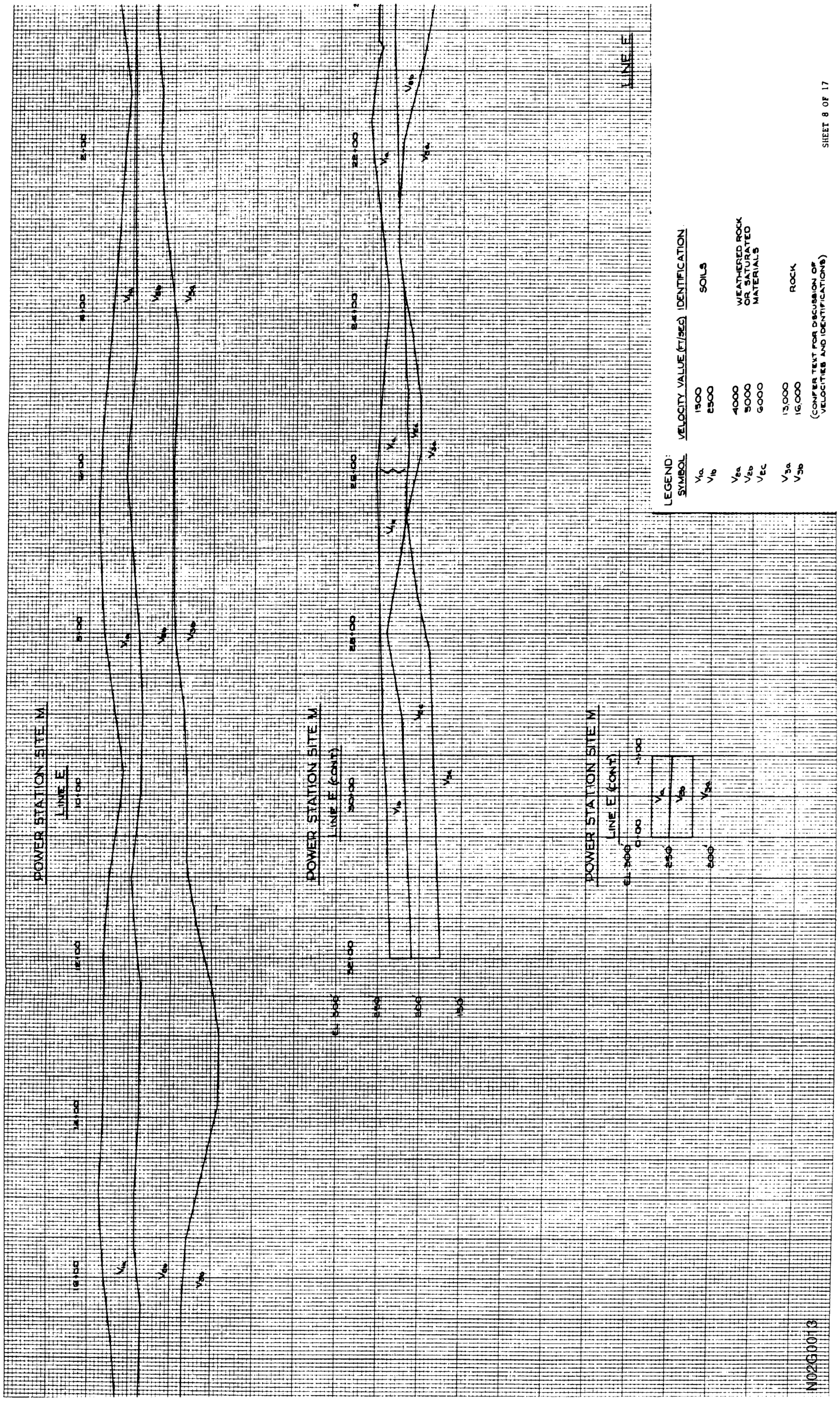
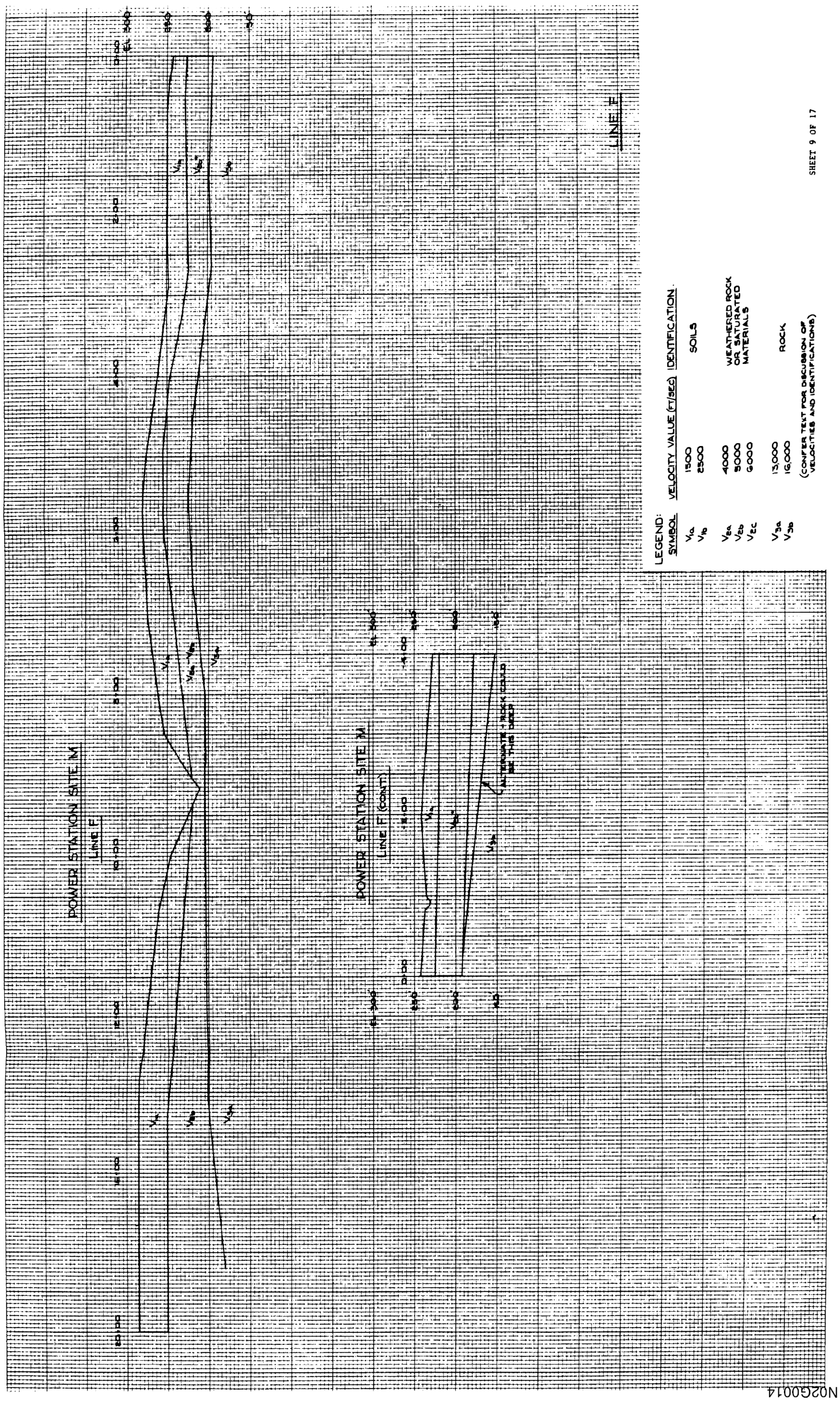
SHEET 7 OF 17
N02G0012


POWER STATION SITE M
LINE E
POWER STATION SITE M
LINE E (CONT)
POWER STATION SITE M
LINE E (CONT)
LINE E
LEGEND:
SYMBOL
VELOCITY VALUE (FT/SEC)
IDENTIFICATION
V1a 1500
V1b 2500 SOILS
V2a 4000
V2b 5000
V2c 6000 WEATHERED ROCK OR SATURATED MATERIALS
V3a 13,000
V3b 16,000 ROCK
(CONFER TEXT FOR DISCUSSION OF VELOCITIES AND IDENTIFICATIONS)
SHEET 8 OF 17
N02G0013


POWER STATION SITE M
LINE F
POWER STATION SITE M
LINE F (CONT)
ALTERNATE - ROCK COULD BE THIS DEEP
LEGEND:
SYMBOL VELOCITY VALUE (FT/SEC) IDENTIFICATION
V1a 1500 SOILS
V1b 2500
V2a 4000 WEATHERED ROCK OR SATURATED MATERIALS
V2b 5000
V2c 6000
V3a 13,000 ROCK
V3b 16,000
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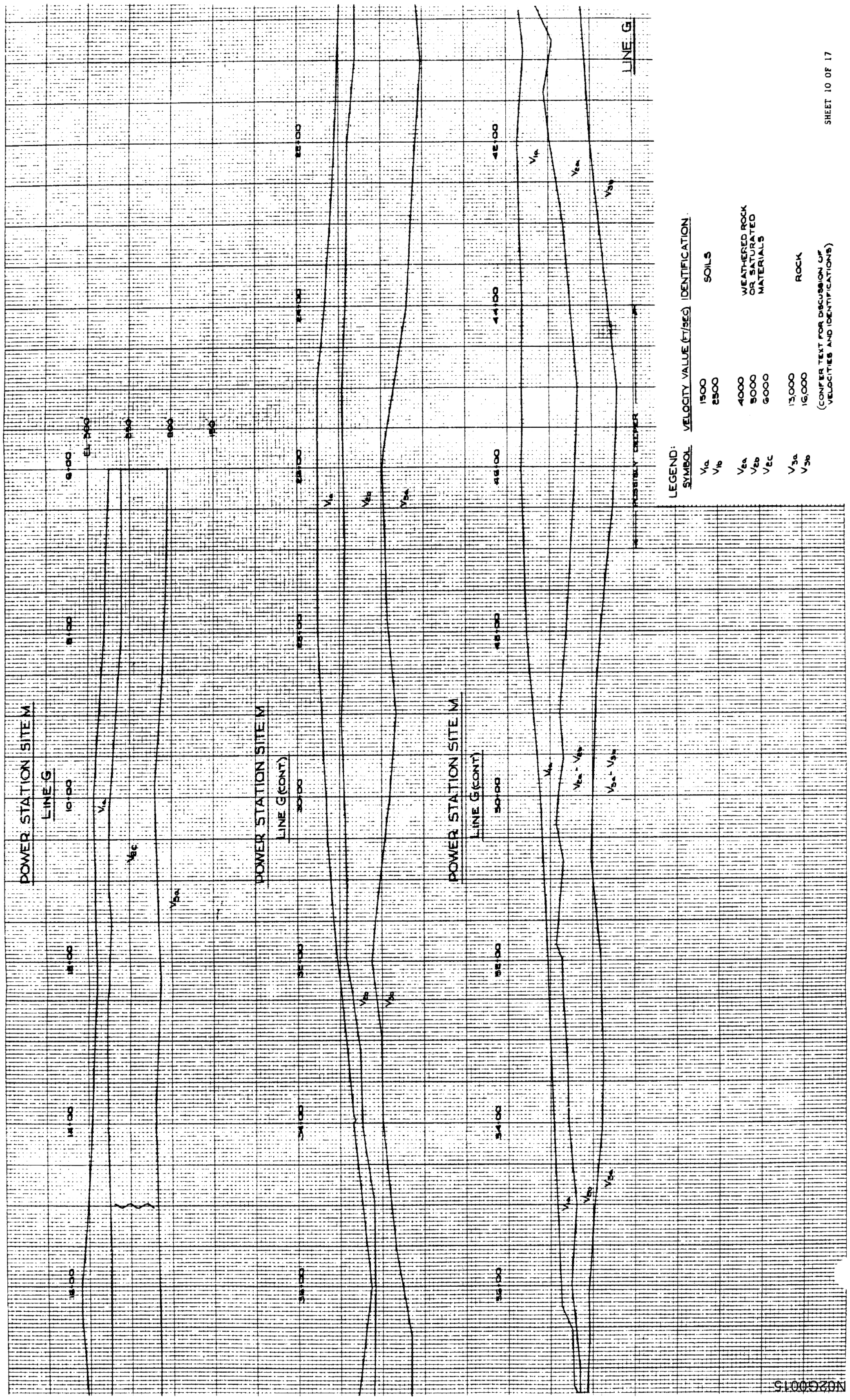
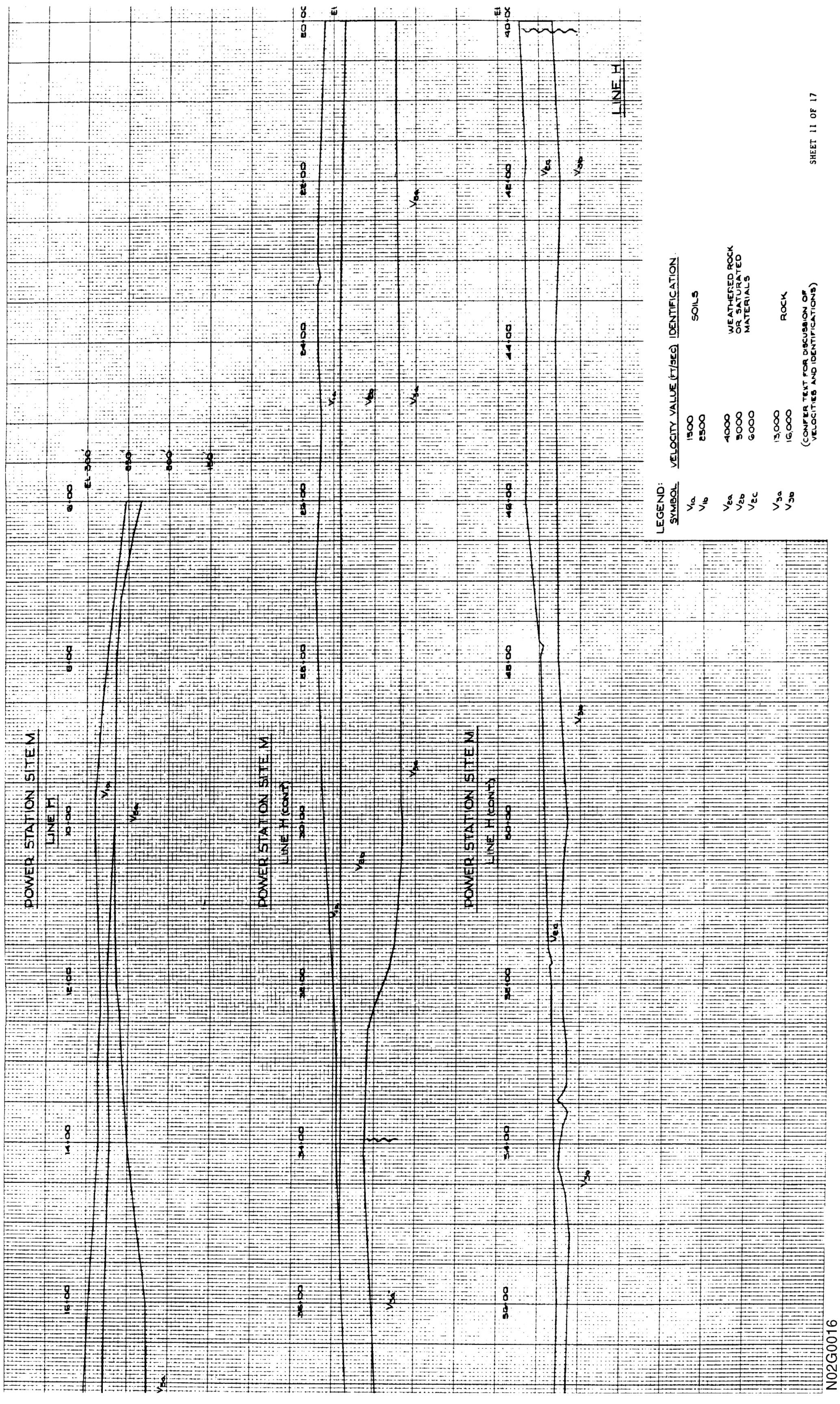
LINE F
SHEET 9 OF 17
N02G0014


