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The Quality of Connecticut's Surface Waters

Chester E. Thomas Jr.
USGS

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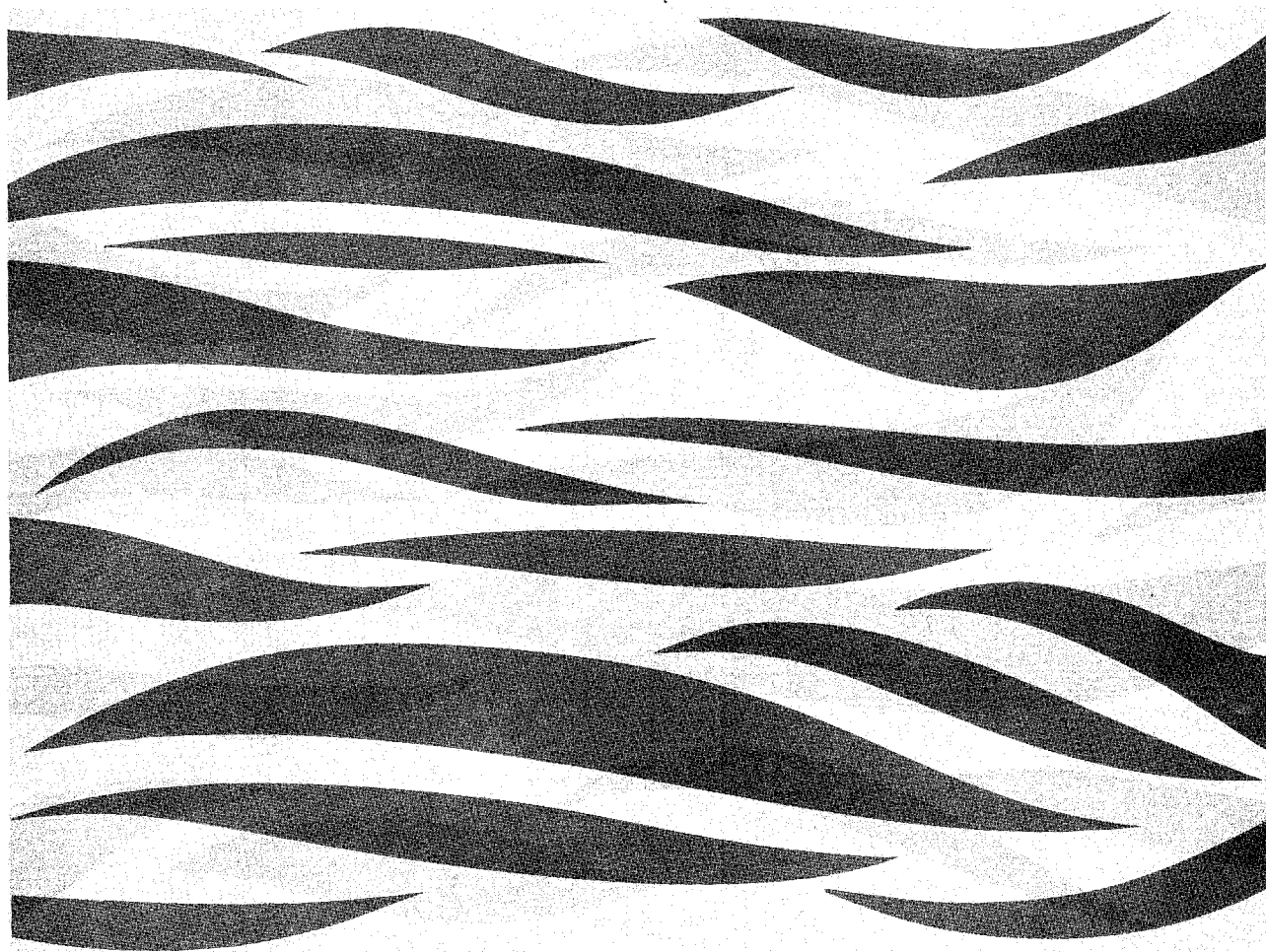
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THE QUALITY OF CONNECTICUT'S SURFACE WATERS

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July 1968



INSTITUTE OF WATER RESOURCES
The University of Connecticut

THE QUALITY OF CONNECTICUT'S SURFACE WATERS

CHESTER E. THOMAS, JR.
Hydrologist
United States Geological Survey
Hartford, Connecticut

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FOREWORD

One of the continuing activities of the Institute of Water Resources has been to sponsor lectures, open to the public, on a broad range of topics relating to water resources.

