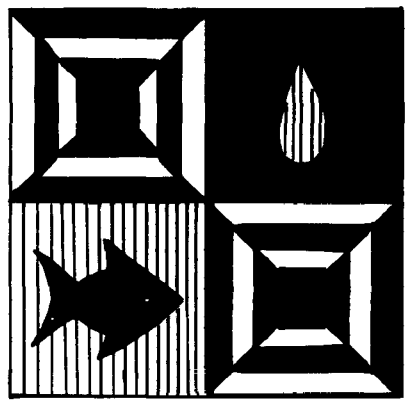
Water Quality Assessment for the

KANAWHA RIVER BASIN

(North Carolina, Virginia, West Virginia)

WORK DOCUMENT 50



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
WHEELING FIELD OFFICE
SURVEILLANCE & ANALYSIS DIVISION

Water Quality Assessment Report

Kanawha River Basin

by

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Region III

Surveillance and Analysis Division

Wheeling Field Office

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Water Quality Assessment Report

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INTRODUCTION

The purpose of this document is to provide answers to four questions: (1) what is the current water quality situation; (2) why does the situation exist; (3) what has been the trend in recent years; and (4) what will the water quality be in years to come? In so doing, identification is made of significant water bodies that, in 1973, met the 1983 goal of water quality adequate for swimming and for the protection and propagation of fish and wildlife and water bodies that might achieve the 1983 goal by 1977, 1983 or some later date.

The document is summary in nature and is not intended to provide a detailed analysis of the water quality of all the streams in the basin or to examine all of the factors present or potential which act upon the water quality of a given stream. The information contained in the document is based on surveillance and monitoring activities carried out by the Wheeling Field Office, Surveillance and Analysis Division, plus appropriate data from cooperating State and Federal agencies.

The document should provide a starting point for the detailed examination of needs, priorities, standards, load limitations and other factors to meet the 1983 goal.

BASIN DESCRIPTION

The New River portion of the Kanawha River rises near Blowing Rock, North Carolina, flows northeastward through North Carolina into Virginia, turns and flows northwestward through Virginia and West Virginia to its confluence with the Gauley River near Gauley Bridge, West Virginia where they form the Kanawha River. The Kanawha River continues to flow northwestward through West Virginia to its confluence with the Ohio River at Point Pleasant, West Virginia, 266 river miles below Pittsburgh, Pennsylvania. The basin embraces about 12,300 square miles of which 8,450 are in West Virginia, 3,080 in Virginia and 770 in North Carolina. Total length of the Kanawha-New River is 347.2 miles with the lower 90.6 miles being navigable.

The basin is bounded on the north by the Little Kanawha and Monongahela River basins, on the east by the Potomac, James and Roanoke basins, on the west by the Tennessee, Big Sandy and Guyandotte River basins and on the south by the Peedee River basin.

The greater Charleston, West Virginia area is a major chemical manufacturing center within the United States. The extremely complex and ever-changing nature of the wastes from the chemical industry makes the solution to this portion of the Kanawha's water quality problems quite difficult and expensive.

Principal tributaries to the Kanawha-New River are the Elk, Coal, Pocatalico, Gauley, Bluestone and Greenbrier Rivers.

METHODOLOGY

Streams having a drainage area less than one hundred square miles are generally excluded unless they have a significant impact on the receiving stream, have a significant recreational value or include a potential reservoir site under active consideration by the Soil Conservation Service or the U. S. Army Corps of Engineers. The criteria for classifying the streams are listed in Table 1. "Put and take" trout stocking in a stream does not qualify it for classification under cold water fishery. The trout placed in such a stream may be able to live in the stream year round, but if the temperature and dissolved oxygen criteria are not suitable for trout propagation, the stream is classified for warm water fishery. In general, there is a lack of data available for evaluation of taste and odor content and effects and total dissolved gases content with respect to the existing atmospheric conditions. For the purpose of this report, current data are considered as that collected from 1970 to present. For comparative purposes and for trends, pre-1970 data were also evaluated.

THE CURRENT WATER QUALITY SITUATION

New River and major tributaries

The Stream Water Quality Table (Table II) includes a total of 1,887.6 miles of streams. Of this amount, 651.3 miles do not presently meet water quality standards for recreational uses. The wide distribution of the larger degraded streams is illustrated on the maps of the basin which identify streams that meet standards for various recreational uses in the past, at present, and projected to the years 1977 and 1983.