LINE G
POWER STATION SITE M
LINE G
POWER STATION SITE M
LINE G (CONT)
POWER STATION SITE M
LINE G (CONT)
LEGEND:
SYMBOL VELOCITY VALUE (FT/SEC) IDENTIFICATION
V1a 1500 SOILS
V1b 2500
V2a 4000 WEATHERED ROCK OR SATURATED MATERIALS
V2b 5000
V2c 6000
V3a 13,000 ROCK
V3b 16,000
(CONFER TEXT FOR DISCUSSION OF VELOCITIES AND IDENTIFICATIONS)
SHEET 10 OF 17
N02G0015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LINE H
POWER STATION SITE M
LINE H (CONT)
POWER STATION SITE M
LINE H (CONT)
LINE H
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V1a 1500 SOILS
V1b 2500
V2a 4000 WEATHERED ROCK OR SATURATED MATERIALS
V2b 5000
V2c 6000
V3a 13,000 ROCK
V3b 16,000
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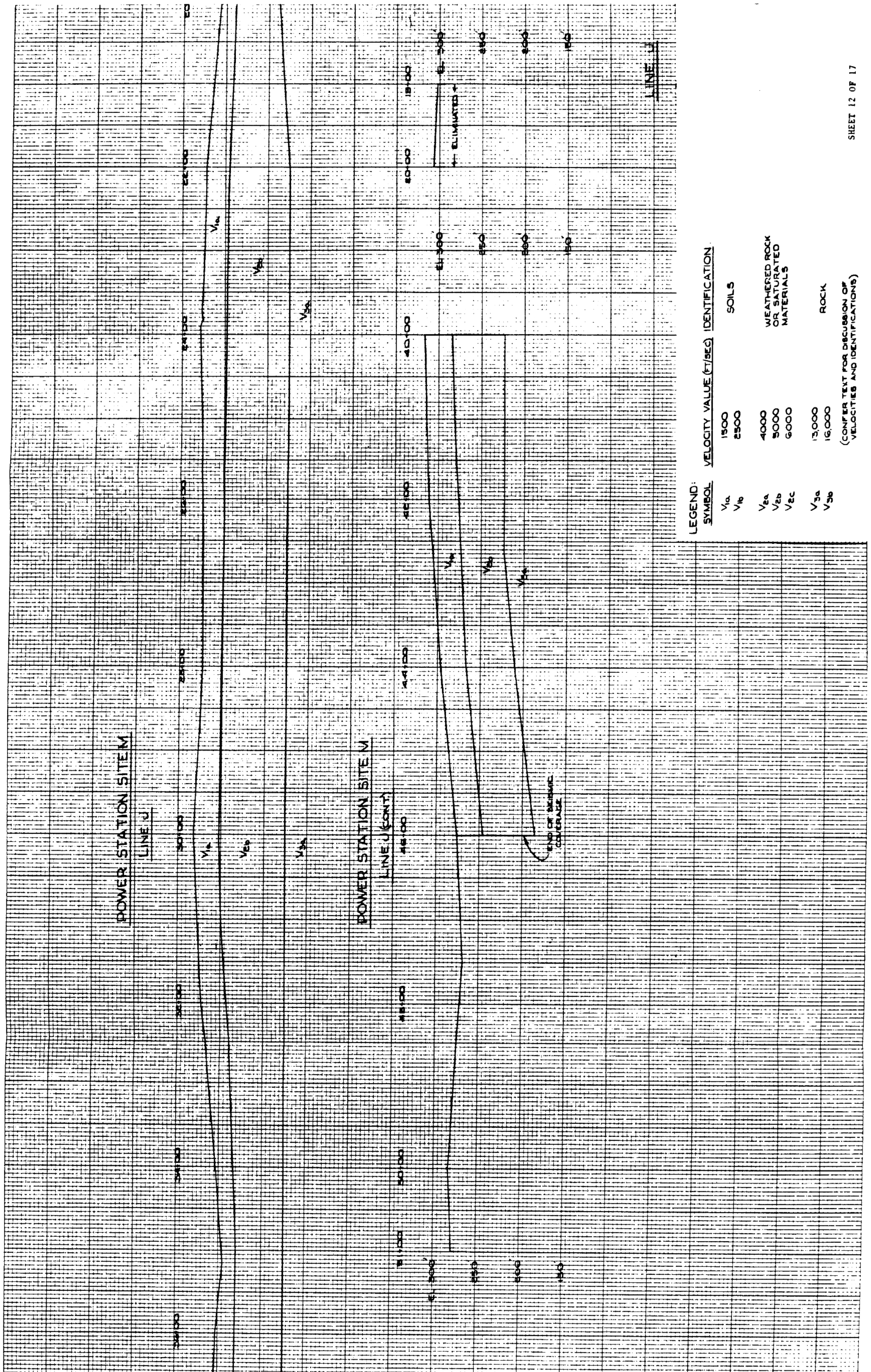
SHEET 11 OF 17
N02G0016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V2a 4000 WEATHERED ROCK OR SATURATED MATERIALS
V2b 5000
V2c 6000
V3a 13,000 ROCK
V3b 16,000
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SHEET 12 OF 17
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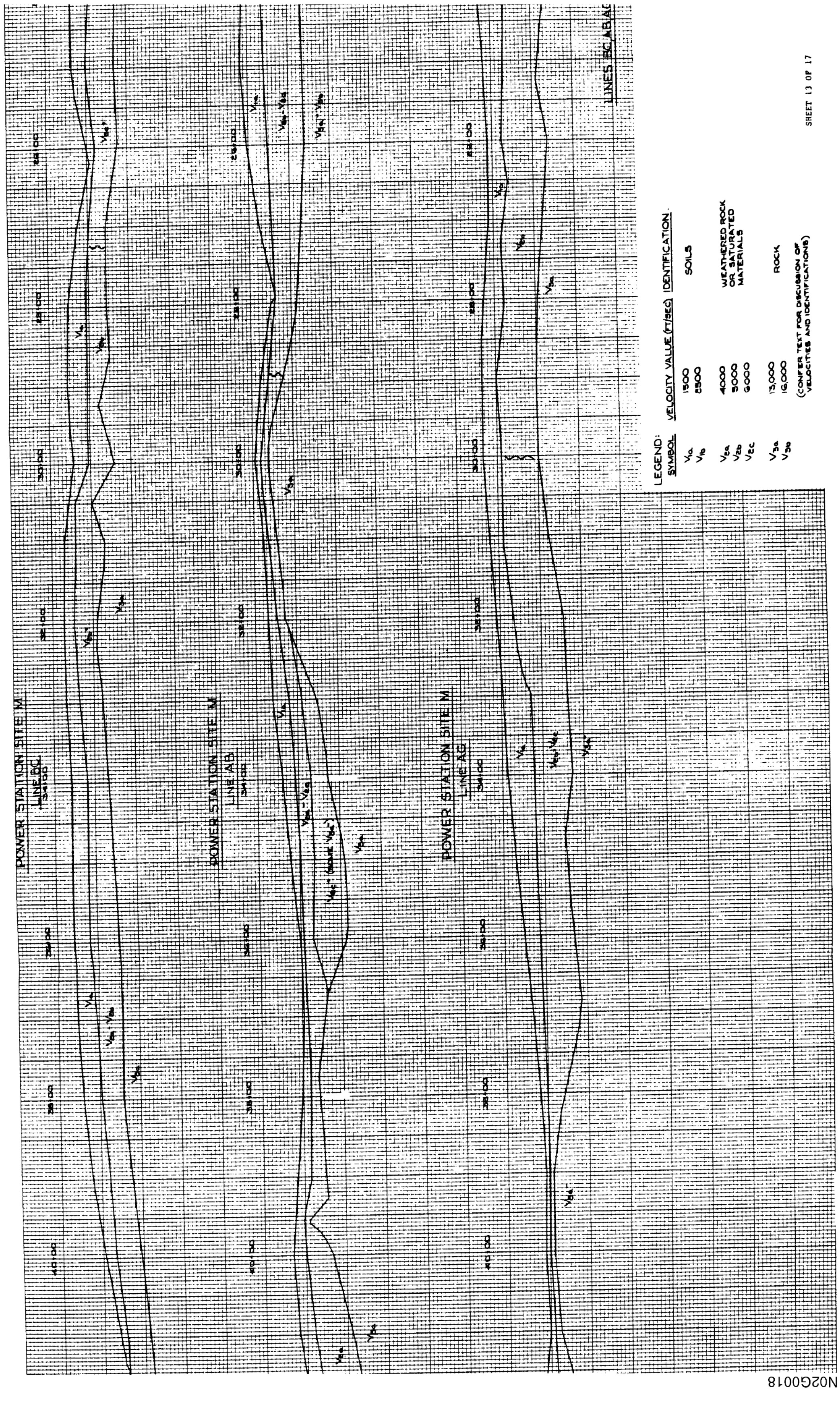
ELIMINATED

N02G0017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POWER STATION SITE M
LINE AB
POWER STATION SITE M
LINE AG
LINES BC, AB, AG
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V1b 2500
V2a 4000 WEATHERED ROCK OR SATURATED MATERIALS
V2b 5000
V2c 6000
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V3b 16,000
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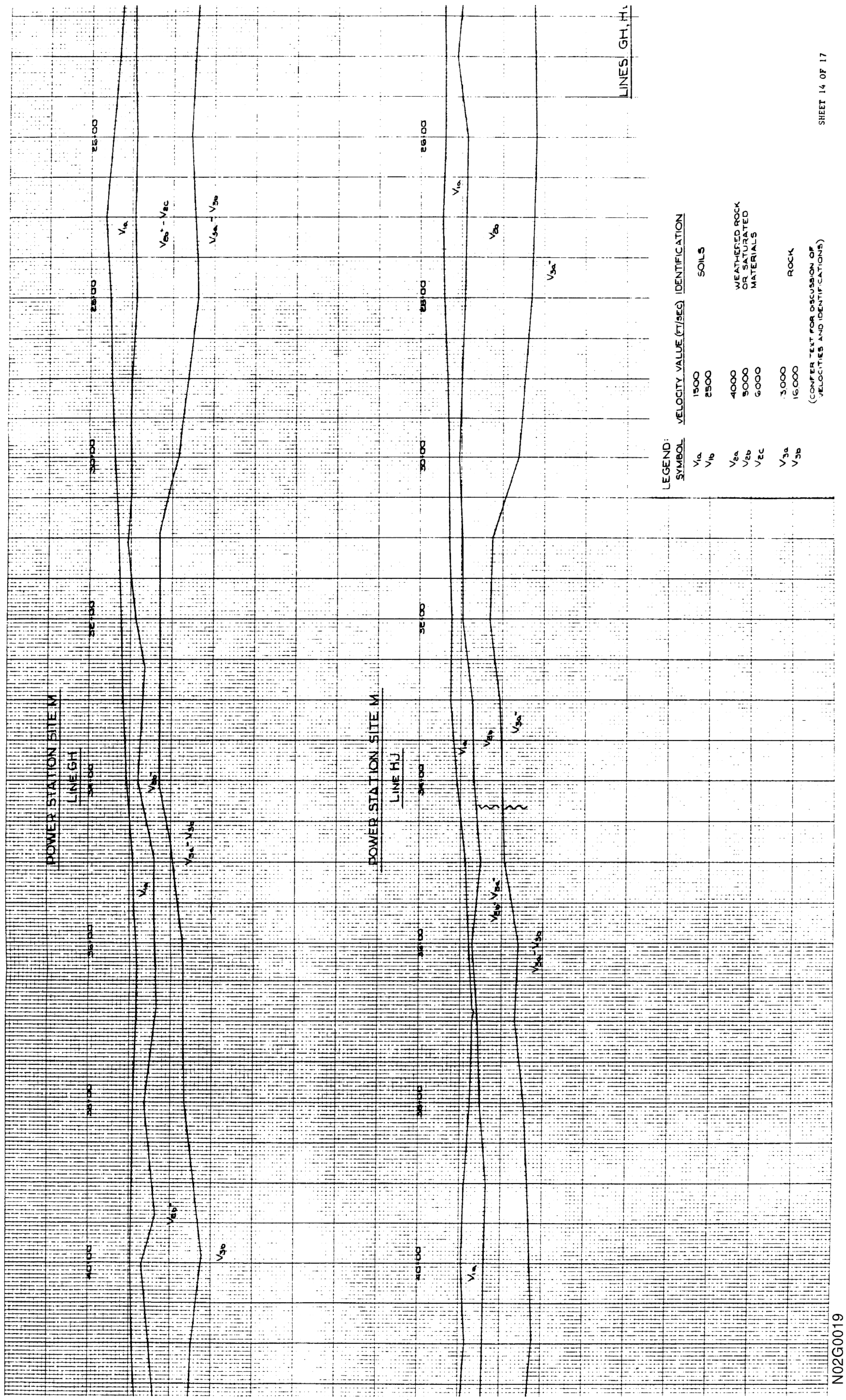
SHEET 13 OF 17