In order to develop a thorough understanding of and a sound basis for planning the proper development and use of water, it first is necessary to understand the situation as it now exists. In this regard, the Institute was pleased to sponsor the lecture given on October 18, 1967 in which Mr. C. E. Thomas, Hydrologist with the U. S. Geological Survey in Hartford, discussed the quality of surface water in Connecticut.

Quite properly, Mr. Thomas began his lecture by describing the hydrologic cycle and the effect which man has on water quality. He then described the comprehensive water quantity and quality survey which the U. S. Geological Survey has undertaken in cooperation with the Connecticut Water Resources Commission and discussed details of what is known about selected basins including those of the Thames, Norwalk, Housatonic and Connecticut Rivers.

His conclusion that "the chemical quality of most surface waters in the state is good" is heartening to all citizens. It should be recognized, however, that there is room for substantial improvement of water quality, especially in certain areas of the State. This must be accomplished for the proper future development of Connecticut.

We are pleased to publish Mr. Thomas' lecture as this report of the Institute.

William C. Kennard
Director
Institute of Water Resources

THE QUALITY OF CONNECTICUT'S SURFACE WATERS

WATER QUALITY AND ENVIRONMENT 1

by
Chester E. Thomas, Jr. 2

Water, one of our most important natural resources, is a dynamic resource. The endless movement of water from the clouds to earth and back again is referred to as the hydrologic cycle or water cycle. Water, with its unique ability to dissolve more substances than any other liquid can dissolve, is unable to remain chemically unchanged as it moves through the various phases of the hydrologic cycle. What changes occur to the quality of water under natural conditions? Water that evaporates from the land and water surfaces and passes as vapor into the atmosphere is relatively pure. As water vapor condenses to form rain, snow, sleet, or hail, it incorporates tiny particles of dust, salt spray from the ocean, and other particulate matter from the air. These particles themselves contain mineral matter dissolved from the air, and the water picks up additional mineral content from the gases which make up the atmosphere, including carbon dioxide, nitrogen in various forms, and sulfur dioxide. Thus, even as it starts its journey to the land surface, water is no longer "pure." Generally, precipitation is slightly acidic and low in dissolved-solids content. The dissolved-solids concentration of the portions of water that reach the land surface and flow directly across the surface to discharge outlets in streams generally does not greatly exceed the dissolved-solids concentration of precipitation because of the short period of time the water is in contact with the rocks and soil on the land surface and the general absence of readily soluble material.

