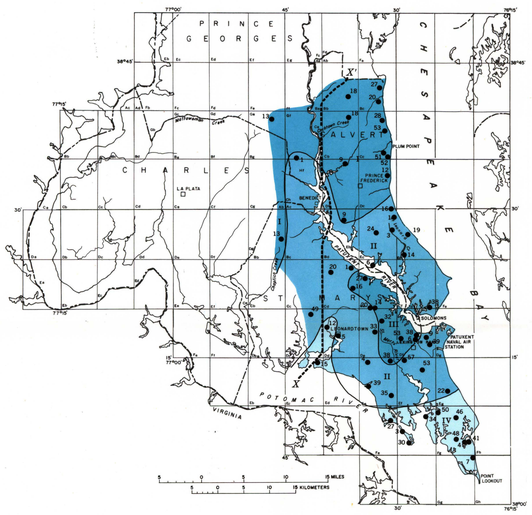
QUALITY OF WATER



EXPLANATION

Hardness of water, in milligrams per liter

- Soft, 0–60
- Moderately hard, 60–120
- Hard or very hard, More than 120
- No data

III — Area in which average values of chemical constituents and properties are as shown in accompanying table, based on analyses of water from wells shown on this map

39 — Sampling site and well number

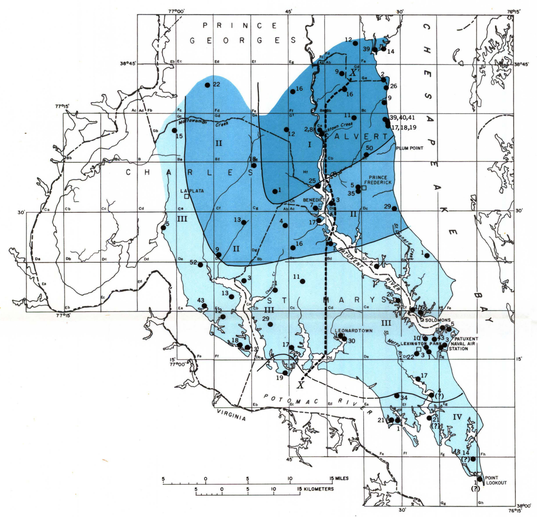
X--------X' — Line west of which almost all new wells in Calvert and St. Marys Counties tap the Aquia hydrologic unit, and east of which almost all new domestic wells tap the Piney Point-Nanjemoy unit

Averages of the analyses of water from wells located on this map

Constituent or property		Area I	Area II	Area III	Area IV
Temperature	°C	15.6	16.1	16.1	16.7
Silica	mg/l	47	41	51	25
Iron	mg/l	0.29	0.26	0.15*	0.12
Hardness	mg/l	161	100	129	27
Sodium	mg/l	3.4	14	6.6	109
Potassium	mg/l	11	13	12	9.9
Bicarbonate	mg/l	182	160	167	311
Chloride	mg/l	2.4	1.9	2.3	4.0
Fluoride	mg/l	0.2	0.3	0.3	0.9
Dissolved solids	mg/l	238	194	214	325
pH		8.0	8.1	8.1	8.3
Color		2	2	2	2
Number of analyses		13	24	8	12

*Median reported when more representative

HARDNESS AND GENERAL CHEMICAL QUALITY OF WATER IN PINEY POINT-NANJEMOY HYDROLOGIC UNIT



EXPLANATION

Hardness of water, in milligrams per liter

- Soft, 0–60
- Moderately hard, 60–120
- Hard, 120–180
- No data

III — Area in which average values of chemical constituents and properties are as shown in accompanying table, based on analyses of water from wells shown on this map

39 — Sampling site and well number

X--------X' — Line west of which almost all new wells in Calvert and St. Marys Counties tap the Aquia hydrologic unit and east of which almost all new domestic wells tap the Piney Point-Nanjemoy unit

(?) — Well penetrates Aquia hydrologic unit more deeply than do other wells in vicinity

Averages of the analyses of water from wells located on this map.