N02G0018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LINES GH, H
LEGEND:
SYMBOL VELOCITY VALUE (FT/SEC) IDENTIFICATION
V_{1a} 1500 SOILS
V_{1b} 2500
V_{2a} 4000 WEATHERED ROCK OR SATURATED MATERIALS
V_{2b} 5000
V_{2c} 6000
V_{3a} 13,000 ROCK
V_{3b} 16,000
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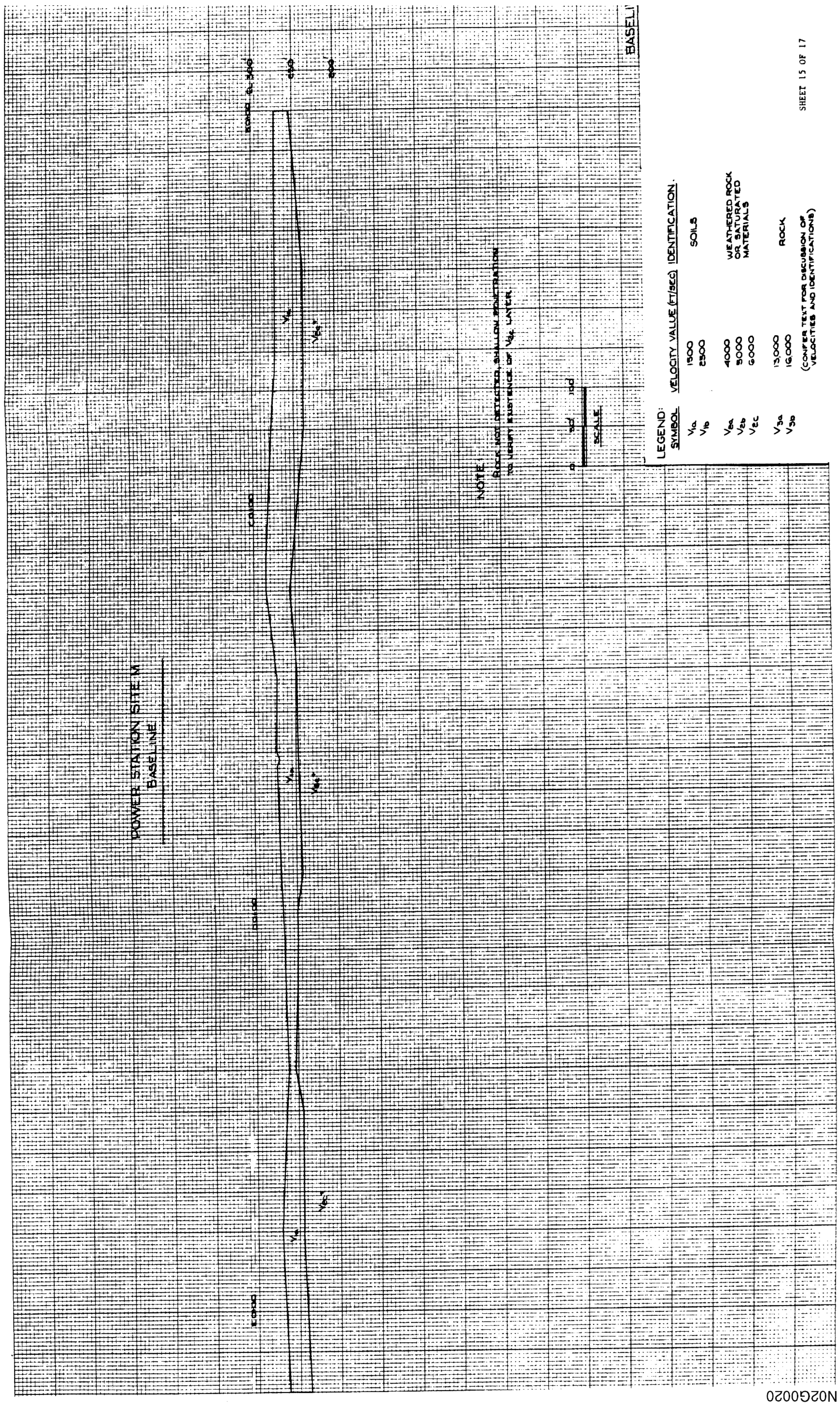
SHEET 14 OF 17
N02G0019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NOTE:
ROCK NOT DETECTED, SHALLOW PENETRATION
TO VERIFY EXISTENCE OF V2c LAYER.
0 50' 100'
SCALE
LEGEND:
SYMBOL VELOCITY VALUE (FT/SEC) IDENTIFICATION.
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V1b 2500
V2a 4000 WEATHERED ROCK OR SATURATED MATERIALS
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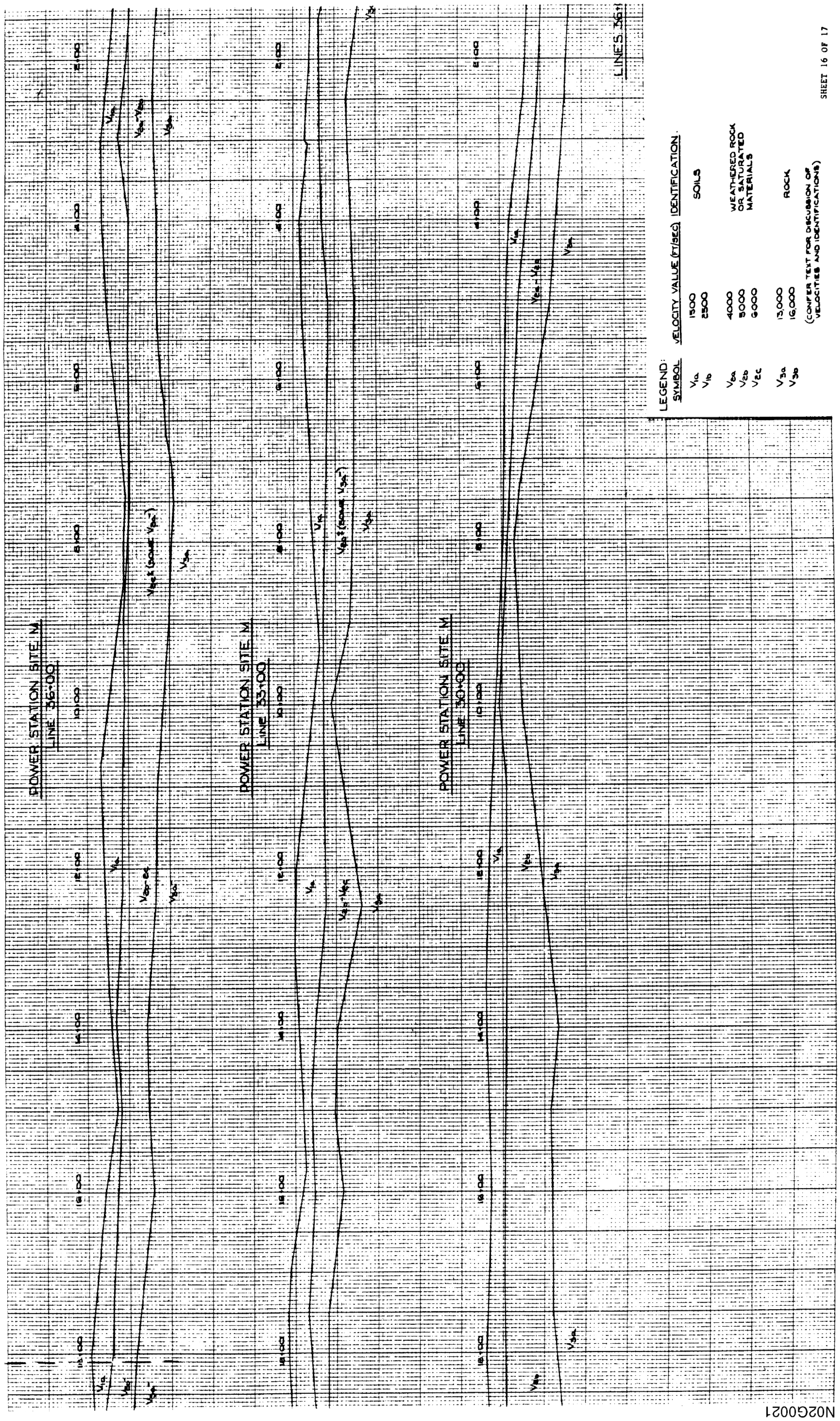
SHEET 15 OF 17
N02G0020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IDENTIFICATION
1500
2500
SOILS
4000
5000
6000
WEATHERED ROCK OR SATURATED MATERIALS
13,000
16,000
ROCK
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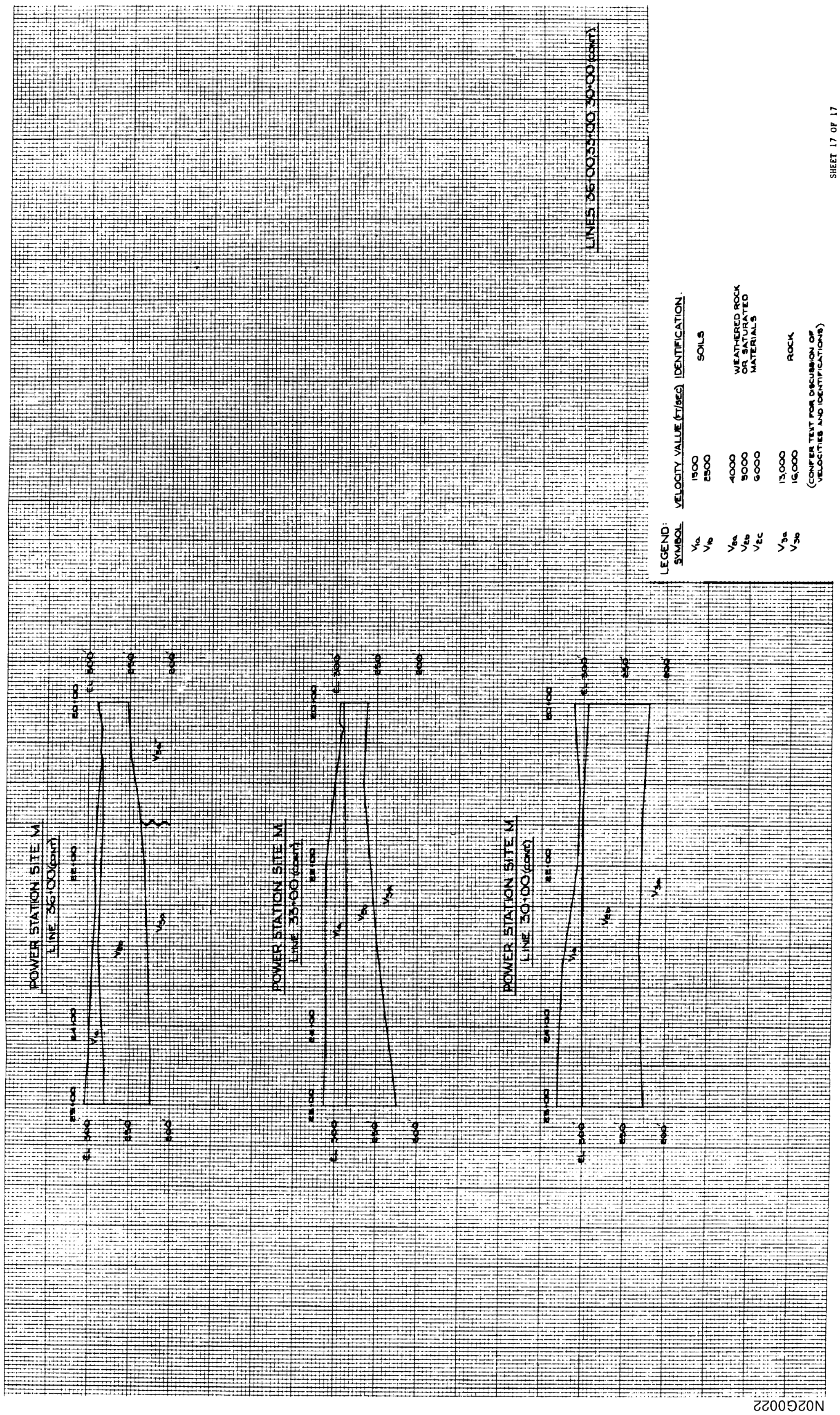
SHEET 16 OF 17
N02G0021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5000
6000
WEATHERED ROCK OR SATURATED MATERIALS
13,000
16,000
ROCK
(CONFER TEXT FOR DISCUSSION OF VELOCITIES AND IDENTIFICATIONS)
SHEET 17 OF 17
N02G0022

Appendix 2C[1]
Report on Foundation Studies for the Proposed North Anna Power Station in Louisa County, Virginia
PREPARED BY DAMES & MOORE

1. Appendix 2C was submitted as Appendix B in the original FSAR.

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VIRGINIA EARTHQUAKES

BACKGROUND

The PSAR submitted for the proposed North Anna Power Station in Louisa County, Virginia includes an Engineering Seismology report. In this report 12 percent of gravity is recommended for the "Design Basis Earthquake" ground accelerations.

In a subsequent discussion with the AEC staff and their consultants they made a recommendation for a "Design Basis" ground acceleration of 15 percent of gravity. The recommendations in both instances are for sound rock foundation conditions. We will discuss only the selection of the "Design Basis Earthquake" since the "Operational Basis Earthquake" accelerations are reached through a halving of the "Design Basis" shock criteria for the North Anna environment.

Pages IIC-1 to IIC-13 of the "Engineering Seismology" section of Appendix A to Part B of the PSAR provides the background for this study. In summary, the "Design Basis" earthquake was selected through the following reasoning.

1. There is a history of minor earthquake activity (see Plate IIc-1) related to faulting associated with certain synclinal and graben structure in the region to the southeast and southwest of the site. The closest shocks are along the Arvonia Syncline and in the Richmond Basin.

2. Since epicenters of old earthquake cannot be precisely located we have conservatively assumed that a number of the older shocks were associated with the Arvonia Syncline, and projected this synclinal structure along the trend of regional structure.

3. We then took what was found to be the largest reported shock in the Piedmont Province and postulated its occurrence in the vicinity of the site. The shock used was the 1875 shock, apparently located near Arvonia, Va. and listed as Modified Mercalli VII. (see pgs IIC-6 and IIC-7). On the basis of this assumption, the maximum acceleration expected on the sound foundation rock (gneiss) at the site was 12% of gravity.

We believe that the procedures used in the North Anna Seismology study are in general accord with those proposed in the tentative AEC “Seismic and Geology Siting Criteria for Nuclear Power Plants”.

In discussion with the AEC consultants they indicated a wish to assign a “Design Basis” intensity rating of low Modified Mercalli VIII to the North Anna site. This rating would result in a ground acceleration of 15 percent of gravity.

It was stated at that time that Dames & Moore believed a more extensive review of the earthquakes history of the site region would tend to downgrade the intensity of the significant historical shocks.

CURRENT INVESTIGATION

The seismicity of Virginia was extensively reviewed. Particular attention was paid to the larger shocks, with special reference to those that might have affect, or whose recurrence might affect the North Anna site. Our seismologists visited the epicenter regions, reviewed the areal geology, and recovered and reread the contemporary newspaper accounts of the most significant earthquakes. We consider these shocks to be the “1774 Eastern Va.” shock, the “1875 Arvonia” shocks, the “1918 Luray, Va.” shock and the “1919 Front Royal, Va. shock”.

The most significant parameters in attempting to evaluate an early earthquake under present day terminology are the damage, the type of construction in the epicentral area, the “felt” area and the length of shaking. We will discuss these points in the subsequent paragraphs.

EARTHQUAKES OF DECEMBER 22, 1875

The shocks of December 22, 1875, were the most important of the previously noted events, since they had the highest reported intensity of any shocks in the Virginia Piedmont in the last 200 or so years. The series of shocks is rated as Modified Mercalli Intensity VII by the USC&GS (ref (6) but are rated as Rossi-Fore1 (RF) Intensity VII by MacCarthy 1964 and Taber (1913). RF VII is generally considered equivalent to about MMVI.

We reviewed a number of newspaper articles of the time (Newspaper References 1-4) as well as the pertinent literature references (7, 14, 18 and 23). Detailed reports from about 36 communities, principally in Virginia but stretching from Maryland to North Carolina indicate widespread rattling of windows and a more than usual amount of ground and structural noise normal in small shocks. We can assume that the houses were of normal,

non-earthquake resistant construction because of the rarity of Virginia earthquakes. However, damage is limited to a very, very few cases of broken window panes, cracked or fallen plaster, and several damaged chimneys. The only report of a fallen chimney is that which occurred during the second (and weaker) of the series of shocks on the evening of December 22. In fact apparently most of the people in Richmond slept through the shocks (which occurred about midnight). The earthquakes were of great concern and interest to the newspapers since they were so unusual in occurrance, thus they were rather extensively reported. A Modified Mercalli Intensity of VI (which may be equated to a Rossi-Forel Intensity of VI to VII) is as high as can be justified in the basis of all the "damage" reports.

In general, the part of the estate affected by the 1875 earthquake (as well as the shocks of 1774, 1918 and 1919 to be discussed later), has but a very thin veneer of soil overlying quite competent rocks. These materials tend to transmit the earthquake energy with little attenuation, so there are but few cases of the amplification of earthquake basement rock motion by overlying soft soils. However, had this rock motion been significant, there would have been more damage reported in some of the softer sites, such as along waterfronts and in the river basins. We would normally expect that some anomolously high intensities even in an area of moderate motions. Even the waterfront of Richmond reported no significant damage in the 1875 shocks.

The reported location of the 1875 shocks is also in doubt. These and other shocks were reported to have epicenters in Buckingham Co., in the vicinity of Arvonia. This epicentral location is proposed by Taber (1913), State Geologist of South Carolina. The epicenter accuracy for the 1875 shocks, indicated by the latitude and longitude determinations to a tenth

of a degree, by Taber does not appear to be valid. The best evaluation from the available that we can make is to assume that the macro-seismic zone coincides with the epicentral area, so that Richmond or the area just to the west would be the epicenter.

The most distant point in which the shock was felt was at White Sulphur Springs, just west of Covington, Virginia, approximately 150 miles west of Richmond. The felt distances to the north and south of Richmond are less than this. However, if we conservatively take 150 miles as a radius of perceptability, the felt area is approximately that reported by Taber, about 50,000 square miles. Taber assigns a Rossi-Fore1 intensity of VII and we believe his comments accurately summarize the reports of contemporary newspapers.

As previously indicated the area of perceptability of a shock is a measure of its size.

A discussion of the intensity-felt are a relationship of the region is given by Bollinger, (1969). He states that there is an extreme variability (of up to three orders of magnitude) in the felt area for a given epicentral intensity. This variability is tool too large to be accounted for by incomplete surveys or by differences in interpretational techniques. Thus it appears to be the nature of the origin of the shocks and the regional geology. Earthquakes centered in Virginia with assigned maximum intensities of VI have had felt areas varying from 1,000 square miles to 400,000 square miles.

Thus the 50,000 square mile felt area reported in the literature for the 1875 earthquakes places them we11 within the range indicated.

A maximum intensity of VI also is compatable with the area of perceptability.

The length of shaking estimated most by the local inhabitants is 10 seconds. One estimate was as low as 5 seconds and one as long as 2 minutes. All other time estimates were in the 10 to 20 second range, indicating a relatively low magnitude shock.

EARTHQUAKE OF FEBRUARY 21, 1774

Less information on the shock of 1774 is available than that for the shocks of 1875. However, in comparing the available data (4, 7, 8, 9 and 20) on the 1774 and similar shocks, it appears that the 1774 shock is smaller than the largest of the Dec. 22, 1875 shocks.