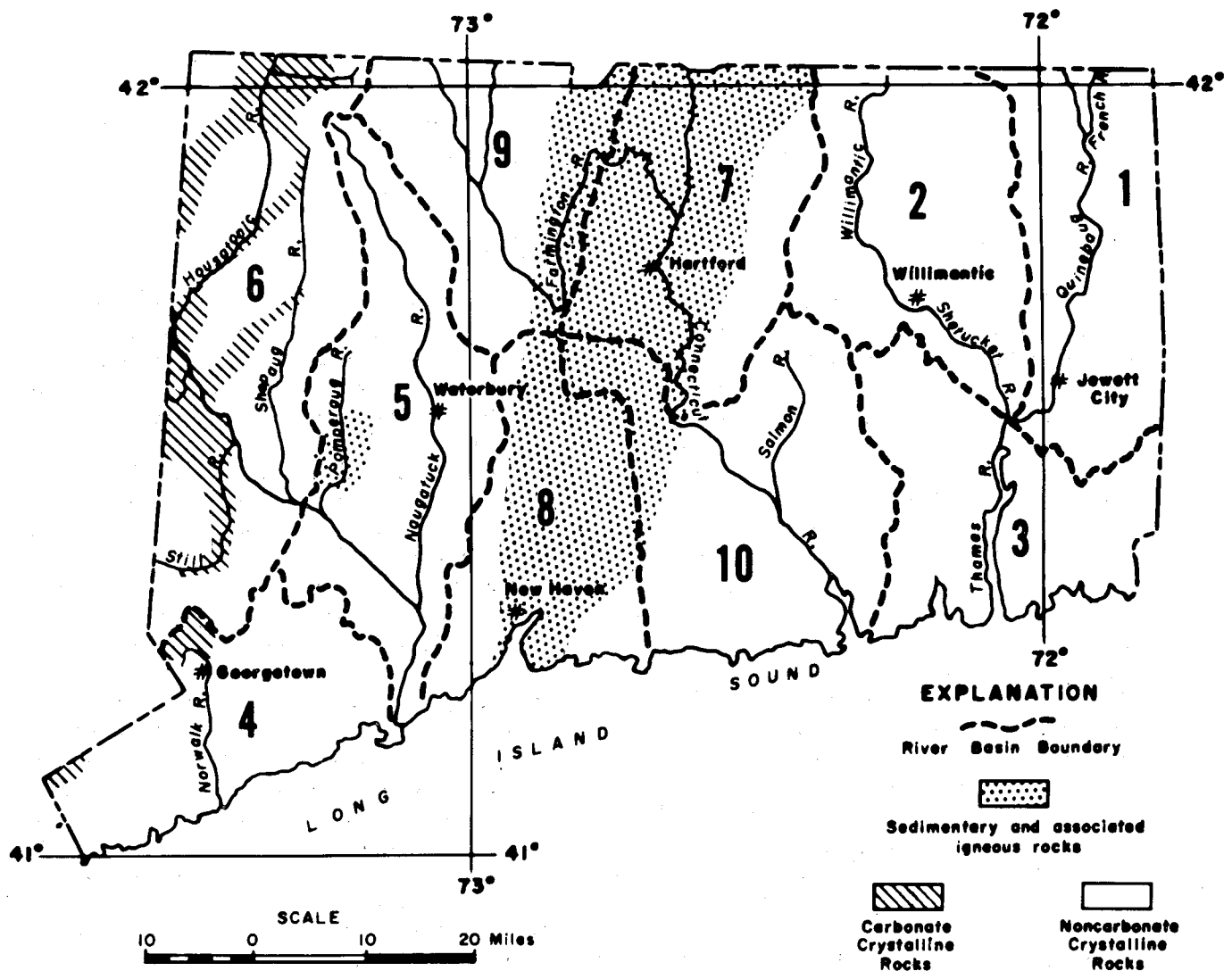
Water that percolates into the ground has much more opportunity to dissolve mineral matter from rock materials than water which flows directly across the land surface. Accordingly, ground water contains more dissolved solids than does rain water or water in streams. Most of the time, water in streams is a mixture of overland runoff and more highly mineralized ground-water runoff. For this reason, streams generally contain the greatest concentration of dissolved solids during periods of low streamflow which time most of the water is ground-water runoff. Streams contain the lowest concentration of dissolved solids during periods of high

flow when most of the water is the less mineralized overland runoff. Under natural conditions the dissolved-solids content of a stream during intermediate-flow conditions represents a blending of the quality of both the ground-water runoff and the direct overland runoff. This content varies according to the streamflow contribution from each source. Comparison of the average chemical character of stream water during periods of high flow with the chemical character of precipitation suggests that a considerable part of the dissolved-solids concentration of overland runoff is already present by the time the water reaches the land surface.

During long dry periods, the flow of streams is maintained by ground-water runoff. Consequently, streams generally reflect the chemical character of ground water during dry periods. The quality and movement of ground-water are influenced by the character of the water-bearing material thru which it passes. Streams may originate in one geologic setting but may be influenced by ground-water contributions from other geologic environments before the stream reaches its mouth. Connecticut is underlain essentially by 3 rock types: (1) noncarbonate crystallines (granite, gneiss and schist) in the eastern and western uplands, (2) carbonate crystallines (dolomitic and calcitic marble) in the western part of the State, and (3) in the Connecticut Valley, principally sedimentary rocks (sandstone and shale) as shown on figure 1. In the eastern and western uplands the noncarbonate crystallines are chemically similar. Waters issuing from these locales are low in dissolved solids and calcium, magnesium hardness. The carbonate terranes yield ground water that is high in pH, hardness, bicarbonate, and dissolved solids. Most samples of ground water associated with the sandstones, shales, and associated trap rock are of the calcium-sulfate type having a high dissolved-solids concentration. Most of the State is covered by the mantle of glacial drift. The glacial material has been derived from one of the parent materials previously mentioned and the waters draining this material will have influence on the water quality similar to that of the parent material.