Constituent or property		Area I	Area II	Area III	Area IV
Temperature	°C	16.7	16.7	17.2	17.8
Silica	mg/l	15	13	12	12
Iron	mg/l	0.38*	0.26	0.09*	0.14
Hardness	mg/l	137	97	15*	11
Sodium	mg/l	4.6	11	56	114
Potassium	mg/l	10	14	7.4	6.5
Bicarbonate	mg/l	176	152	165	287
Chloride	mg/l	1.8	1.2	2.4	3.0
Fluoride	mg/l	0.2	0.2	0.3	0.9
Dissolved solids	mg/l	179	154	179	304
pH		7.9	7.9	8.2	8.4
Color		5	3	2	3
Number of analyses		21	14	25	7

*Median reported when more representative

HARDNESS AND GENERAL CHEMICAL QUALITY OF WATER IN AQUIA HYDROLOGIC UNIT

GROUND-WATER QUALITY

Introduction.—Of the ground-water sources utilized in Calvert and St. Marys Counties, the Piney Point-Nanjemoy and the Aquia hydrologic units are the most extensively and intensively developed. For this reason, the detailed ground-water-quality information in this report pertains exclusively to these units.

The quality of the ground water in the upland and lowland deposits (water-table aquifers) of Pleistocene age and in some of the aquifers of Cretaceous age is described in earlier publications (Overbeck, 1951; Ferguson, 1953; Otton, 1955). Generally the water-table aquifers contain mildly acidic and soft to moderately hard calcium bicarbonate water. The few water samples collected from aquifers that may be of Cretaceous age are very similar in quality to samples collected from the Aquia hydrologic unit in the same vicinity.

The quality of the ground water in Charles County was described by C. P. Laughlin (Slaughter and Otton, 1968). Therefore, sample collection and much of the analysis of ground-water-quality data for this study were confined to Calvert and St. Marys Counties.

Ground-water temperatures at 100 feet below sea level in southern Maryland are about 15 degrees Celsius (59 degrees Fahrenheit), and increase at a rate of about 4/5 degree Celsius (1 1/2 degrees Fahrenheit) for each additional 100 feet of depth to at least 700 feet below sea level.

General quality of water in Aquia and Piney Point-Nanjemoy hydrologic units.—Analyses of about 190 water samples from the Piney Point-Nanjemoy and Aquia hydrologic units, to be presented in the upcoming report Maryland Geological Survey Water Resources Basic Data Report No. 4, show that, for the constituents and properties examined, the water is suitable for domestic and many industrial uses without treatment. Most of the samples were analyzed for the major reacting ions plus silica, iron, fluoride, hardness, dissolved solids, specific conductance, and pH. Many were also analyzed for temperature, manganese, nitrate, phosphate, and color.

The quality of the water in the artesian hydrologic units remains virtually constant at any given location. There has been no measurable change in chemical quality of water from these units over the 20-year period of record. Water-quality records of several wells at Patuxent Naval Air Station show that for a 15-year period (1947–62) any changes that may have occurred were not detected by the procedures used. (It is believed that the minor variations in quality exhibited by the analyses of water from individual wells at Patuxent Naval Air Station are due to differences in analytical and collection procedures rather than to changes in the quality of the water in the aquifer.) The methods used for the analysis of these samples were equivalent to or identical with those described by Rainwater and Thatcher (1960). The fact that water-quality maps can be drawn using data collected over a 20-year period further substantiates that the hydrologic units yield water of consistent quality. However, the units are not immune to contamination caused by the activities of man.

Water quality within the hydrologic units changes gradually from one area to another. With the exception of iron concentration, neighboring wells in the same hydrologic unit will yield water of very similar chemical quality. Although the concentration of iron is difficult to predict and the data appear erratic, parts of Calvert and St. Marys Counties where undesirable iron concentration is most likely to occur in the water in the units are shown on the iron distribution map.

Iron concentrations greater than 0.3 mg/l (milligrams per liter) are considered undesirable because of the tendency to stain plumbing fixtures, clothing, and cooking ware.

One source of the iron observed in several water samples probably was iron or steel plumbing. Because plumbing is a possible source of iron, protection against corrosion is important in areas where the concentration of iron in water in the hydrologic unit approaches or exceeds the acceptable limit.

As an aid in determining which unit contains the better water for domestic use, Swenson and Baldwin (1965) discuss in layman's terms the significance of the properties and constituents examined. Hem (1959), and McKee and Wolf (1963) present a more technical discussion of the significance of the constituents and properties.

Quality of water in the Piney Point-Nanjemoy hydrologic unit.—The water from this unit contains bicarbonate as the predominant anion. This anion is balanced by a combination of hardness-causing ions, calcium and magnesium; and the other major cations, sodium and potassium. Because the dissolved-solids concentration is fairly uniform (averaging 200–300 mg/l), the hard water generally contains less sodium and potassium than does the soft water.