EARTHQUAKE OF APRIL 9, 1918

The earthquake of April 9, 1918 also appears to have been rated on Rossi-Fore1 intensities and carried over into the literature as Modified Mercalli intensities. Wattson (1918) indicated a Rossi-Fore1 VI, intensity assignment to the shock. This rating would be substantially a Modified Mercalli V. Details reported by Wattson and the local newspapers from Staunton and Winchester, do not reveal damage in excess of a Modified Mercallie Intensity V. A few broken window, cracked plaster, rattled dishes and noise constitute the total damage. Soil conditions in the area would not generally amplify motion. Even in the flat areas soil covers of 20 to 30 feet are general, with outcrops of harder rock normal in the hills. The only unusual earthquake report concerned a spring in a road near Hamburg. This is an area of solution activity with erratic flow paths in the sinkholes. Variation in springs and flow would be normal, with or without an earthquake.

EARTHQUAKE OF SEPTEMBER 5, 1919

Damage reported from the September 5, 1919 earthquake was not greatly different from the shock of the preceeding year. The most extreme effect was a few cases of the falling of plaster and a few streams muddied. The muddied streams may have been through areas of red residual clay, common to the area. The report by Woolard (1919), also indicated the change of flow of spring, and rocks falling from chimneys near Arco. An intensity of MMVI would apparently be the maximum justified for this earthquake. Surface amplification effects would not be expected in the Warren County area in this or the 1918 earthquakes.

CONCLUSIONS

Examination of the source material, newspapers, the literature, and discussion with local residents, indicates that the earthquakes of 1774, 1875 and of 1918 are slightly overrated. In the case of the 1875 earthquakes we feel that the Rossi-Fore1 intensity may have been improperly carried forward into the Modified Mercalli scale without justification. Richmond's newspapers at the time provided us with a wealth of field detail, missing from shocks having epicenters in less populous areas.

We do not feel that events larger than those postulated in our original report are probable for this portion of the Virginia Piedmont. We believe that the recorded earthquake history indicates no shocks larger than MMVI have occurred in the Piedmont of Virginia and thus our original analysis of the areal seismicity is adequately conservative or perhaps even over conservative.

VIRGINIA EARTHQUAKES

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4.	Gordonsvi11 Gazette		Jan. 6, 1876
5.	Old Commonwealth		
	Harrisburg, Va.		Dec. 30, 1875
6.	Warren Sentinel		
	Ft. Royal, Va.		Sept. 12, 1919
7.	The News		
	Lynchburg, Va.		April 10, 1918
8.	The Daily Progress		
	Charlotteville		April 10, 11, 1918
9.	Winchester Evening Star		April 10, 11, 1918
10.	Staunton Daily News		April 10, 11, 1918

ANCHORAGE HOUSTON
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DAMES & MOORE

CONSULTING ENGINEERS IN THE APPLIED EARTH SCIENCES

14 COMMERCE DRIVE · CRANFORD, NEW JERSEY 07016 · (201) 272-8300
CABLE: DAMEMORE TWX: 710-996-5959

May 8, 1969

Virginia Electric and Power Company
700 East Franklin Street
Richmond, Virginia

Attention: Mr. Stanley Ragone

Gentlemen:

We submit herewith ten copies of our "Report, Foundation Studies, Proposed North Anna Power Station, Louisa County, Virginia, Virginia Electric and Power Company."

The scope of this work was planned in agreement with Virginia Electric and Power Company and Stone and Webster Engineering Corporation. The information presented herein complements that presented in our Site Environmental Report on the North Anna Site.

Foundation conditions at the site are generally excellent. Attention should be paid to the emergency cooling water pond dikes and stability of the reactor excavations, as described herein.

We wish to thank the Virginia Electric and Power Company for the opportunity to have assisted on this project and their continued confidence in Dames & Moore.

If you have any questions, please do not hesitate to contact us.

Yours very truly,

DAMES & MOORE

Joseph A. Fischer

JAF-TET;ep
(10 copies submitted)
cc(10): Stone and Webster Engineering Corporation
225 Franklin Street
Boston, Massachusetts
Attention: Mr. William F. Swiger

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REPORT
FOUNDATION STUDIES
PROPOSED NORTH ANNA POWER STATION
LOUISA COUNTY, VIRGINIA
VIRGINIA ELECTRIC AND POWER COMPANY

INTRODUCTION

GENERAL

This report presents the results of our foundation studies for the proposed North Anna Power Station. The station is to be constructed by the Virginia Electric and Power Company at a site located adjacent to and southeast of North Anna River, about 32 miles northwest of Richmond, Virginia. The site is shown in relation to the surrounding topographical and cultural features on the Map of Area, Plate 1.

PURPOSES

The purposes of these studies were to provide specific recommendations and criteria for use in the design and installation of foundations for the proposed facilities and to provide general information relative to the construction of the major and appurtenant facilities.

SCOPE OF WORK

Our investigation for the proposed power station site was divided into two parts: site environmental studies and foundation studies. The results of our site environmental studies are contained in a prior report*

*"Report, Site Environmental Studies, Proposed North Anna Power Station, Louisa County, Virginia, Virginia Electric and Power Company."

dated January 13, 1969. The present report is concerned exclusively with our foundation studies for the proposed plant facilities. However, the information contained in our previous report was fully considered in the development of the conclusions and recommendations presented herein.

A total of 60 borings have been drilled to define subsurface conditions at the proposed location so the plant facilities. Field operations were performed under the technical supervision of Dames & Moore soils engineers and engineering geologists.

Fifty-four borings were drilled at specific building locations to obtain foundation design data. Six other borings were drilled at various locations across the site to obtain general geologic information. In addition, a number of test pits and trenches were excavated in the proposed station area to help in defining geologic conditions. The results of all borings were considered in the preparation of this report.

Undisturbed soil samples, suitable for laboratory testing, were extracted from selected borings utilizing the Dames & Moore soil sampler. Standard split-spoon samples were also obtained in selected borings for correlation and identification purposes. NX-size rock cores were extracted from 54 borings. All soil samples and selected rock cores were forwarded to our New York office for further examination and laboratory testing. Most rock cores were stored near the site in a facility provided by the Stone & Webster Engineering Corporation.

The manner in which the field investigation was conducted is more fully described in our previous report. The results of the field explorations and laboratory tests, which provide the basis for our engineering analyses and recommendations are also presented in our previous report. Certain laboratory tests (not included in our previous report) were performed specifically to evaluate foundation criteria and are presented in the Appendix to this report.

DESIGN CONSIDERATIONS

The proposed nuclear generating station will be composed of both Class I and appurtenant facilities. The Class I facilities will include:

1) two reactor containment vessels;
2) an auxiliary building;
3) a pumping station;
4) a fuel handling building; and
5) an emergency cooling water storage system.

The major appurtenant facilities include turbine generator buildings, an administration building, and a service building.

Design data pertaining to the main structures were provided by Stone & Webster Engineering Corporation. The bearing pressures imposed by the individual structures were assumed to be equal to the corresponding components of Virginia Electric & Power Company's Surry Nuclear Power Station, as suggested by Stone & Webster. The design data used in our analyses are presented on Table 1.

TABLE I
ASSUMED DESIGN DATA

STRUCTURE	APPROXIMATE PLAN DIMENSIONS	BASE ELEVATION*	DESIGN PRESSURE AT BASE
	(feet)	(feet)	(psf)
Reactor Unit	145 (diameter)	+204±	8,000
Turbine Mat	170 x 50	+243±	5,000
Turbine Building	540 x 135	+243±	3,000
Pump House	80 x 190	+200±	3,000
Fuel Handling Building	41 x 136	+245±	8,000
Auxiliary Building	115 x 100	+243±	2,000
Service Building	295 x 66	+243±	1,000

The locations of the proposed facilities are shown on the Plot Plan, Plate 2.

SITE CONDITIONS

SURFACE FEATURES

The site is located southwest of and adjacent to the North Anna River, about four miles northeast of the town of Mineral, in Louisa County, Virginia. The site area is characterized by hilly, rolling topography, and is generally densely wooded. Surface elevations at the site vary from about +320 feet in the southwest portion of the site to +205 feet near the North Anna River. The proposed plant will be located in the central, higher portion of the site. Existing surface elevations within the proposed construction area range from about +295 feet to +270 feet ±.

*All elevations presented in this report refer to U.S.G.S. Datum.

Several seasonal streams which flow into the North Anna River are found on the site. Several springs are also found on the site but their discharge rates are dependent on climatic factors. During periods of deficient rainfall, the flows of the springs diminish, and in many instances cease. Drainage from the proposed construction area is to the north and the east. Runoff to the north enters an eastward flowing creek which discharges in to the North Anna River. Drainage to the west goes directly into the North Anna River.

Access to the construction area was, at the time of our investigation, through an unpaved road which intersects Virginia Route 652. Several timber clearing operations were in progress at that time in areas near the site. A high voltage transmission line running approximately northeast-southwest crosses the construction area south of the proposed location of Unit 2. Trees beneath the transmission line have been cleared for a width of about 100 feet.

The dense woodlands and vegetation found over the majority of the site required relatively extensive clearing operations to provide access for the drilling equipment. The exposed soils were found to be firm and relatively dry and easily capable of supporting such equipment.

SUBSURFACE CONDITIONS

The results of the field exploration program indicate that the station area is underlain by three basically different, but related materials. These are, in order of increasing depth:

1) residual silty fine sand and sandy silt with some gravel (saprolite);

2) highly weathered rock; and

3) relatively fresh rock.

A layer of surficial silty clay and clayey silt, generally about four to six feet thick, is found over a large portion of the site. These cohesive surficial soils are residual, but have been weathered to the extent that they no longer retain any of the structural characteristics of the parent rocks. The underlying silty sand-sandy silt materials, on the other hand, retain many of these parent structural features. The strike and the dip of the foliation, metamorphic segregation, and minor folds and joints are evident in these saprolitic silty sands and sandy silts. These soils are generally moderately compact to very compact and because of their retained rock structure, display an apparent cementation. The average thickness of saprolite development across the site is on the order of 40 feet. Within these selected construction areas, the average saprolitic development is relatively shallow, averaging about 25 to 30 feet in depth below the existing grade. The thickness of weathering was found to vary considerably over short horizontal distances, and thus relatively sharp variations in thickness of saprolitic development should be anticipated in future construction operations.

A zone of relatively compressible soils was encountered in the proposed switchyard area, toward the southwest portion of the site. In this area, the saprolites are noticeably softer and contained higher percentages of silts and clays than in other portions of the site.

Bedrock underlying the proposed site consists of granitic and hornblende gneisses, probably of Ordovician age. The predominant rock type at the site is a gray, fine-grained, granitic gneiss. Weathering of this rock type has produced a yellowish-brown silty sand which predominates in the saprolitic overburden.

The hornblende gneiss occurs as zones within the granitic gneiss. Two such zones are found near the northern and southern limits of the proposed construction area. These zones, which are about 200 feet and 70 feet wide, respectively, run approximately northeast-southwest, roughly parallel to the building limits. Weathering of the hornblende, which is generally deeper than weathering of the granitic gneiss, has produced the greenish-gray sandy silt saprolite.

Both rock types strike from North 60 degrees East to North 80 degrees East and dip to the northwest in the proposed station area. Occasional quartz seams and pegmatite dikes are found within the rock.

In general, as would be expected, the rock gradually becomes less weathered with increasing depth of a particular seam. As a result of the inclination and variation in properties of the parent material, in some instances a more weathered zone could be encountered below less weathered material. Within the proposed construction area, the surface of the relatively fresh rock was generally encountered a t Elevation +240 feet ±. Contours of the surface of the relatively fresh rock are shown on the Plot Plan, Plate 2.

The reactor facilities will be founded at about Elevation +204 feet on relatively fresh rock. Most other major facilities will be

installed on slightly to moderately weathered rock at higher elevations. The subsurface conditions beneath the locations of each of the proposed facilities are discussed in further detail in subsequent sections of this report.

FOUNDATION DESIGN CRITERIA

GENERAL

Based upon the results of this investigation it is our opinion that, from a foundation standpoint, the firmer residual soils, the weathered rock, and the relatively fresh rock are all suitable for the support of the proposed plant facilities. Although the anticipated foundation movements will be small, it may be desirable to support individual heavily loaded structures on a single type of foundation material, i.e., either soil or rock but not both, in order to minimize differential foundation movements.

Selection of the proposed construction area was based on the results of preliminary field geophysical surveys which indicated that fresh rock was found at relatively shallow depths. Consequently, the Class I facilities will be founded on either fresh rock or slightly weathered rock. Certain appurtenant facilities will be underlain by limited thicknesses of compact residual soil.

It is our opinion that the subsurface material underlying each of the proposed facilities will be suitable for support of those facilities. The rock supporting each of the proposed Class I facilities will not be subject to loss of strength under earthquake loading.

Similarly, the compact residual soils which may underlie certain of the appurtenant facilities will not be subject to liquefaction under earthquake conditions because of:

1) the high relative densities of the in-situ soils; and

2) the apparent cementation exhibited by the soils (saprolites).

MAJOR FACILITIES

Reactor Containment Facilities: The reactor containment buildings will be constructed in the southeastern portion of the construction area, as shown on the Plot Plan, Plate 2. The lowest floor of the structure will be established at about Elevation +204 feet. In order to reach this elevation, excavations about 90 to 100 feet deep will be required. We understand that the mat pressures imposed on the foundation materials will be about 8,000 pounds per square foot.

The results of our investigation indicate that the containment mats will be founded below the surface of the relatively fresh rock. Consequently, it is anticipated that the rock encountered at the proposed foundation floor will be sound. However, our investigation revealed occasional seams of weathered rock to significant depths below the surface of the relatively fresh rock. We do not expect these seams to be thick enough to affect the mat performance. However, it is recommended that the rock exposed at foundation level be carefully examined by an experienced engineering geologist. If large weathered rock seams are found, they should be removed to a depth such that the mat is underlain by at least five feet of unweathered rock and replaced with lean concrete.

Since the excavation will be open for a considerable period of time, it may be prudent to install a “mud mat” of lean concrete, about three inches thick, to protect against deterioration of the foundation rock, particularly due to freeze, thaw cycles. The concrete mat foundations for the structures subsequently can be placed directly on the concrete slab. This recommendation is applicable for any building excavations which will expose the supporting materials for a relatively long period of time.

We estimate that the containment mat will experience center settlements consisting of elastic deformations of less than one-half inch under a design load of 8,000 pounds per square foot. The deformation will occur immediately upon load application. Since the structures consist primarily of dead load we expect most of the deformation will occur during construction. Post-construction movement will be small, less than one-quarter of an inch.

Fuel Handling Building: The fuel handling building will be constructed between the two containment facilities at Elevation +245 feet ±. It will be supported on a mat foundation and will impose pressures of about 4,400 pounds per square foot. The results of our investigation indicate that the fuel handling building location is underlain by sound rock at the proposed mat elevation.

We estimate that the fuel handling building supported on a mat foundation on the relatively fresh rock will experience elastic movement of less than one-quarter inch due to the anticipated bearing pressure. The deflection will result from elastic compression of the rock and should occur immediately upon load application.

Turbine Generator Buildings: The turbine generator buildings will be installed northwest of the containment facilities. The mat beneath the turbine generators will be about 150 by 70 feet. It will be installed at Elevation +243 feet and impose bearing pressures on the order of 5,000 pounds per square foot. A relatively lightly loaded concrete floor slab will cover the remaining building area of the turbine generator buildings.

The results of our investigation indicate that the supporting materials at the location of the Unit 1 turbine mat will consist of fresh rock. We estimate that the elastic deformation of the foundation rock will be less than one-half inch beneath the turbine mat. Since the imposed pressures will be due principally to dead load, the anticipated deformation should occur during construction and installation of equipment.

Borings drilled at the location of the turbine mat to be installed for Unit 2 indicate that the mat will be underlain by from 10 to 30 feet of saprolitic soils which overlie relatively fresh rock. The saprolite is approximately ten feet thick near the northeast corner of the turbine mat and it thickens toward the southwest. The results of our investigation indicate that the saprolite is slightly compressible at these locations. Differential movements of up to about one inch can be expected between the northeast and southwest portions of the turbine mat, assuming the mat is isolated from the surrounding building floor.