¹ Publication authorized by the Director, U.S. Geological Survey.

² Hydrologist, U.S. Geological Survey, Hartford, Connecticut.



THE WATER RESOURCES INVENTORY OF RIVER BASINS IN CONNECTICUT

PART 1 Quinebaug River Basin

PART 2 Shetucket River Basin

PART 3 Lower Thames and Southeastern
Coastal River Basins

PART 4 Southwestern Coastal River Basins

PART 5 Lower Housatonic River Basin

PART 6 Upper Housatonic River Basin

PART 7 Upper Connecticut River Basin

PART 8 Quinnipiac River Basin

PART 9 Farmington River Basin

PART 10 Lower Connecticut and Central
Coastal River Basins

Figure 1-- Index map showing locations of river basins and generalized bedrock units in Connecticut.

Water moving across the land surface and in the stream channels dislodges particles of soil, silt, sand, and occasionally gravel; this material is carried in suspension or is rolled along channel bottoms. Generally, sediment load increases as streamflow increases and the highest sediment loads occur during spring thaw and following severe storms such as hurricanes, when streamflows are highest.

Surface-water temperatures follow a seasonal trend in response to changes in air temperature; near freezing-point temperature is reached during the winter months and maximum water temperatures commonly occur in July or August. Ground-water temperatures become relatively constant with depth. During periods of low flow in the summer, streams are noticeably cooler where the relatively cold ground water enters the channels.

Salty or brackish water from Long Island Sound is carried upstream in the estuaries by each flood tide and downstream by each ebb tide. The extent of such tidal invasion into the estuaries is evidenced by an increase in the concentration of dissolved solids and by the change in proportions of the various chemical constituents. For example, sea water contains 3 times as much magnesium as calcium, whereas fresh water normally contains twice as much calcium as magnesium. Furthermore, sea water contains about 35,000 ppm of dissolved solids, of which about 19,000 ppm are chloride ions whereas fresh water in the State normally contains between 30 and 300 ppm of dissolved solids.

The extent of tidal invasion of salt water in an estuary is dependent on a number of factors, some of which are fresh-water inflow, quantity of sea water moving upstream from the Sound, range and stage of tide, and climatological conditions. In late summer and early fall, fresh-water inflow is usually at a minimum, and upstream movement of the sea water in the estuary is at a maximum. During the spring, fresh-water inflow is at its maximum and the upstream movement of sea water is at its minimum.

Evaporation from the surface of streams, lakes, ponds, and from the surface of the ocean, along with transpiration from plants and trees completes our hydrologic cycle.

MAN'S EFFECT ON WATER QUALITY IN THE HYDROLOGIC CYCLE

The quality of water now is a reflection of the interplay between natural and cultural environments. The natural quality of most streams in Connecticut has been changed by man-made variations in the natural regimen of the drainage basin. Some of the smoke, soot, and fumes discharged into the air from industries, homes and vehicles, as well as dust from quarries and fertilizers spread on farm land, are incorporated in

precipitation and some simply settles on the land surface as dry fallout. These materials contribute to the dissolved-solids content of runoff. Precipitation contacts and dissolves the contaminants as it falls through the atmosphere and usually becomes more acidic. This acidity increases water's solvent power and its capacity to dissolve mineral matter. Samples of precipitation have been collected that had a dissolved-solids concentration of 200 ppm (generally the mean is 25 ppm) and pH values as low as 3.5. Generally sulfate is the dominant chemical constituent in precipitation. Urban and industrial areas with low infiltration capacities yield a higher proportion of surface runoff during most storms than that from a forest or cultivated lands. Runoff from roofs and pavements in municipal areas adds previously precipitated chemical and organic pollutants to the dissolved-solids content. Solutions from road salt used on highways in winter, animal wastes, chemical fertilizers, and pesticides spread on agricultural lands also are carried into streams or percolates into the ground. The discharge of chemical wastes, treated or untreated, by industrial users can increase the dissolved-solids content of the receiving stream. Waste discharged into streams is usually diluted by high streamflows, but at times of low flow the water available for dilution is reduced and the water quality deteriorates. Waste water being carried by combined sewer systems to treatment plants often bypasses the plants during storm runoff and enters the stream untreated. Loosened soil during construction of highways, buildings and other structures makes possible rapid erosion which increases the sediment and turbidity concentration in streams. Disposal of domestic and industrial waste to the ground can, in some cases, contaminate nearby wells in densely populated areas or can progressively deteriorate the quality of the water in the aquifer. The damage, while not irreparable, in some cases may require a long time to correct. Most of the water withdrawn from streams or wells and used by industry for cooling, washing, and other purposes is returned to the streams and the ground at higher or lower temperatures or with a higher dissolved-solids content than when withdrawn. No matter how effective man's treatment of waste effluent or curtailment of exhaust smoke, or stabilization of soil erosion, there will still be an increase in the dissolved-solids and suspended sediment content of the water in an inhabited basin over the amounts supplied by natural processes.