Within area I (see map showing water quality in Piney Point-Nanjemoy hydrologic unit), very hard water (>180 mg/l) occurs in the Piney Point-Nanjemoy unit in a band that extends 2 miles inland from the Bay and northward from Plum Point to beyond the Calvert County line.

In area IV the dissolved solids average 325 mg/l, which is about 100 mg/l greater than in other areas in this unit. At Point Lookout this unit probably would yield water with more than 500 mg/l dissolved solids. The chlorides do not show a pronounced increase. Fluoride concentrations are about optimum for drinking water in area IV except in the western part where they are below optimum.

Quality of water in the Aquia hydrologic unit.—Bicarbonate is the predominant anion in the water from this unit. The bicarbonate is balanced by a combination of hardness ions, calcium and magnesium, and the other major cations, sodium and potassium. Because the dissolved-solids concentration is fairly uniform (averaging 150–200 mg/l except in area IV), the hard water in the northeast contains less sodium and potassium than the soft water in the south and west.

The dissolved solids in area IV (see map showing water quality in Aquia hydrologic unit) average 304 mg/l which is about 130 mg/l greater than in other areas in this unit. At Point Lookout this unit yields water having more than 500 mg/l.

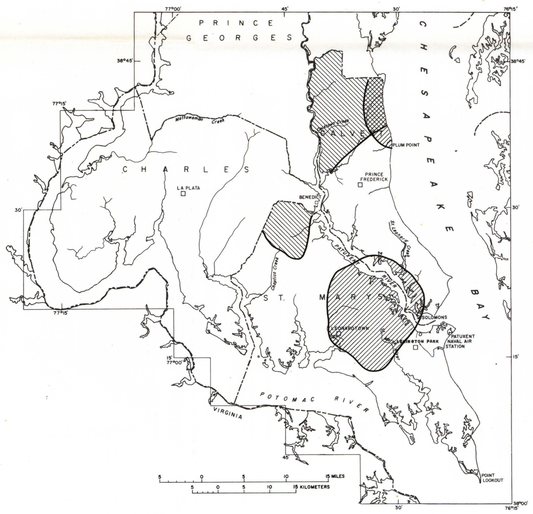
If wells SM-Ef 4, Gg 14, and Gh 1 end in the Aquia hydrologic unit, they are deeper in the unit than the other Aquia wells in the area. Despite their depths, these wells yield water of a quality similar to that from other Aquia wells in the area.

Ground-water contamination by salt water.—Available chemical analyses of water in southern Maryland give no evidence of ground-water contamination by salt water at present (1967). Along much of the shore, however, shallow deposits of permeable materials extend out to or under the salt water. There is the definite possibility that heavy pumping of wells near the shore in these materials would lower the water table below sea level locally, and induce salt water through the bottom sand and into the unconfined aquifers.

Salt-water contamination of the artesian aquifers might also occur locally under certain conditions. Abandoned offshore flowing wells, completed in the artesian aquifers and having rusted-out casings, occur submerged along the coast of southern Maryland. Conceivably, if the piezometric levels in the corresponding aquifers were to be lowered below sea level, flow from the wells would be reversed and salt water could enter the aquifers through the wells.

Furthermore, most of the shore is bordered from the tidal zone seaward for half a mile or more by sand, which is about 30 feet thick along the eastern shore of Calvert and St. Marys Counties. Grain-size analyses (Ryan, 1953) indicate that at least the upper part of the sand is moderately permeable. Along parts of the shore the artesian aquifers utilized as ground-water sources subcrop offshore under the sand. If large-scale withdrawals of ground water were to lower the piezometric surface below sea level, salt water would possibly be induced to move down through the shallow offshore sand and into the underlying aquifers. The infiltrating salt water would be diluted proportionately by water drawn toward the point of withdrawal from other directions.

The position of the salt water-fresh water interface in the confined ground-water aquifers is not known precisely. In general it probably lies at least several miles east of southern Maryland in the Piney Point and Aquia Formations and farther east in the Magothy Formation. Large-scale long-term withdrawals of ground water might cause movement of the interface toward the center of pumping. Based on available hydrologic data, the maximum rates of lateral intraformational ground-water movement that would be induced by large-scale ground-water withdrawals from artesian aquifers are less than 10 feet per day and probably more nearly 1 or 2 feet per day. Encroachment of salt water may set ultimate limits to the amounts of water that can be removed from storage, but further pursuit of the problem is beyond the scope of this report.