The saprolites below mat elevations will expand because of a stress release caused by removal of the overburden in excavating to the desired elevation. We would estimate that the rebound would be on the order of one-quarter of an inch toward the northeast corner of the mat

and up to three-quarters of an inch toward the southwest corner. Upon application of the mat load, the soils will recompress to near their original density and additional compression will take place since the applied load will be greater than in the previously existing overburden pressure. We would estimate that total settlements on the order of three-quarters to one and one-fourth inches near the northeastern portion and one and three-quarters to two and one-half to the southwest portion of the mat will occur upon load application. The results of the consolidation tests performed on the saprolites indicate that they will drain relatively quickly, so settlements should take place rapidly, essentially on load application.

Differential settlement of the Unit 2 turbine mat can be minimized by supporting the mat on are in forced monolithic slab underlying the entire turbine building. The effect of a single slab would be to distribute load over a greater bearing area and to tend to bridge areas containing less competent supporting materials. However, considering that the saprolite seems to thicken toward the southwest corner of the turbine building, some differentia1 movements should be anticipated beneath any monolithic slab poured to support the turbine building. If the mat is made sufficiently rigid, however, the differential movements would be significantly less than those previously described for an isolated turbine mat.

Auxiliary Building: The auxiliary building will be located north of the fuel handling building as shown on the Plot Plan, Plate 2. The building will be supported at Elevation +23± on a mat foundation about 115 by 100 feet. A design bearing pressure on the order of 2,000 pounds per square foot is anticipated.

The results of our investigation indicate that the auxiliary building is underlain primarily by slightly weathered to fresh rock. However, saprolitic soils were found to extend to about Elevation +218 feet ± in a nearby boring somewhat northwest of the proposed auxiliary building location. Therefore, it is possible that the northern portion of the auxiliary building will be underlain by saprolitic soils.

We believe however, that negligible settlement would occur from founding the auxiliary building on a combined saprolite-rock surface at the proposed location since the saprolites in this area were observed to be very dense and the design bearing pressure is relatively low (2,000 pounds per square foot). We estimate that settlement will be one-quarter inch or less if the mat is founded on either fresh rock or compact saprolite.

Pump House: The pump house (screen well) will be constructed north of the proposed units within an existing valley. The structure will be supported on a mat foundation approximately 80 by 190 feet at Elevation +200 feet ± and will impose design bearing pressures on the order of 3,000 pounds per square foot.

The results of our investigation indicate that competent, relatively fresh rock will be encountered beneath the pump house at the proposed founding elevation. We believe the fresh rock will provide suitable support for the pump house foundation mat. Settlements of the mat will consist of elastic compression of the underlying bedrock and will be less than one-quarter inch. All deformations will occur essentially on load application. Residual settlements will be negligible.

<u>Emergency Cooling Water Supply</u>: An emergency cooling water storage pond will be constructed south of the proposed plant at the location shown on Plate 2, Plot Plan. The cooling water supply will be stored in an open pool, the bottom of which will be established at about Elevation +295 feet.

Approximately ten feet of water will be maintained within the pool. Existing surface elevations at the proposed pool location range from about +270 to near +310 feet. Consequently, construction of the pond will require the building of a dike in the lower areas and cuts into in-situ materials where higher elevations presently exist. We understand it is planned to place compacted on-site fill in the lower portions of the area and construct the needed dikes of similar compacted material. We further understand that the slope of the outboard dike face will be on the order of one vertical to two horizontal, and that the entire exposed pool bottom will be lined with compacted impermeable material.

We believe that the lining of the pool is important since the lining will:

1) eliminate the necessity of designing the dike to resist rapid drawdown conditions; and

2) reduce the water loss through the dike and pond floor, thus reducing the possibility of loss of quantities of radoactive material.

We estimate the amount of water which might percolate through the proposed dike, if constructed only of on-site materials compacted to 95 percent of the maximum dry density defined by AASHO Test T-180-61, would be on the order of 1,000 gallons per day for a dike length of 400 feet. Percolation through the pond floor would also account for about

2,000 gallons per day flowing under the dike. Thus, lining the pond will reduce the amount of make-up water needed to maintain a constant water volume in the pool. In addition, use of an unlined dike would probably require dike design to resist rapid drawdown conditions. This design would require flatter slopes than those presently anticipated.

We understand the pool bottom is to be lined with compacted clay, which is presently found to a depth of four to five feet throughout most of the site area. The clay will be stockpiled during stripping and excavating operations and placed within the pool after excavation to the desired depths. The thickness of the clay layer should be controlled by the amount of clay necessary to adequately compact a three-inch layer. It is recommended that the clay be compacted with a sheeps-foot roller. Assuming that the upper 6 inches are not sufficiently compacted by a sheeps-foot roller, it is recommended that the loose thickness of the clay be on the order of 9 to 12 inches. Compaction should continue until the roller "walks out" of the clay. We understand the proposed dike slopes will be 1 vertical to 2 horizontal on the outboard face.

The results of our analyses indicate that the dikes will be stable at the proposed slopes. However, under earthquake conditions the factor of safety against failure is only 1.3. If additional conservatism is desired, it is recommended that the dike slopes be flattened to 1 vertical to 2½ horizontal. We have computed a factor of safety of about 1.6 under dynamic conditions for those slopes. It is recommended that cuts into the saprolite be also made at a slope of 1 vertical to 2 horizontal. The cut slopes should be carefully examined for evidence of clay filled seams along the foliation. Evidence of such seams may require flattening of the slopes at those locations to avoid stability problems.

SMALLER FACILITIES

The service building (and relay rooms) will be installed north of the auxiliary building. The service building will be supported on a mat foundation about 295 by 65 feet in plan dimensions and will impose pressures of approximately 1,400 pounds per square foot.

The results of our investigation indicate that the foundation mat will be underlain at the proposed location by variable subsurface conditions. The pertinent borings indicate: 1) that lightly weathered to relatively fresh rock will be encountered in the northeast portion of the building; and 2) that up to 25 feet of saprolite will be encountered toward the southwest. We estimate that the mat settlements may be as great as one-half to three-quarter inches in the southwest portion of the service building. The northeastern portion of the mat will be supported on relatively fresh rock which will experience negligible deflection under the anticipated load. Settlements will occur essentially upon load application.

Switchyard: The switchyard will be located to the east of the proposed reactor units at the location shown on the Plot Plan. The proposed switchyard area is about 800 by 1,000 feet in plan dimensions. Existing surface grades within the switchyard vary from about +320 feet to +260 feet. The higher portions are toward the southern corner and the lower portions toward the northern corner of the area. We understand the nature of the equipment contained in the switchyard is such that a wide range of foundation sizes and bearing pressures may be imposed.

Our investigation in the switchyard area indicates that relatively compressible silts and clays are found above compact saprolites which in turn overlie bedrock. The thickness of compressible materials varies from 25 feet near the sourthern switchyard corner to negligible amounts near the northern corner.

The existing ground surface slopes considerably within the switchyard area. Significant site preparation will therefore be required to provide suitable support for the proposed facilities. A number of grading alternates is available for founding the proposed facilities. Possible grading plans would include:

1) excavating of all in-situ materials to a uniform site grade;

2) establishing individual units on terraces approximately following existing grades; or

3) filling the lower areas to provide a uniform grade.

Excavation of existing materials to provide a uniform elevation will probably be most suitable from a foundation point of view. The excavated clays and silts would be suitable for use as compacted liner material in the emergency cooling water storage pond. The excavation should probably be carried to about Elevation 260 to insure exposure of either compact saprolitic soils or weathered to fresh bedrock. Seismic surveys performed by others, prior to the site selection, indicate that sound rock is found at about Elevation +255 feet in the general switch-yard area. Therefore, it is likely that weathered rock and saprolite will be exposed in excavating to about Elevation 260.

Spread or mat foundations established on exposed compact saprolites can be designed utilizing bearing pressures of up to 6,000 pounds per square foot. A minimum footing width of two feet is recommended. Settlements under these pressures will be relatively small and would occur essentially on the load application.

Foundations established on weathered rock may be designed utilizing the pressures of up to 12,000 pounds per square foot. A minimum footing dimension of two feet is recommended. Foundations of the assumed sizes would experience negligible deflections.

If the switchyard components are established on terraces formed in compressible in-situ clayey soils, significant settlements will occur. If a terrace-type grading scheme is required, we recommend that bearing pressures be limited to maximum of 3,000 pounds per square foot. Estimated settlements for varying imposed loads, bearing pressures, and thicknesses of compressible material are shown on Plate 3. The estimated settlements would occur after a period of time proportional to the square of the thickness of compressible material. We estimate that 90 percent of the settlement due to 10 feet of compressible soils would occur in about one year. In using the data presented on Plate 3, the thickness of compressible materials may be assumed to be 25 feet in the southern portion of the switchyard, 15 to 20 feet near the center and less than 10 feet near the northern portion of the area.

It i s suggested that the third grading alternative, i.e., fill placement to attain a uniform grade, not be adopted because of:

1) the possibility of inducing stability problems in the relatively soft slays and silts in the southern portion of the site; and

2) significant areal settlements which might occur as a result of fill placement upon the compressible materials.

If it is an absolute necessity to place fill in the switchyard to attain a uniform grade, we would be pleased to perform additional analyses to evaluate the stability and settlement performance of the underlying soils.

FOUNDATION INSTALLATION

GENERAL

Preparation of the North Anna site for construction of Units 1 and 2 will consist primarily of excavating the in-situ soils and rocks to attain the desired grades. This section of the report discusses the excavation and dewatering, necessary to install the proposed facilities.

EXCAVATION

It is understood that the entire building area will be excavated to about Elevation +255 feet prior to the installation of any facility. Most of the excavated material will be used in the construction of dikes and dams associated with the proposed reservoir. However, the surficial four to six feet of clayey silt and silty clay encountered on most of the site area will be stockpiled for use in lining the emergency cooling water storage pond.

It is recommended that the silts and clays which are to be used in lining the cooling pond, be thoroughly grubbed prior to stockpiling to avoid inclusion of roots and other deleterious materials in the pond liner. After removal of the surficial materials it will be necessary to remove an additional 20 feet or so of residual saprolite to attain the desired grade of Elevation +255 feet. It is anticipated that relatively fresh rock will be exposed over most of the site in excavating to this grade. It should be further anticipated that ribs of relatively fresh rock may be encountered above this grade in certain areas. It is likely that blasting will be required to remove these materials.

REACTOR EXCAVATIONS

The reactor units will be founded at Elevation +204 feet ±, requiring cuts of up to 50 feet beneath the general construction grades. Rock excavation at the reactor locations will require blasting. Pre-splitting should be used around the excavation perimeter to facilitate formation of relatively smooth sides.

A number of joint systems are found in the bedrock at the site. Detailed descriptions of the observed joint patterns are contained in our previous report. Brief descriptions of the joint sets follow:

Set 1: Strike N 10° - 20° E
Dip: 80° W
Description: Seldom show movement or clay fill

Set 2: Strike: N 60° - 80° E
Dip: 45° 60° NW
Description: Bedding Plane joints, little clay fill

Set 3: Strike: N 90° E
Dip: 85° N
Description: Little clay fill

Set 4: Strike: N 60° E
Dip: 50° SE
Description: Some clay fill

Set 5: Strike: N 50° W
Dip: 50° SW
Description: Some clay fill

Set 6: Strike: N 30° - 50° E
Dip: 50° SW
Description: All are clay filled and show shear movement.

It is possible that certain of these joint sets may singly or in combination, affect the stability of the reactor containment excavations. The stability of the excavations will be dependent on the number, type and specific locations of joint planes relative to the excavation walls. The orientation of the pertinent joint systems and an indication of the relative stability danger associated with these systems are shown on Plate 4, Danger of Wedge-Type Rock Failures in Reactor Excavation.

Those joints most menacing to the stability of the excavations are numbered sets 1 and 2 above, and on Plate 4. The intersection of these two joint sets on the southeastern portion of the excavations could present a very unfavorable stability situation. The intersection would tend to form a wedge which could slide into the cut in the direction of the line of intersection of the two joint planes.

Joint Set No. 1, which dips at an angle of about 80 degrees, is one of the most abundant sets observed across the site. Another steeply dipping set, number 3, although observed only in rock outcrops near the site and believed to be widely spaced, could conceiveably be found near the proposed excavations. We believe that occurrence of either of these joint systems in the excavation wall would result in an unstable rock condition. To avoid the potential stability problems associated with these joints, it will be necessary to cut the excavation walls at an angle of 80 degrees or less from the horizontal.

For wall slopes of less than 80 degrees, slope stability will be influenced by the foliation and joint Sets 2, 4, and 5.

We believe the shear strength of the relatively fresh rock along the planes of foliation is suitable to support even a vertical cut. However, either the relatively low shear strength found along foliation planes of severely weathered rock or the presence of clay-filled joints along the foliation (joint Set 2) may adversely affect the stability situation in the south and southeastern portions of the cuts.

Boring data indicate that relatively fresh rock will be encountered in the southeastern portions of the proposed reactor cut. Isolated thin zones of slightly to moderately weathered rock were observed in the pertinent borings, but no evidence of joint Set 2 was found. The orientation of rock cores from Boring 28 has identified the presence of joint Sets 4 and 5 at about Elevation +245 feet ±.

Thus, the available evidence suggests that stability problems may exist at least in the south to southeast portions of the reactor cuts. Potentially unfavorable joint and rock conditons have been observed, and could influence excavation stability even if the excavation walls are cut at an angle of about 80 degrees, as previously recommended.

Realizing that potential problems do exist, several courses of action are available:

1) to perform detailed analyses using the available data and formulate a specific but necessarily very conservative design of tie back or retaining systems;

2) to utilize slopes of less than 45 degrees in both reactor cuts and replace the excavated slope rock with concrete; or

3) to carefully examine the exposed rock characteristics after excavating to the general construction grade of about Elevation +255 feet ±, and then decide on the most economical and reasonably conservative excavation scheme.

The ramifications of each of these alternates are discussed in subsequent paragraphs.

The design of a tie back or retaining system based on the presently available data would have to be predicated on the assumption that unfavorably oriented continuous clay-filled joint systems, similar to those previously mentioned, and continuous seam of severely weathered rock do, in fact, exist in the excavation face. This assumption may be very conservative since, many of the joints observed in our investigation had been healed, suggesting that the continuity of joint systems and weathered rock zones presently considered dangerous should

be more definitively established before major expenditures for remedial measures are made.

The second alternative listed above would be satisfactory from an engineering viewpoint but may be quite expensive. The costs of this alternative would include additional blasting and rock excavation, concrete placement and probably a system to tie the concrete to the underlying rock.

The third alternative, if workable into scheduling and contractual arrangements, would afford a good chance of a much more economical solution to the potential stability problem. We understand the entire construction area will be excavated to a uniform construction grade of about Elevation +255 feet. Exposure of the bedrock found at, or slightly below this elevation will afford the opportunity to carefully examine the local joint and rock conditions at the specific locations of the proposed reactor cuts. It is conceivable that the field observations will indicate that no major tie back system is required to safely complete the excavations. In the event that unfavorable conditions are found, this scheme will afford the opportunity to develop more specific parameters for use in design of economical stabilization systems. Parameters developed presently would be necessarily conservative extrapolations of data obtained in the borings and test pits performed at the site.

If this construction sequence is adopted, it will be necessary for an experienced engineering geologist to thoroughly and continually inspect the excavation as it progresses. The inspector should be fully familiar with the site conditions, proposed construction, and type of data required.

If a tie back system is deemed necessary, by the identification of dangerous joint, the most appropriate type for this type excavation would probably be prestressed anchors. Various rock mechanics methods are available to determine the number, lengths and directions of the anchors. The analytical approach should be determined by the degree of complexity of the observed conditions.

DEWATERING

The present static ground water level is found about 10 to 15 feet beneath the existing ground surface, and generally follows the topographical features. Since the construction area is located in a high portion of the site, recharge to the water level is provided by precipitation only. Consequently, we do not anticipate significant problems in dewatering the site during construction. We believe that the individual excavations may be adequately dewatered by sump pumping from peripheral drainage ditches.

Further discussion on hydrologic considerations is presented in our previous report.