SURFACE WATER QUALITY IN THE STATE

The U.S. Geological Survey, in cooperation with the Connecticut Water Resources Commission, has undertaken a series of studies to determine the quantity and quality of water that is available in the State. Connecti-

cut has been subdivided into 10 study areas bounded by natural drainage basins (figure 1). The following data on surface-water quality collected prior to and during these inventory studies will be incorporated in the reports published by the State for each of the 10 areas. The data deal primarily with the chemical content of surface waters in Connecticut rather than with their biological or bacteriological content. From this point of view stream waters may be classified as being of excellent or good quality, (1) if they have a low dissolved-solids concentration, or (2) if the chemical constituents are within the limits set for most industrial and commercial uses. However, the same stream waters may have a high coliform content or a low dissolved-oxygen content, making the waters unsuitable from a sanitary point of view for domestic or recreational use.

Surface water in the eastern third of the State contains generally less than 100 ppm dissolved solids, whereas surface water in the western third of the State generally contains between 100 to 300 ppm dissolved solids, depending upon whether the stream drains carbonate or noncarbonate areas. Dissolved-solids concentrations up to 1,000 ppm are found along the Norwalk and Naugatuck Rivers. Currently in the central third of the State, surface-water quality data are available only in the northern part above Middletown. In this part of central Connecticut, calcium-sulfate type water are characteristic of most of the area; they contain between 100 to 300 ppm of dissolved solids. The highest concentrations are found in the Hartford area.

A detailed look at water quality of surface waters in some regions of the State follows.

THAMES RIVER BASIN

The quality of surface waters in the Thames River basin is as good as or better than the quality of surface water in the other basins throughout the State. The basin drains an area underlain by crystalline bedrock veneered with stratified drift and till. Because of the relatively low solubility of the minerals in both these deposits, only moderate quantities of mineral matter are dissolved. The dissolved-solids concentrations are as low as 26 ppm and hardness is as low as 11 ppm. A comparison of chemical characteristics in the three subbasins comprising the Thames River basin shows an overall similarity in the chemical quality of streams under natural conditions. The most common constituents in the naturally occurring stream waters are calcium, sodium, bicarbonate, and sulfate; these constituents comprise about 80 percent of the total dissolved solids in samples collected. Hardness of the waters sampled ranged from 11 to 62 ppm, dissolved-solids concentrations ranged from 26 to 150 ppm, and sulfate ranged from 4.4 to 29 ppm. Under low-flow conditions half of the streams sampled contained less than 70 ppm

dissolved solids. In addition to being soft, waters that contain few dissolved solids generally have low alkalinity. This, together with the presence of dissolved carbon dioxide and organic acids, results in the slightly acidic waters which are found in the basin.

Dilution by overland flow is an important factor and is reflected in the fluctuations of dissolved solids in the major streams of the basin. The variations of chemical quality of water with changing streamflow at a point in a stream can be illustrated by data from a continuous specific conductance recorder and a stage recorder at a gaging station. (Specific conductance gives a rough measure of the dissolved-solids concentration of water). Continuous records from two stations, on the Quinebaug River at Putnam and on the Willimantic River near South Coventry, illustrate the relationship. The data show that as streamflow decreases (from May to October) dissolved-solids concentration increases, and conversely, as streamflow increases (from November to April) dissolved-solids concentration decreases. Variations in amounts of industrial wastes discharged upstream caused rather large daily fluctuations in dissolved-solids concentrations during periods of low streamflow when there was almost no variation in streamflow from day to day. On the other hand, during periods of higher streamflow, where there was an abundance of water to dilute and transport the wastes, fluctuations in dissolved-solids concentration were relatively small.