EXPLANATION

Areas where undesirable concentrations of iron in water in the Aquia hydrologic unit are most common and locally exceed 0.3 milligrams per liter

Areas where undesirable concentrations of iron in water in the Piney Point-Nanjemoy hydrologic unit are most common and locally exceed 0.3 milligrams per liter

Area boundary

IRON DISTRIBUTION IN WATER IN AQUIA AND PINEY POINT-NANJEMOY HYDROLOGIC UNITS IN CALVERT AND ST. MARYS COUNTIES

SURFACE-WATER QUALITY

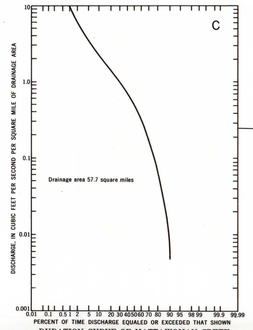
Surface water in Calvert and St. Marys Counties is generally soft, contains less than 100 mg/l dissolved solids, and has a pH of about 6.0 to 8.0. Calcium usually accounts for at least half of the cations in solution; bicarbonate and sulfate account for more than half of the anions in solution. Chlorides and nitrates are generally present in concentrations of less than 10 and 2 mg/l respectively. Iron concentrations were less than 0.03 mg/l in all water analyzed except for streams such as St. Clement Creek and St. Marys River, which drain upland swamps.

Water-quality analyses of several samples from streams in the area will be included in Maryland Geological Survey Water Resources Basic Data Report No. 4 that is being prepared.

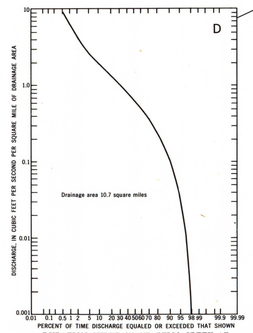
With one exception, estuaries (drowned valleys) in the study area contain brackish water. Upstream from Benedict, the Patuxent River and its tidal tributaries are subject to wide variations in chemical quality controlled mainly by streamflow volume (Heidel and Frenier, 1965), and sometimes contain fresh water.

The change from fresh to brackish water occurs without exception downstream from the 20-foot land-surface contour, and generally occurs in the meander reach immediately upstream from the estuary head.

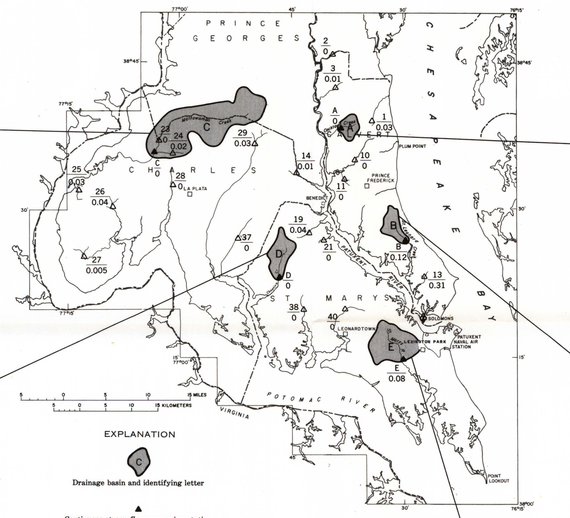
STREAMFLOW



DURATION CURVE OF MATTAWOMAN CREEK NEAR POMONKEY



DURATION CURVE OF CHAPTICO CREEK AT CHAPTICO



EXPLANATION

C — Drainage basin and identifying letter

▲ — Continuous streamflow measuring station

△ — Miscellaneous streamflow measuring site

◆ — Precipitation station at Solomons

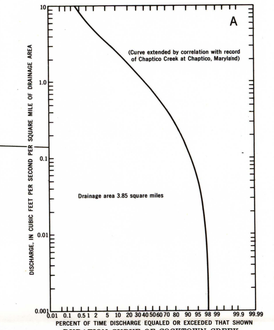
19 / 0.04 — Station number or letter; 7-day minimum discharge in cubic feet per second per square mile of drainage area (cfsm), having a 10-year recurrence interval