Most streams in the basin are potentially suitable for warm water fish and primary water contact recreation. Four stream reaches presently meet the criteria for primary recreation and cold water fishery, with two others having the potential to meet this criteria by 1977. A number of the headwater areas either presently meet the criteria or have the potential for a cold water fishery.

The New River area has numerous State parks and recreational areas on and around water developments such as Claytor and Bluestone Lakes and Sutton and Summersville Lakes. Boating, water skiing, swimming, camping and fishing activities are popular in these areas.

The principal water quality problem existing in the New River area is caused by the discharge of inadequately treated domestic sewage. While some 250,000 persons are served by municipal water systems, most communities have less than adequate waste treatment facilities. Approximately 20 communities provide no waste treatment

and, of those with primary or secondary treatment facilities, most do not provide adequate chlorination.

In addition to the established municipalities, the semi-urban and rural development which is prevalent along many basin streams results in a significant domestic waste load which generally is inadequately treated.

Excluding mine drainage problems, industrial pollution is a significant problem in reaches of the main stem of the New and Greenbrier Rivers and several tributaries. Waste discharges from the Radford Army Ammunition Plant at Radford degrade the New River for approximately 24 miles below Radford, Virginia. These discharges, along with those from the Celanese Corporation plant at Narrows, Virginia, have caused intermittent fish kills in the New River from Eggleston to the Virginia-West Virginia State line.

Tannery wastes from the Howes Leather Company Tannery at Frank, West Virginia, degraded the Greenbrier River for some five miles downstream of Durbin. These wastes, along with the untreated domestic wastes from Durbin, impaired the stream use as a municipal, industrial and agricultural water supply; water contact recreation; and support and propagation of aquatic life. Recent field investigations by aquatic biologists indicate a significant improvement in water quality, as reflected by aquatic life, below this facility.

A combination of municipal and industrial wastes in the Bluefield area cause pollution problems in the Bluestone River in both West Virginia and Virginia. Other sources of pollution problems include coal mine drainage; coal washeries; oil, gas and brine field wastes; and erosion and sedimentation resulting from land disturbances.

The degradation of the aesthetic values of the streams in the area are a great impairment to property values and affect the social environment in general.

Kanawha River main stem and tributaries

Water Quality Table III lists a total of 90 miles of the Kanawha River main stem and 64 miles of principal tributary streams. Presently, some 56 miles of the main stem Kanawha will not meet water quality standards for recreational use. At least 52 miles of tributary streams are also known to not meet standards.

Most of the Kanawha River main stem is potentially suitable for warm water primary recreational use. In the past, public bathing beaches were common to the Charleston area, located at several sites in and around the city, in addition to all other popular water oriented diversions.

At present, every reach is used for boating, some contact recreation and residents have expended a great deal in some areas to maintain backyard areas and bank areas with orientation towards water recreation.

Three main tributary streams are potentially suitable for primary water recreation with sizable populations and stream bed areas with development potential.

Water quality problems are severe in these tributary areas with respect to acid mine drainage, siltation and domestic waste influence in the Paint Creek and Cabin Creek streams especially. Davis Creek was, until recently, heavily polluted from two large chemical manufacturing firms. A series of remedial measures have been taken to alleviate this problem.

The Kanawha main stem has definite zones or reaches of varying water quality. The upper reach from the Kanawha Falls extending down river below the Chelyan Bridge areas has been generally unpolluted and is of primary water recreational use quality. The Belle, West Virginia area of the river is affected by some domestic waste and a significant industrial waste load from the DuPont Chemical Plant. Water recreation uses of a secondary nature would be currently permissible in this reach with recovery from the industrial source fairly rapid.

Water quality below this point is fairly good and is used for limited contact water recreation extending to the Route 60 Bridge at Charleston, which marks the beginning of the heavily industrialized portion of the Kanawha resulting in degradation extending nearly to the mouth of the main stem.

Industrial pollution, generated by a significant chemical manufacturing complex, is the single most significant factor in the water quality degradation causing a loss of dissolved oxygen in the area below Charleston and extending below the Winfield Lock and Dam, a distance of 25 miles or more. This oxygen demand of the river is the single most prevalent degradant in the Kanawha River affecting at least 40 miles of the main stem. Generally, pH considerations are not a detriment to the Kanawha with the possible exception of a localized affect near an outfall.