At very high streamflow the dissolved-solids concentration of the waters of the Quinebaug River in the reach from Quinebaug to Jewett City showed a variation in dissolved solids between 30 and 40 ppm. However, at very low streamflow there was a significant increase in the dissolved-solids concentration in the Quinebaug River. At low flow the French River increased the dissolved-solids content in the Quinebaug River from 80 to about 130 ppm. An increase in sodium and bicarbonate content accounted for most of the increase.

For the most part, the chemical quality of the water in the Shetucket River at its mouth is practically the same as that of the water of the major tributary streams throughout its basin. With the exception of the Little River at Versailles, stream samples collected during April, July and September 1963 had less than 100 ppm dissolved-solids. The water in Little River had 212 ppm dissolved solids. Though the dissolved-solids concentration of the Willimantic River at low flow did not differ widely from projected natural conditions, organic wastes from sewage effluent noticeably lowered the dissolved-oxygen concentration to a point detrimental to the to the propagation of aquatic life. While the dissolved-oxygen concentration was near 100 percent saturation from Stafford Springs to Willimantic during an April 1964 high streamflow profile, it was only at a

22 percent saturation level due to an increment of sewage effluent from Stafford Springs during a July 1964 low streamflow period. Sewage contains relatively large quantities of nitrates and phosphates. Stream samples collected during the same July 1964 low-flow period contained 19 ppm of phosphate and 12 ppm of nitrate at Stafford Springs and decreased downstream as the dissolved oxygen increased.

Overland runoff from heavily fertilized areas may cause a marked effect on the chemical quality of smaller streams. Data collected in 1963 and 1964 indicated that the concentration of dissolved solids at a gaging station on Ash Brook near North Coventry increased when streamflow increased. This relationship is contrary to that found under ordinary conditions. The stream sample collected at low flow, largely composed of ground-water runoff, had a chemical quality expected of this basin. However, samples collected at medium and high flows after rainfalls showed an increase in acidity (pH 6.5 to 3.6) and an increase in dissolved-solids concentration (61 to 133 ppm); the increase resulted from surface runoff from an area upstream which had been heavily fertilized with a superphosphate fertilizer.

Iron makes up only a small fraction of the dissolved solids in stream waters, but it may be present in amounts large enough to be troublesome. An iron content of 0.3 ppm or more is objectionable for most domestic and industrial uses. Iron in natural surface water is derived either directly from minerals of rocks and soils or indirectly from decaying vegetation that has assimilated iron from the soils. Iron concentrations from samples of natural streams ranged from 0.01 to 1.3 ppm.

Daily iron concentrations in major streams in the basin range widely, but generally have the same relationship with streamflow as do dissolved solids. Daily samples collected from the Quinebaug River during 3 different water years showed that iron concentrations 0.3 ppm or greater were measured at Quinebaug 75 percent of the time, at Putnam 71 percent of the time and at Jewett City 45 percent of the time. Iron concentration for the Willimantic River near South Coventry was 0.3 ppm or greater 55 percent of the time and 40 percent of the time in the Shetucket River near Willimantic. Concentrations of iron in stream waters resulting from industrial pollution have been measured as high as 2.3 ppm.

SOUTHWESTERN COASTAL RIVER BASINS

Analyses of samples of naturally occurring stream water of the south-western coastal river basins collected during low-flow periods indicate that calcium, sodium, bicarbonate, and sulfate make up most of the dissolved-solids concentration. In general specific conductance measurements revealed that the dissolved-solids content

is less than 100 ppm in areas draining noncarbonate rock types and 100-300 ppm in areas draining carbonate rock types. Chemical analyses of samples collected show that the waters range from soft to moderately hard (29 to 112 ppm hardness) and that the dissolved-solids concentration generally lies in the 53 to 154 ppm range. The chemical quality of water in streams north of the Merritt Parkway in this region generally exhibit little or no effect on man's activity, with one notable exception, that being the Norwalk River. Along portions of the Norwalk River south of Georgetown, the lower reaches of the Noroton River and lower reaches of the Byram River, the dissolved-solids concentrations exceed 500 ppm. In the above-mentioned reach of the Norwalk River, man's activity is plainly visible in the chemistry of the river's water. Samples collected above the industrial area had a pH 7.6 while in the industrial area, the pH falls to 3.5 and then rises to 6.1 at the next sampling site downstream. The dissolved-solids concentration at these respective sites were 136 ppm, 700 ppm and 317 ppm at the 80 percent flow-duration period.