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The following Plates and Appendix are attached and complete this report:

Plate 1	-	Map of Area
Plate 2	-	Plot Plan
Plate 3	-	Estimated Settlements of Spread and Mat Foundations in Switchyard
Plate 4	-	Danger of Wedge-type Rock Failures in Reactor Excavations
Appendix	-	Laboratory Tests

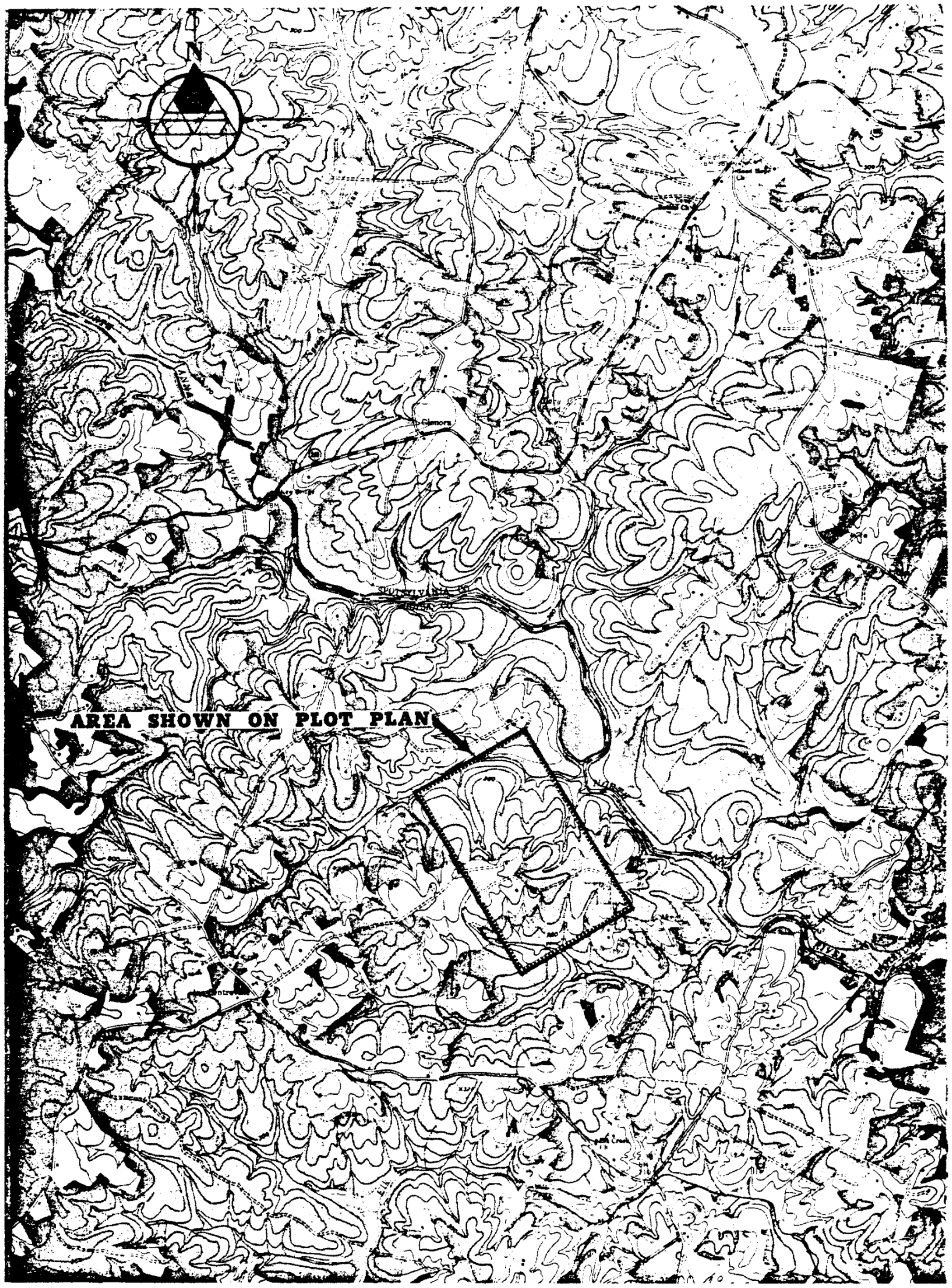
Respectfully submitted,

DAMES & MOORE

Joseph A. Fischer

Thomas E. Tully

JAF: TET/kc



MAP OF AREA

CONTOUR INTERVAL 20 FEET

REFERENCE:

THIS MAP WAS PREPARED FROM A PORTION OF USGS CONTRARY CREEK, VA. QUADRANGLE, 1942.

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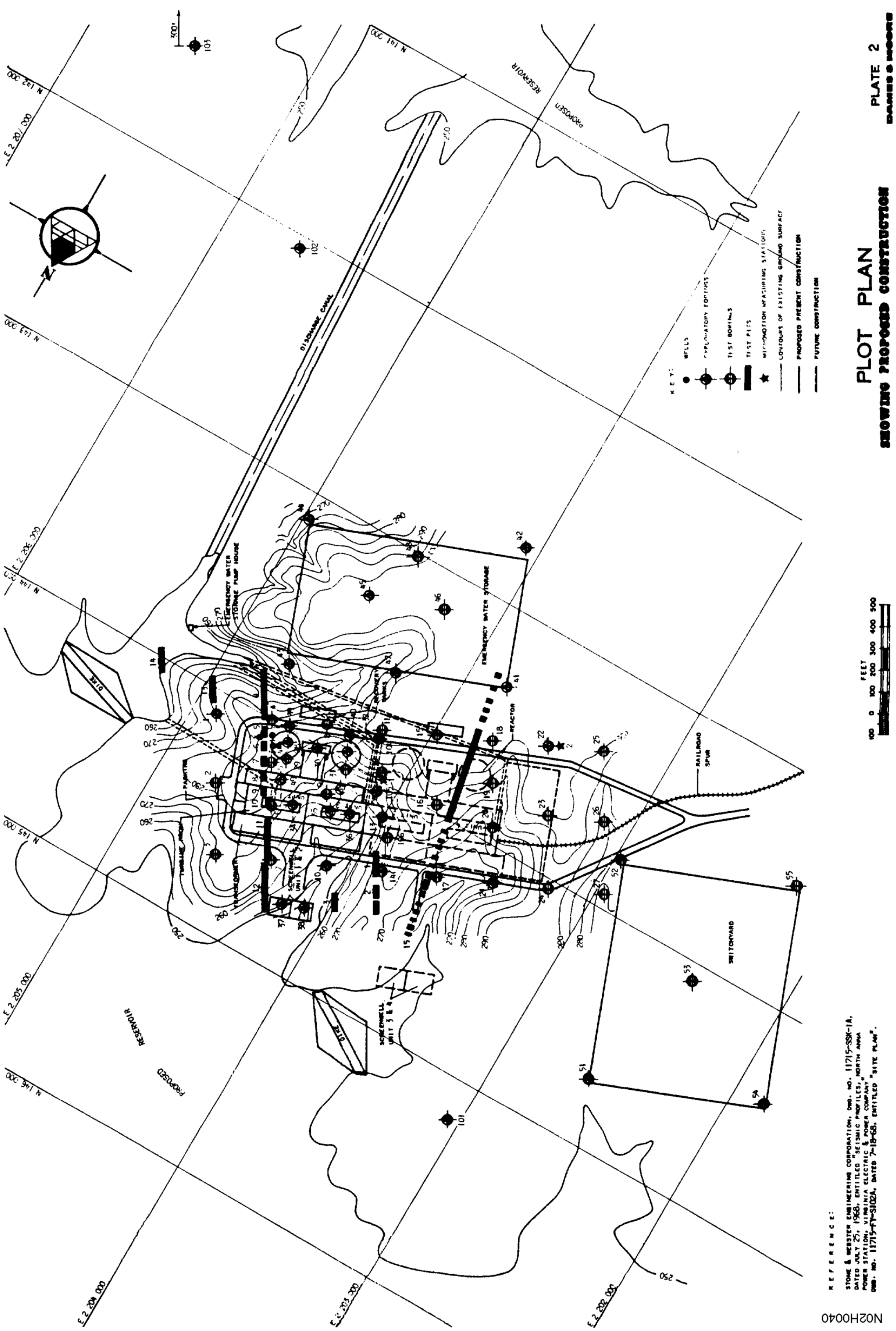
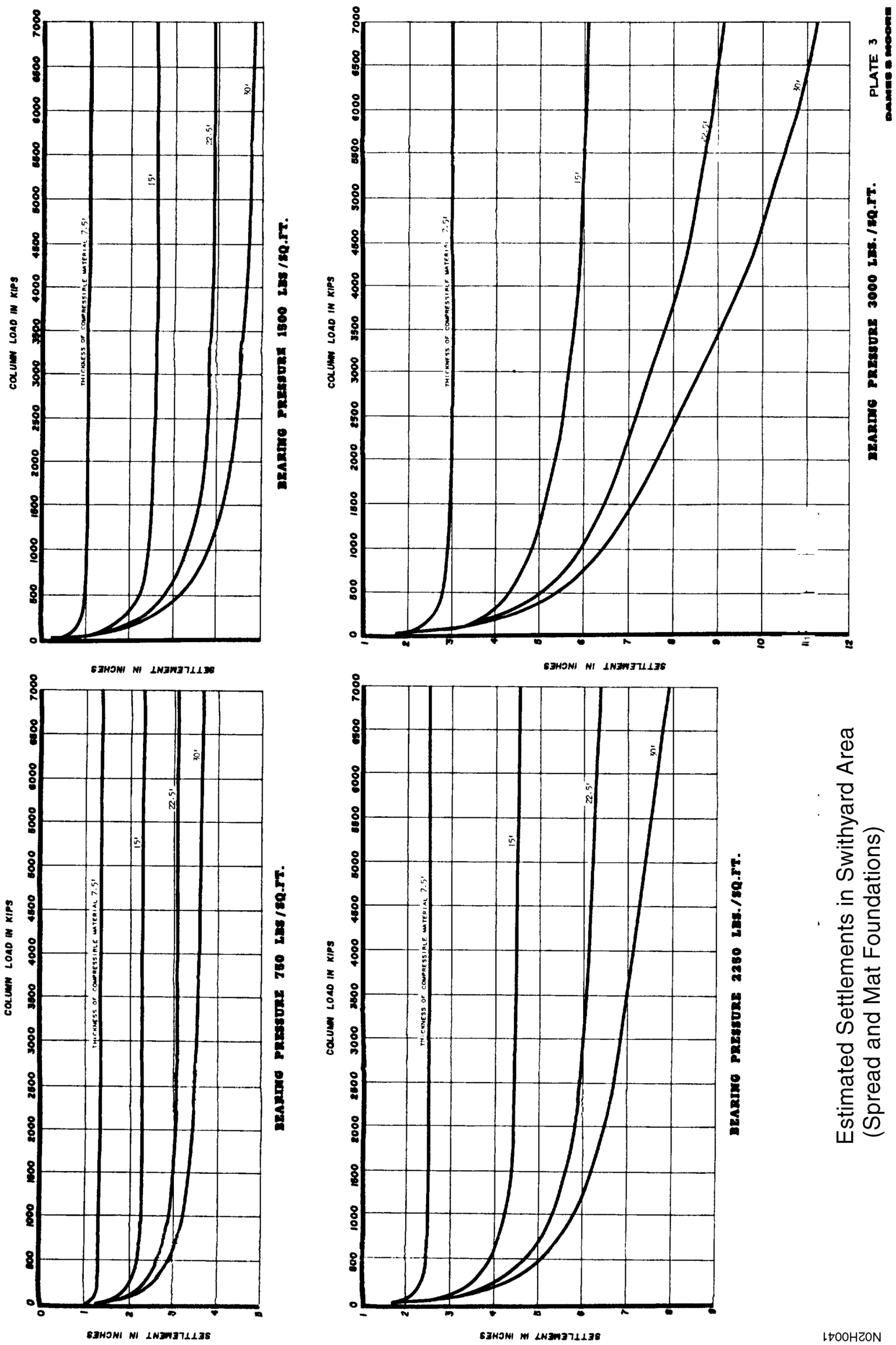
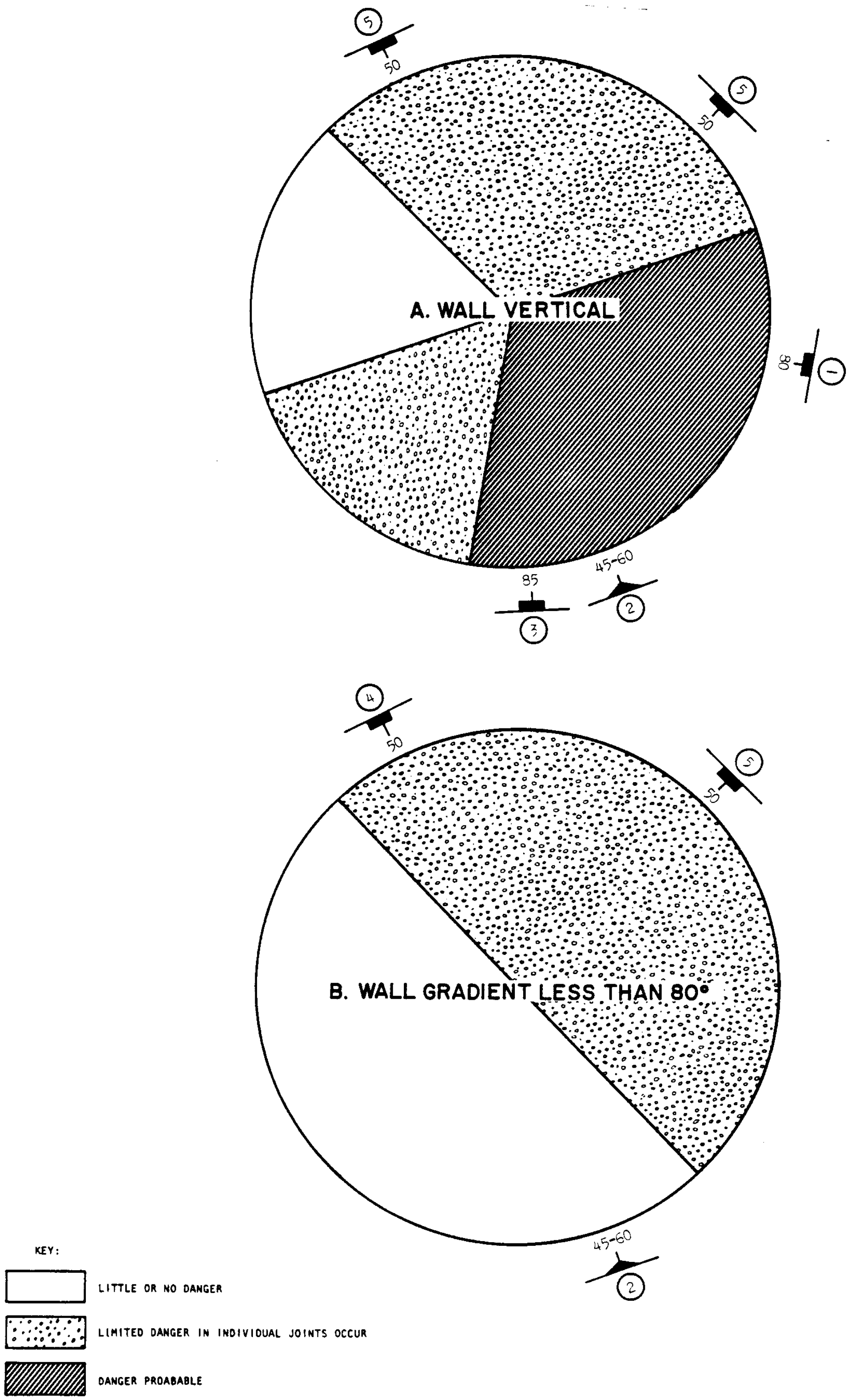
N02H0039


PLOT PLAN
SHOWING PROPOSED CONSTRUCTION
PLATE 2
DAMES & MOORE
DISCHARGE CANAL
EMERGENCY WATER STORAGE
REACTOR
SWITCHYARD
RAILROAD SPUR
PROPOSED RESERVOIR
FEET
N02H0040



Estimated Settlements in Swithyard Area
(Spread and Mat Foundations)

N02H0041



N02H0042

DANGER OF WEDGE TYPE ROCK FAILURES

IN REACTOR EXCAVATIONS

PLATE 4

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APPENDIX
LABORATORY TESTS

INTRODUCTION

The principal results of the field explorations and laboratory test programs performed for the proposed North Anna Power Station site were presented in our previous report. Copies of this report have been previously transmitted to Virginia Electric and Power Company and Stone and Webster Engineering Corporation. The results of all borings, geophysical investigations, hydrologic reconnaissance and investigation, etc., were documented in the referenced report. However, certain of the laboratory tests which were performed primarily to evaluate foundation conditions were not included in the report primarily because of scheduling commitments on submission of the Preliminary Safety Analysis Report. The results of those field explorations and laboratory tests which may be useful in foundation design studies are included in this Appendix.