KEY TO STREAMFLOW MEASURING SITES

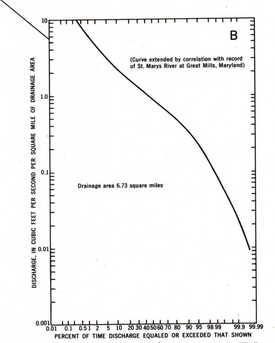
A. *Cocktown Creek near Huntingtown*
B. *St. Leonard Creek near St. Leonard*
C. *Mattawoman Creek near Pomonkey*
D. *Chaptico Creek at Chaptico*
E. *St. Marys River at Great Mills*

1. *Flaking Creek*
2. *Lyons Creek*
3. *Holl Creek*
10. *Hunting Creek*
11. *Mill Creek*
13. *Helen Creek*
14. *Susanna Creek*
19. *Locks Swamp Creek*
21. *Persimmon Creek*
23. *Mattawoman Creek near Bennville*
24. *Old Woman Creek*
25. *Reeder Run*
26. *Ward Run*
27. *Nanjemoy Creek*
28. *Port Tobacco Creek*
29. *Zekiah Swamp Run*
37. *Gilbert Swamp Run*
38. *St. Clements Creek*
40. *McIntosh Run*

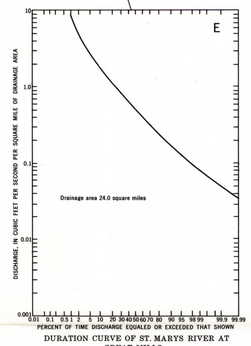
LOCATIONS OF STREAM-GAGING SITES AND DRAINAGE BASINS



DURATION CURVE OF COCKTOWN CREEK NEAR HUNTINGTOWN



DURATION CURVE OF ST. LEONARD CREEK NEAR ST. LEONARD



DURATION CURVE OF ST. MARYS RIVER AT GREAT MILLS

STREAMFLOW

Introduction.—Streamflow consists of base flow and storm runoff. Base flow is essentially the ground-water contribution and fluctuates slowly in response to the seasonal changes in ground-water storage. Storm runoff is contributed by precipitation that falls on the streams or that runs overland to the streams without having entered the ground. Storm runoff fluctuates rapidly because it is a product of individual storms.

Most of the ground-water contribution to streamflow in southern Maryland is from water-table aquifers. Little of a hydrologic nature is known about the water-table aquifers locally, although they are easily accessible and formerly were widely used as a source of ground water. Contribution to streamflow from artesian aquifers is mostly indirect and occurs through vertical leakage, the extent and precise nature of which are not generally known.

Streams, whose basins lie wholly or partly in Calvert, St. Marys, and Charles Counties, discharge to the Potomac River or Patuxent River, or directly to the Chesapeake Bay. Floods are seldom of such magnitude as to be destructive; however, when peak discharges occur during exceptionally high tides, flooding can occur in low-lying areas. Low flows in the area are variable—the result, primarily, of the influence of local geology upon the hydrology. Precipitation falls rather uniformly on southern Maryland, both areally and seasonally; it is the source of overland runoff and the principal source of water available to recharge aquifers and provide ground water to sustain streamflow between periods of rain.

For purposes of this analysis the 7-year period 1958–64 (the longest period for which concurrent records are available for the five continuous-record streamflow stations in the area) was used for comparative evaluation. Streamflow records for these short-term stations were extended by correlation with long-term streamflow stations in adjacent areas to develop long-term values for streamflow characteristics. *The extended records should be used with caution.*

Average discharge.—The average annual discharge of a stream indicates the total quantity of water available for use in the basin above that point. For practical purposes this quantity can seldom be approached in developing a water supply, because of the within-year variability of streamflow. In order to completely utilize the average annual streamflow for most streams, storage capacity would have to be very large. For example, for the period 1950–64 the average annual discharge of Mattawoman Creek near Pomonkey was 56.3 cfs (cubic feet per second) or 36 mgd. This stream is dry about 10 percent of the time and once in 50 years can be expected to have an uninterrupted dry period of about 6 months. About 1,300 million gallons of water in storage would be required to maintain average discharge during the 6-month dry period. Approximately 70 percent of the days in any year have less than average discharge.