Iron, as previously mentioned, can be troublesome in small concentrations. During the low-flow period 21 percent of the stream samples collected at unaffected or natural sites had iron concentrations 0.3 ppm or greater; whereas samples collected at portions of the streams where man's influence is evident showed 57 percent of the samples contained more than 0.3 ppm iron. The iron concentration ranged from 1.7 to 32 ppm. Other increases in chemical constituents were as follows: sulfate from 24 to 280 ppm, nitrate from 4.6 to 11 and pH from a minimum of 6.8 to 2.8.

HOUSATONIC RIVER BASIN

In the Housatonic River basin in the western part of the State the chemical quality of surface waters ranges from excellent to poor. The dissolved-solids concentration may range from less than 50 ppm to greater than 1,000 ppm and hardness ranges from soft to hard water. This broad range in quality reflects the influences of diverse geology, hydrology, and man's activity.

In the upper portion of the basin streams drain both carbonate rock and noncarbonate rock areas. Here the dissolved-solids concentrations range from 100 to 300 ppm. The presence of carbonate rocks is reflected in the chemical composition of the water of the main stem and its tributaries. For example, in the Housatonic River at Falls Village, Blackberry River at Canaan, and Tenmile River near Gaylordsville, approximately 80 percent of the dissolved-solids concentration consists of calcium, magnesium, and bicarbonate.

Because the cations are principally calcium and magnesium, hardness is a prominent chemical characteristic of the surface waters in this portion of the basin.

Highest amounts are found in stream waters draining the carbonate rock areas but decreases downstream where the river begins to receive drainage from the noncarbonate crystalline rock terrain. High streamflow also has an ameliorating effect on hardness as dilution by surface runoff takes place. In 1956 hardness ranged from 61 to 149 ppm in the Housatonic River at Falls Village but during a high flow in April 1960 the hardness dropped to 52 ppm.

In the Tenmile River 95 percent of the samples equaled or exceeded a hardness of 109 ppm. This harder water is the result of a larger quantity of carbonate materials in the drainage area.

In the water from the Still River near Lanesville, calcium, magnesium, and bicarbonate are also high, but the percent of composition of these constituents is less, 65 percent, as compared to 80 percent in the previously mentioned streams. The dissolved-solids concentration ranged from 61 to 220 ppm and hardness ranged from 38 to 133 ppm. The percent of calcium, magnesium, and bicarbonate constituents is lower than anticipated from a carbonate drainage area, although the dissolved-solids concentration is still high. The percentage is less because industrial and domestic wastes discharged to the surface waters in this basin contain increased amounts of other chemical constituents, such as sodium, sulfate and nitrate. For example, sulfate concentrations as high as 40 ppm and higher were not uncommon in 1959. Also sodium and nitrate concentrations were higher than in the other streams.

In the lower section of the Housatonic River basin noncarbonate crystalline rocks make up the bedrock and were the source materials for the overlying glacial deposits. Because of the low solubility of these rocks, the waters in that area are softer and have a lower dissolved-solids concentration than the Housatonic River and its northern tributaries, which have their waters discharging from carbonate areas. The concentration of dissolved-solids in natural waters is less than 100 ppm and hardness ranges between 16 and 50 ppm at low-flow periods. In water from the Shepaug River near Roxbury, 90 percent of the daily stream samples collected during the 1959 water year had a dissolved-solids concentration that ranged from 50 to 81 ppm and an average hardness of 38 ppm. Similarly, in the valley of the Pomperaug River the average dissolved-solids concentration at Southbury was 65 ppm and average hardness was 35 ppm during the 1961 water year.