LABORATORY TESTS

Certain laboratory tests were performed primarily to evaluate the suitability of the in-situ soils and rock to support the proposed plant facilities. Most of the tests were performed in a manner described in Section I-C of our previous report. The data presented herein supplement those presented in the referenced report.

A-2

<u>Triaxial Compression Test Data:</u> The results of unconsolidated, undrained triaxial compression tests on prepared soil samples were previously presented. The samples were remolded to dry densities equal to 95 percent of the maximum dry density for the tested materials as defined by the Modified AASHO Method of Compaction Test, Designation T-180-66. The samples were prepared to moisture contents approximately equal to the optimum moisture content used in control of compacted fill.

Stress-strain curves for these tests are presented in this report on Plates A-la and A-lb. Since rapid drawdown conditions will not be considered in the design of the proposed emergency cooling water embankment, these data should provide criteria regarding the behavior of the compacted fill materials under a quick, undrained failure condition such as that which might result from an earthquake-type loading.

Consolidated, quick triaxial compression test with pore pressure measurements were performed on selected representative samples of the in-situ residual soils. In these tests, the samples were saturated and consolidated to pressures slightly larger than their original over-burden pressure. The chamber and back pressures were applied in increments not exceeding five pounds per square inch while maintaining an effective stress of about two pounds per square inch in the sample. Saturation in the sample was verified by attaining a Bishops “B” value of at least 0.95, (Bishm and Henkel, 1957).

Following saturation, the sample was consolidated in increments to the desired effective stress by raising the chamber pressure. The samples were after, consolidation, tested in a quick, undrained triaxial procedure, and pore pressure measurements were obtained. The rate of testing was determined in accordance with procedures suggested by Bishop and Gibson in 1963.

We believe the soil parameters indicate d on Plate A-2 to be appropriate for the tested materials and consistent with the test results.

Unconfined compression tests were performed to evaluate the unconfined compressive strengths of representative rock samples. The results of these tests were presented in our previous reports. Stressss-strain curves obtained in the rock testing program are presented on Plate A-3 of this report.

The results of these tests are presented on Plate A-2.

Consolidation Tests: The results of consolidation and confined compression tests performed on representative soil samples were presented in our original report. In this report we present time-consolidation data associated with those tests. These data are presented in the form of log of time versus consolidation plots on Plates A-4a and A-4b.

A-4

The following Plate s are attached and complete this Appendix:

Plate A-1a	-	Triaxial Compression Tests on Remolded Samples (Bulk Sample 1)
Plate A-1b	-	Triaxial Compression Tests on Re-molded Samples (Bulk Sample 2)
Plate A-2	-	Triaxial Compression Test Data
Plate A-3	-	Rock Compression Test Data
Plate A-4a	-	Confined Compression Test Data
Plate A-4b	-	Consolidation Test Data

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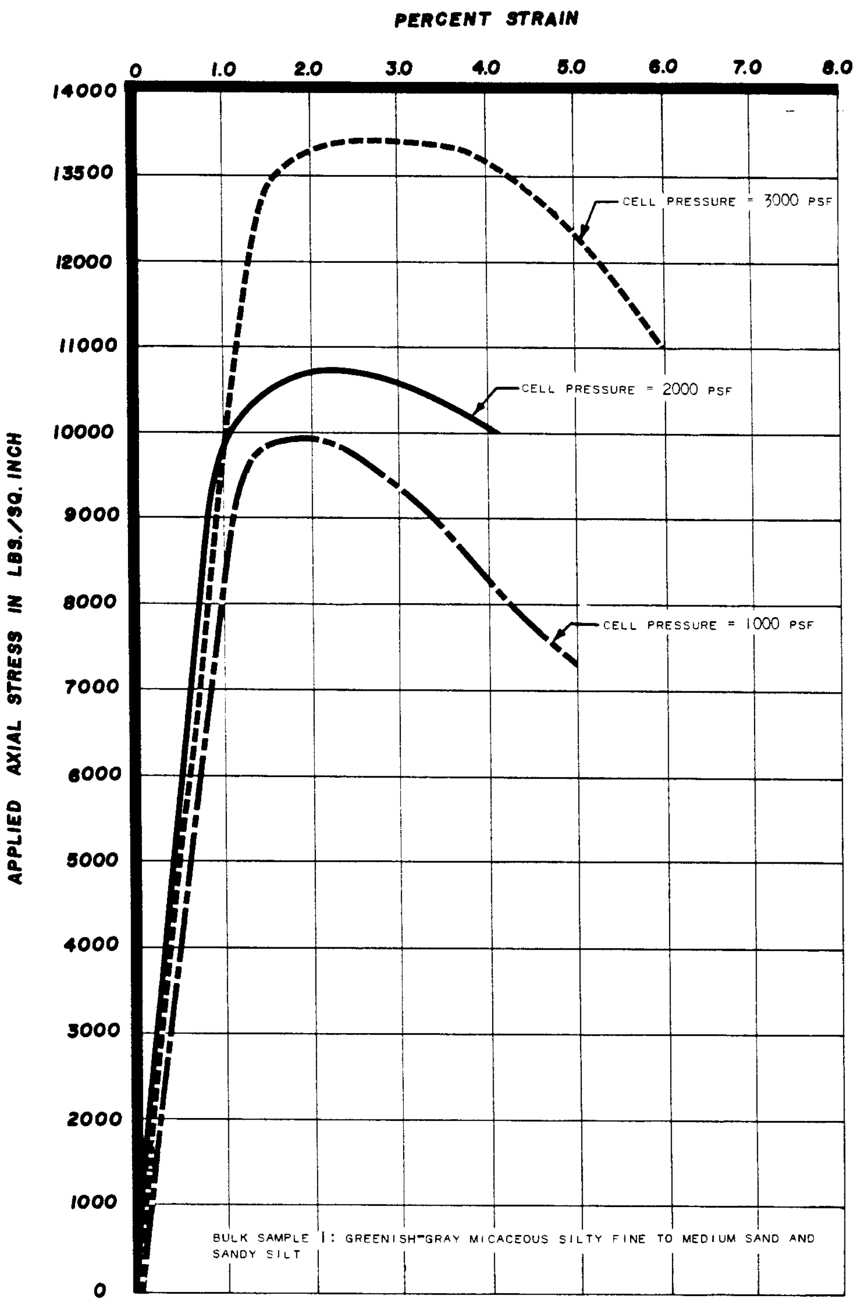

TRIAXIAL COMPRESSION TESTS ON REMOLDED SAMPLES

BULK SAMPLE 1

NOTE:

THESE TESTS WERE PERFORMED ON SAMPLES PREPARED TO DRY DENSITIES EQUAL TO 95% OF THE MAXIMUM DRY DENSITIES ATTAINABLE IN THE A.A.S.H.O. T-180-61 METHOD OF COMPACTION TEST.

N02H0047

PLATE A-1a

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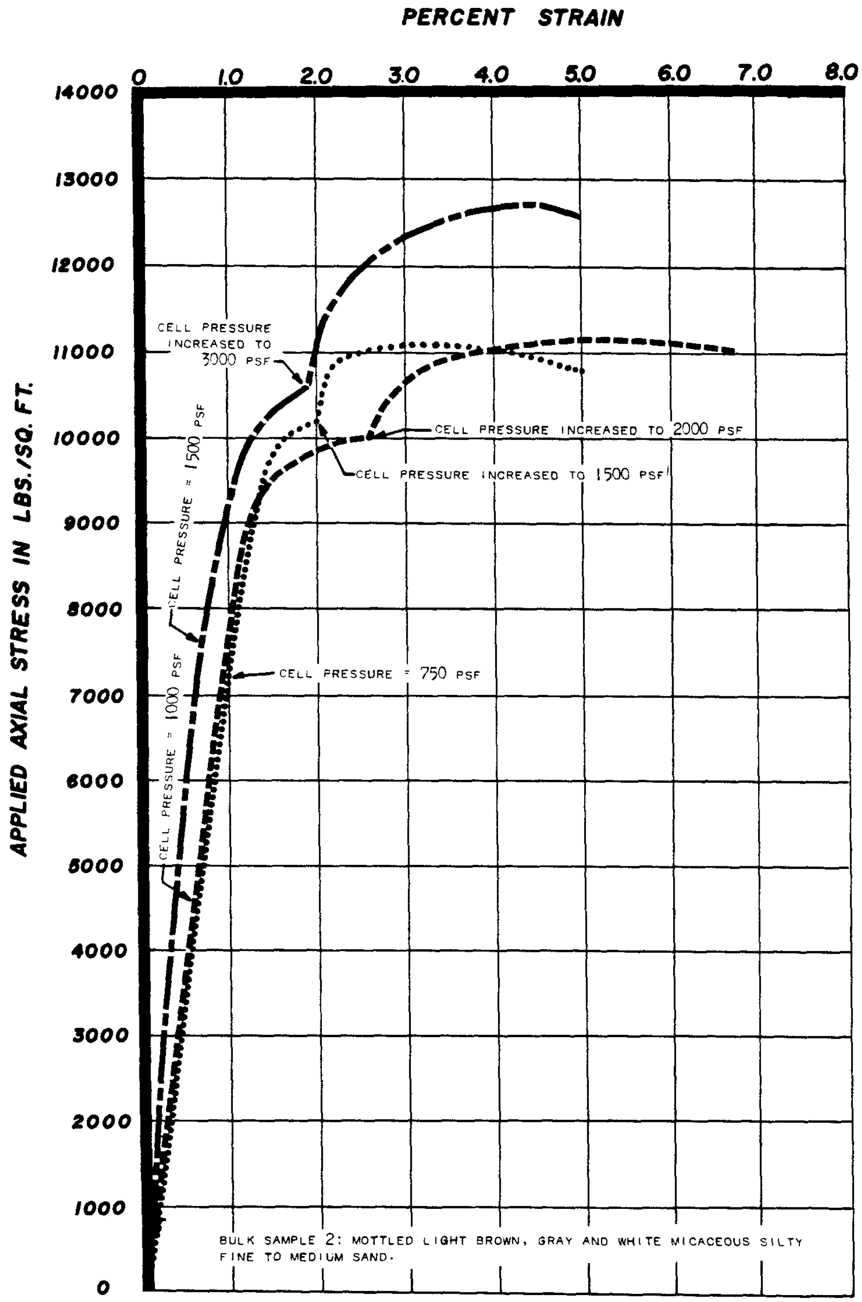

TRIAXIAL COMPRESSION TESTS ON REMOLDED SAMPLES

BULK SAMPLE 2

NOTE:

THESE TESTS WERE PERFORMED ON SAMPLES PREPARED TO DRY DENSITIES EQUAL TO 95% OF THE MAXIMUM DRY DENSITIES ATTAINABLE IN THE A.A.S.H.O. T-180-61 METHOD OF COMPACTION TEST.

N02H0048

PLATE AI-b

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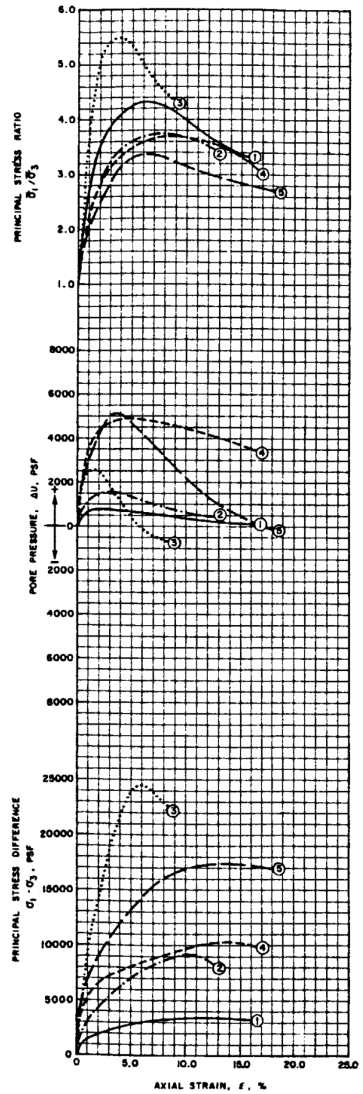
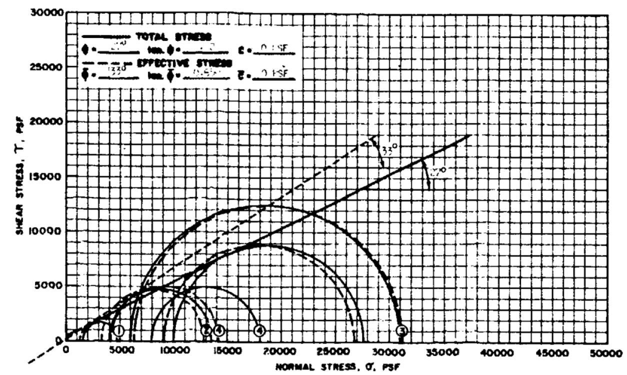
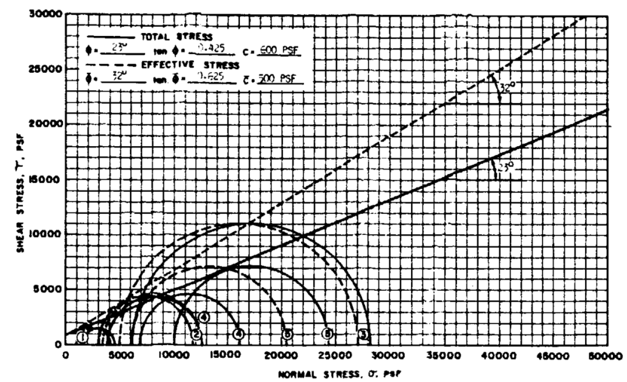
KEY	1		2		3		4		5	
BORING	106		7		9		106		11	
SAMPLE	9		9		10		10		7	
DEPTH (FEET)	41.5		41.0		45.5		46.0		52.0	
* INITIAL ω, %	19.4		18.8		14.4		22.8		19.2	
* INITIAL γ_d, PCF	100		110		119		104		119	
* INITIAL e_o	0.625		0.530		0.393		0.603		0.483	
* INITIAL S	0.80		0.92		0.80		0.70		0.60	
** FINAL ω, %	21.8		19.6		15.2		19.3		17.8	
** FINAL γ_d, PCF	105		115		125		112		127	
** FINAL e_f	0.565		0.525		0.436		0.512		0.473	
** FINAL S	1.0		1.0		1.0		1.0		1.0	
BACK PRESSURE (PSI)	28.0		28.0		28.0		28.0		28.0	
STRAIN RATE (INCHES / MINUTE)	0.005		0.005		0.005		0.005		0.005	
STRESS CONDITION	PEAK $\sigma_1 - \sigma_3$	MAX. $\bar{\sigma}_1/\bar{\sigma}_3$	PEAK $\sigma_1 - \sigma_3$	MAX. $\bar{\sigma}_1/\bar{\sigma}_3$	PEAK $\sigma_1 - \sigma_3$	MAX. $\bar{\sigma}_1/\bar{\sigma}_3$	PEAK $\sigma_1 - \sigma_3$	MAX. $\bar{\sigma}_1/\bar{\sigma}_3$	PEAK $\sigma_1 - \sigma_3$	MAX. $\bar{\sigma}_1/\bar{\sigma}_3$
TOTAL STRESS ϵ, %	13.0	6.06	10.14	7.60	6.04	4.19	14.8	8.00	13.9	6.08
TOTAL STRESS TIME TO FAIL (MIN.)	160	79	122	92	78	36	122	46	162	73
TOTAL STRESS σ_3, PSF	1500	1500	4000	4000	6000	6000	8000	8000	10000	10000
TOTAL STRESS $\sigma_1 - \sigma_3$	3500	3002	9237	8529	24667	22288	10229	9090	17476	14319
TOTAL STRESS σ_1, PSF	5000	4502	13237	12529	30667	28288	18229	17090	27476	24319
TOTAL STRESS $\frac{1}{2}(\sigma_1 - \sigma_3)$	1750	1501	4618	4265	12334	11144	5115	4545	8738	7160
TOTAL STRESS $\frac{1}{2}(\sigma_1 + \sigma_3)$	3250	3001	8618	8265	18334	17144	13115	12545	18738	17160
TOTAL STRESS u, PSF	+187	+590	+576	+893	−245	+1008	+3773	+4694	+878	+3931
TOTAL STRESS A, $u/(\sigma_1 - \sigma_3)$	0.05	0.19	0.06	0.10	−0.01	0.04	0.37	0.52	0.05	0.27
EFFECTIVE STRESS ϵ, %	13.0	6.06	10.14	7.60	6.04	4.19	14.8	8.00	13.9	6.08
EFFECTIVE STRESS TIME TO FAIL (MIN.)	160	79	122	92	78	36	122	46	162	73
EFFECTIVE STRESS $\bar{\sigma}_3$, PSF	1313	910	3424	3107	6245	4992	4227	3306	9122	6069
EFFECTIVE STRESS $\bar{\sigma}_1 - \bar{\sigma}_3$	3500	3002	9237	8529	24667	22288	10229	9090	17476	14319
EFFECTIVE STRESS $\bar{\sigma}_1$, PSF	4812	3912	12661	11636	30912	27280	14455	12396	26598	20388
EFFECTIVE STRESS $\frac{1}{2}(\bar{\sigma}_1 - \bar{\sigma}_3)$	1750	1501	4618	4265	12334	11144	5115	4545	8738	7160
EFFECTIVE STRESS $\frac{1}{2}(\bar{\sigma}_1 + \bar{\sigma}_3)$	3063	2411	8042	7372	18579	16136	9342	7851	17860	13229
EFFECTIVE STRESS u, PSF	+187	+590	+576	+893	−245	+1008	+3773	+4694	878	3931
EFFECTIVE STRESS A, $u/(\bar{\sigma}_1 - \bar{\sigma}_3)$	0.05	0.19	0.06	0.10	−0.01	0.04	0.37	0.52	0.05	0.27
EFFECTIVE STRESS $\bar{\sigma}_1/\bar{\sigma}_3$	3.67	4.30	3.70	3.74	4.95	5.46	3.42	3.75	2.92	3.36
SOIL TYPE	GRAYISH-BROWN FINE TO MEDIUM SAND WITH TRACE OF SILT		GRAYISH-BROWN FINE TO MEDIUM SAND WITH TRACE OF SILT		GRAYISH-BROWN FINE TO MEDIUM SAND WITH TRACE OF SILT		GRAYISH-BROWN FINE TO MEDIUM SAND WITH TRACE OF SILT		GRAYISH-BROWN FINE TO MEDIUM SAND WITH TRACE OF SILT	