Therefore, average daily discharge represents the upper limit of water available as streamflow—a quantity which can be approached only under very favorable conditions, including substantially developed storage. Low-flow characteristics determine the reliability of a stream as a source of water; the possibility of modifying flow characteristics by providing controllable storage is an equally important consideration.

Duration analyses.—One of the tools most frequently used to evaluate streamflow characteristics is the duration curve. A duration curve is a graphic representation of the entire spectrum of daily discharges for a specific stream, ranging from those based entirely on ground-water discharge (base flow) at the lower end of the curve to predominantly storm runoff at the upper end. For streamflow stations which have sufficient length of continuous record the curve is constructed by arranging the data (mean daily discharge, most commonly) in order of magnitude, irrespective of the sequence of events, and plotting values of discharge against the percentage of time for which those discharges were equaled or exceeded during the period of record.

Duration curves can be extended or curves developed for short-term and partial-record stations by correlations with long-term streamflow stations. Extended duration data for Mattawoman Creek near Pomonkey, Chaptico Creek at Chaptico, and St. Marys River at Great Mills, were presented by Darling (1962). Data for Cocktown Creek near Huntingtown, and St. Leonard Creek near St. Leonard, were analyzed and extended by correlation with Chaptico Creek and St. Marys River respectively. The low ends of the curves for St. Marys River and St. Leonard Creek are relatively flat, indicating that there is enough storage within the basins to maintain low flows. The curves for Mattawoman, Chaptico, and Cocktown Creeks indicate that these streams go dry during low-flow periods; the low-flow position of these curves is steep, indicating either little ground-water storage or rapid depletion of the water in storage.

Low-flow characteristics.—Low flows of streams in southern Maryland are much more variable areally than is average annual discharge. Some streams in the area have substantial low flows. Some discharge at relatively high rates (per square mile of drainage area) during low-flow periods, but because of the small size of their drainage areas they do not discharge large quantities of water.

Many streams in this area characteristically are dry during a part of each year. Mattawoman Creek is an example.

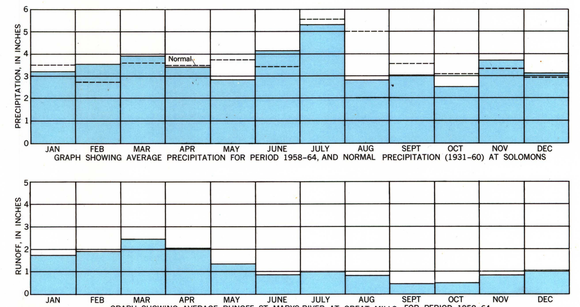
During 1965 and 1966 discharge was measured at many sites in the area during low-flow periods. By correlation analysis, the discharge measurements were used to establish runoff relations with continuous-record streams in the area. From these relations estimates were made of the low-flow characteristics at selected sites (shown on the map), including the minimum 7-day flows which normally might be expected to occur at these sites once in 10 years. Although these values *must* be regarded as estimates, they are essential to preliminary evaluation of streams as sources of water.

Runoff compared with precipitation.—Time distribution of runoff is seasonal in character. The effects of evaporation and transpiration losses during the growing season are apparent in the departure of the runoff and precipitation curves during that period, as compared with the reasonably good correlation during the winter and early spring months.

Elsewhere in southern Maryland, the seasonal distribution of precipitation is similar to that shown for Solomons (see precipitation graph). The seasonal distribution of runoff is basically as shown for St. Marys River (see runoff graph), but the amplitude of the graph varies considerably from basin to basin.

Average annual flows for streams are 1.0 cfs (0.66 mgd) per square mile of drainage area (Darling, 1962).

Streamflow characteristics in southern Maryland are so variable that few generalizations concerning runoff can be made. Those who intend to develop a water supply from a stream, or are concerned with streamflow characteristics for other reasons such as waste disposal by stream utilization, should investigate the stream at the site where information is needed. The limited information contained in this report provides only a preliminary, qualitative evaluation of most streams in southern Maryland.



GRAPH SHOWING AVERAGE PRECIPITATION FOR PERIOD 1958–64, AND NORMAL PRECIPITATION (1931–60) AT SOLOMONS

GRAPH SHOWING AVERAGE RUNOFF, ST. MARYS RIVER AT GREAT MILLS, FOR PERIOD 1958–64

MONTHLY DISTRIBUTION OF PRECIPITATION AND RUNOFF.

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WATER RESOURCES OF SOUTHERN MARYLAND

By
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1970

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