The drainage basin of the Naugatuck River is also underlain by relatively insoluble crystalline bedrock. During low flow, water from Hall Meadow Brook, in the headwaters, has a dissolved-solids concentration less than 100 ppm, hardness less than 45 ppm and sulfate concentration less than 16 ppm. Below the Torrington

area the chemical quality of the Naugatuck River is largely determined by the amount and type of industrial wastes discharged into the river. At Beacon Falls striking changes in water quality can be observed. For example, from November 16 to 23, 1960 continuous specific conductance records showed wide and erratic hourly changes. Much of the week the conductance fluctuated between 150 and 300 micromhos, but higher concentrations were recorded for shorter periods of time. On November 22, the specific conductance rose sharply from 260 to 1,200 micromhos in a short period. During the 1967 water year similar fluctuations were measured, some even greater than 2,000 micromhos (approximately 1,200 ppm dissolved solids). The Mad River in Waterbury was recently measured above 3,500 micromhos. Such rapid fluctuations in chemical quality are not natural and are the result of contamination. At Beacon Falls, water samples collected from the Naugatuck River had sulfate concentrations that ranged from 16 to 115 ppm, chloride from 8.8 to 58 ppm and bicarbonate from 0 to 33 ppm. Nitrate concentrations in the river had been measured as high as 29 ppm and dissolved oxygen as low as 1.5 ppm. At times, the water was acid (pH as low as 3.5) and at other times alkaline (pH as high as 9.1).

In the Housatonic River basin, comparatively large fluctuations in dissolved-iron concentrations were determined for some of the streams. Slightly more than 10 percent of the daily water samples collected from the Housatonic River at Falls Village had iron concentrations in excess of 0.3 ppm; less than 5 percent of the samples in the Tenmile River near Gaylordsville and Shepaug River near Roxbury had an excess of 0.3 ppm; and about 5 percent of the samples in the Pomperaug at Southbury exceeded 0.3 ppm. However, on the Still River more than 25 percent of the samples and on the Naugatuck River near Thomaston more than 50 percent of the samples had more than 0.3 ppm iron.

CONNECTICUT RIVER BASIN

The relatively low mineral content of the Connecticut River and some of its tributaries may be misleading. The Connecticut River, an interstate stream, flows through industrialized areas and is polluted by the industrial and domestic wastes. The low mineral concentration is not the result of the geology in the basin, but rather due to the enormous volume of water carried by the river. The Farmington River, a major tributary to the Connecticut River, above the highly urbanized areas does not appear to have an unusual mineral content in view of the geology of the basin. In some of the smaller streams especially during low flow, the poor chemical quality is attributable to pollution.

The diverse geology from crystallines in the highlands

to sedimentary rocks in the lowlands results in both calcium-bicarbonate type waters (low in dissolved-solids) and calcium-sulfate type waters (high in dissolved-solids). In the water samples from the Connecticut River at Thompsonville, dissolved-solids ranged from 46 to 91 ppm. Dissolved solids in samples collected from the Farmington River at Rainbow were slightly less, 43 to 80 ppm. Hardness of water from these streams ranged from 24 to 53 ppm and 20 to 60 ppm, respectively. Dissolved solids and hardness of the smaller tributaries such as the Salmon River near East Hampton are similar in concentration since they drain areas underlain by crystalline bedrock. Generally at low flow the dissolved-solids concentration in the Connecticut River ranges from approximately 90 ppm at Thompsonville to about 120 ppm near East Haddam.

Salt or brackish water has not been known to move farther upstream than the East Haddam Bridge.

Iron concentrations in the Connecticut River fluctuate within a wide range; concentrations of 0.15 to 1.3 ppm have been measured. In making a dissolved oxygen profile of the Connecticut River on June 22 and 23, 1967 it was determined that the west bank portion of

the river shows a greater downstream decrease in dissolved-oxygen concentration than the east bank portion of the river. Notable declines in dissolved oxygen content were observed below Windsor Locks, Hartford, and the inflow of the Mattabesset River. Tributaries draining the lowlands such as the Scantic River and Goff Brook have a much wider range in dissolved solids (150 to 300 ppm).

SUMMARY

The chemical quality of most surface waters in the State is good. The dissolved-solids concentration generally ranges from less than 100 to about 200 ppm during low streamflow periods. Waters draining areas underlain by noncarbonate crystalline rocks or from the glacial materials derived from them are soft and low in dissolved solids. The higher dissolved-solids concentrations and harder waters occur in the western area of carbonate rocks and in the central lowland area where sedimentary rocks are dominant or where large quantities of industrial wastes are discharged to the streams. Excessive iron concentrations occur in streams at scattered locations throughout the State.