N02H0050





MOHR ENVELOPE – PEAK STRESS

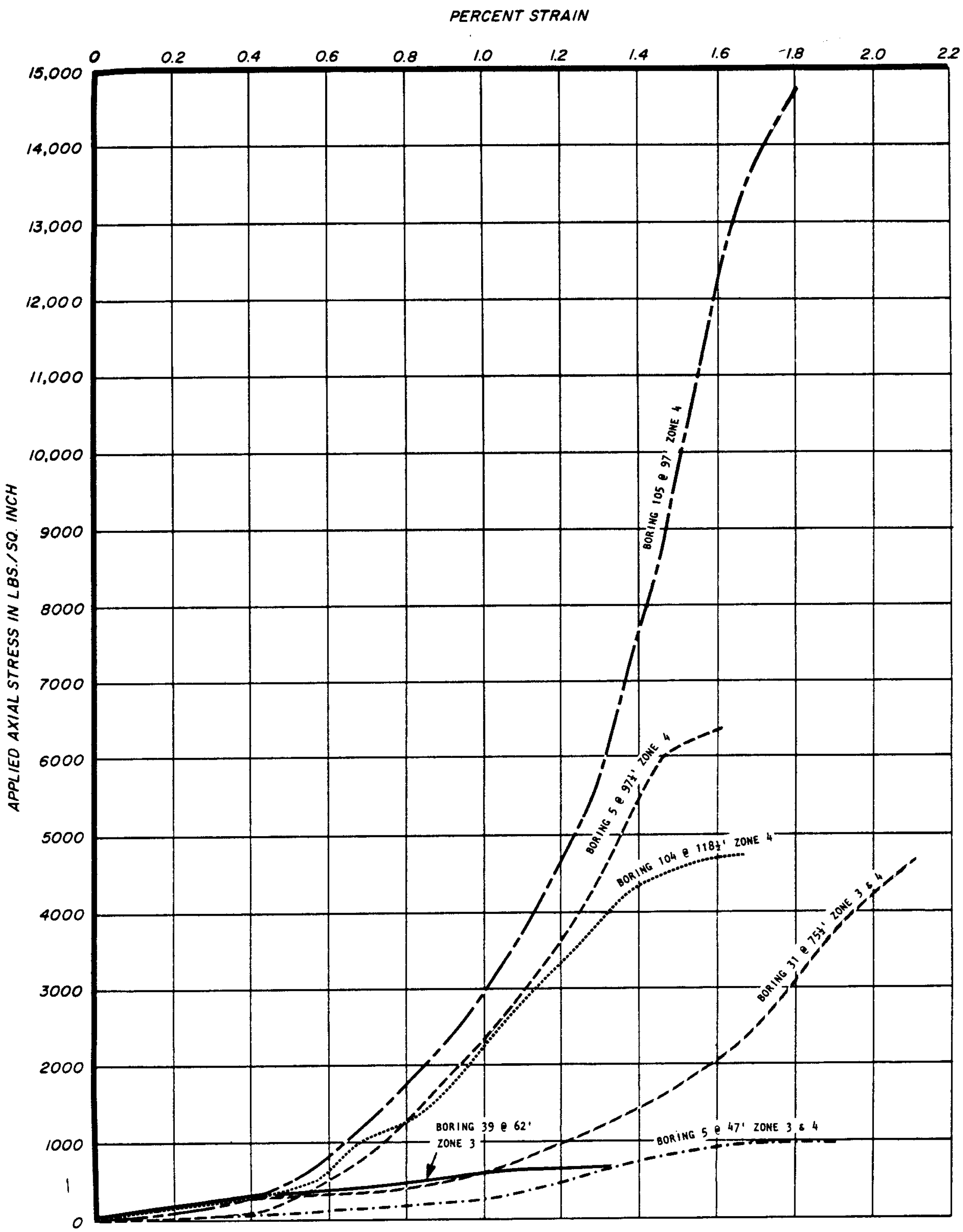


MOHR ENVELOPE – MAXIMUM EFFECTIVE STRESS RATIO

Triaxial Compression Test Data
With Pore Pressure Measurements

NOTES:
* INITIAL REFERS TO CONDITIONS PRIOR TO CONSOLIDATION PHASE OF TEST
** FINAL REFERS TO CONDITIONS AT COMPLETION OF TEST

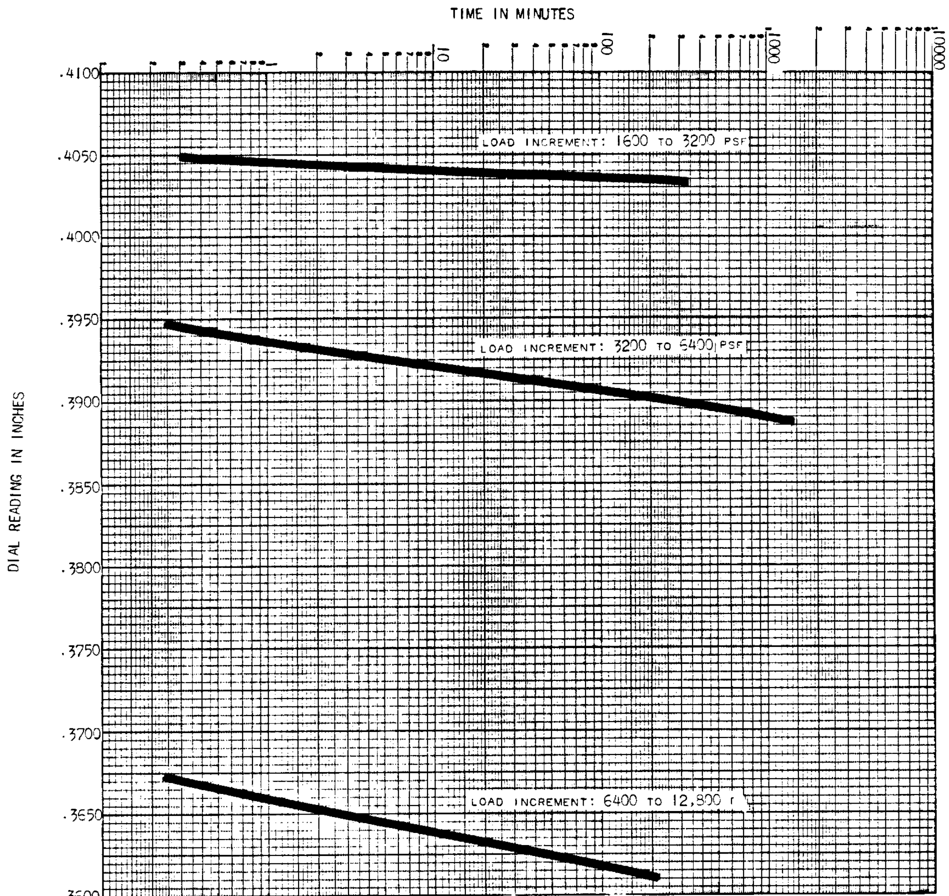
PLATE A-2
DAMES & MOORE



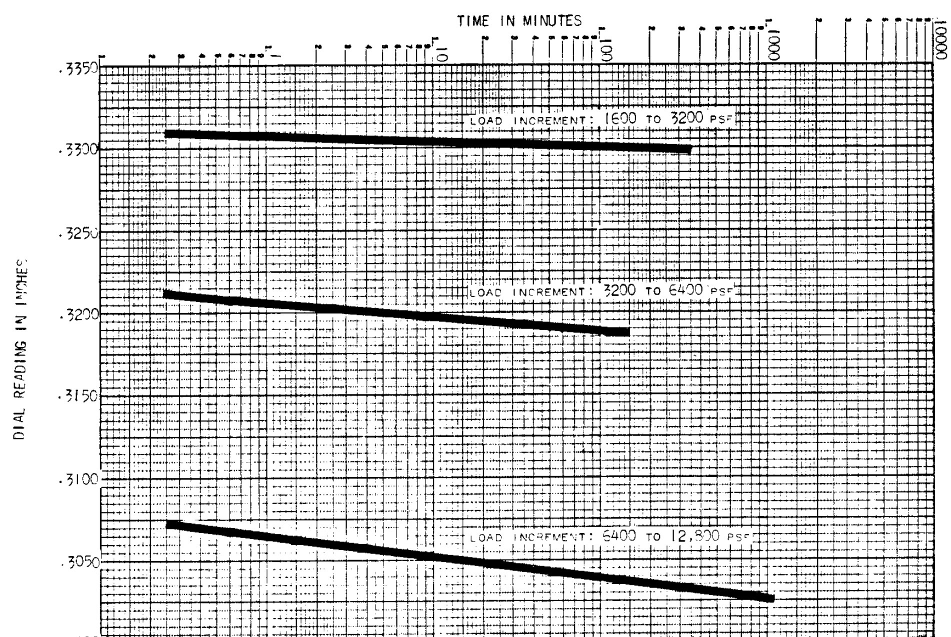
ROCK COMPRESSION TEST DATA

ALL TESTS TAKEN TO FAILURE PLATE A-3

N02H0051



BORING 7 AT 31 FT

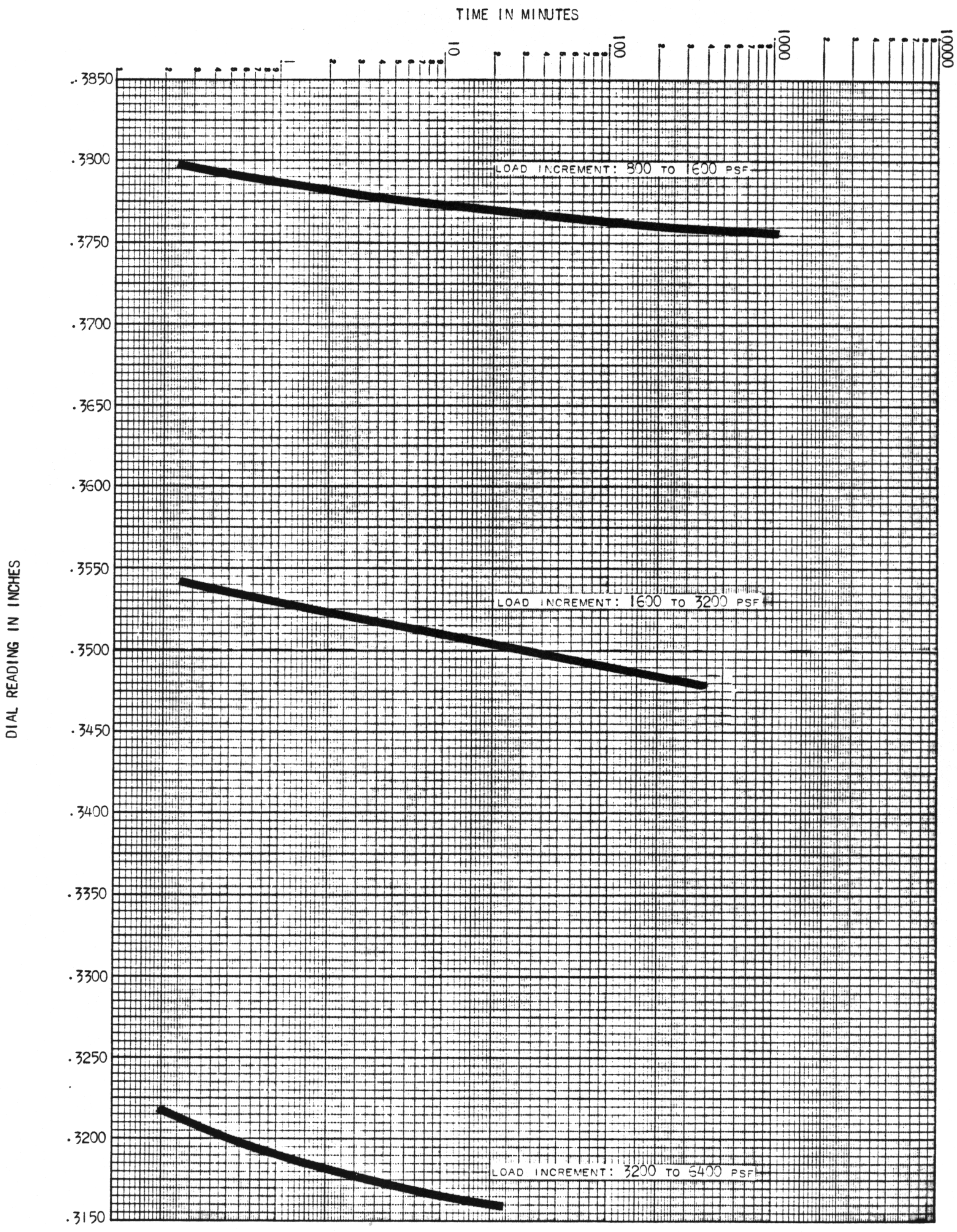


BORING 9 AT 30 1/2 FT

CONFINED COMPRESSION TEST DATA

DAMES & MOORE
PLATE A-4a

N02H0052



BORING 52 AT 11½ FT PLATE A-4b

DAMES & MOORE

N02H0053

CONSOLIDATION TEST DATA