FACTORS AFFECTING WATER QUALITY

New River and major tributaries

Municipal and domestic pollution is prevalent throughout most of the basin. The discharge of these raw and inadequately treated wastes results in high coliform concentrations, high biochemical oxygen demand, floating and suspended solids and odor. These discharges impair the use of the streams for water contact recreation and the support and propagation of aquatic life.

The most serious industrial problem on the New River occurs in the vicinity of the Radford Army Ammunition Plant at Radford, Virginia. This plant discharges large quantities of nitrate, sulfates, solids, TNT red water and generates excess pH and temperature variations.

The upper reach of the Greenbrier River is degraded by wastes from the Howes Leather Company tannery at Frank, West Virginia. Discharges from this tannery result in low dissolved oxygen, high pH, biochemical oxygen demand, alkalinity, sulfates, chlorides, color, high coliforms and solids. Intermittent fish kills have occurred in this reach as a result of this condition.

Coal mining in the New River area is limited to the West Virginia portion of the basin. Generally, however, the acid component of mine drainage in this area is small compared to the highly acid mine drainage common to the northern coal fields of Ohio, Pennsylvania and West Virginia. This mine drainage, although highly mineralized, is alkaline rather than acid. These discharges affect the iron, aluminum, hardness and dissolved solids content of the streams. Another water quality problem emanating from the coal industry is the waste discharge from coal washeries. Their principal waste is solids in the form of coal fines resulting in a "blackwater" condition in the stream.

Past and present oil explorations in the upper Pocatalico River basin have caused stream degradation through the discharge of brine wastes. This pollution was so severe that the Sissonville, West Virginia Public Service District was forced to discontinue their use of the Pocatalico River as a public water supply source in early 1967.

Several oil spills have occurred in the lower reach of the Elk River from the Elk Refining Company, one of several oil industries in the area. These spills, although localized in nature, are a point of concern.

Kanawha River main stem and tributaries

The three main tributary streams are characterized by heavy sedimentation, domestic wastes and chemical manufacturing wastes, the latter confined to Davis Creek. Abandoned and active mining discharges characterize Paint Creek resulting in all the pollutants associated with acid mine discharges and, in particular, a pronounced aesthetic degradation. Cabin Creek has a heavy sedimentation problem which causes a masking of traditional mine drainage aesthetics. Both of these streams are influenced by domestic wastes with Cabin Creek having an area population of about 20,000 people. The majority of this population is serviced by individual systems resulting in a significant domestic waste contribution to the drainage system.

Two large industrial chemical manufacturing firms contributed to pollution of Davis Creek until very recently. The largest company, Union Carbide at South Charleston, which discharged a heavy lime-laden organic discharge, has completed an interceptor system to collect all the discharge and divert it to a secondary treatment system jointly operated with the City of South Charleston. The present residual discharges to Davis Creek are primarily chlorides with some visible oil also in evidence from the FMC Corporation Inorganic Plant located at South Charleston, West Virginia.

The main stem Kanawha River has four distinctive areas of industrial and municipal sources with the industrial portion representing an estimated 95 percent of the total load. A listing of the more important industry and municipal sources includes:

1)	City of Chesapeake City of Belle Diamond Shamrock E. I. DuPont deNemours and Co. City of Marmet	Belle area
2)	City of South Charleston City of Charleston Union Carbide-South Charleston plant FMC Corporation, Inorganic Chemical Division	Charleston area
3)	City of Dunbar W. Va. State College Union Carbide-Institute Chemical Leahman Tank Lines-Institute Mason-Dixon Tank Lines-St. Albans City of St. Albans	Institute area
4)	Allied Chemical-Nitro Chemical Formulators, Inc. Fike Chemical Co. FMC Corporation, American Viscose Division FMC Corporation, Organic Chemicals Monsanto Company City of Nitro	Nitro area

The Kanawha River between Mile 70 and Mile 40 contains one of the oldest and largest concentrated chemical complexes in the country. Pollutant discharges from such a complex run the gamut of a listing of most parameters; however, the organic loadings and toxic materials generally are the important considerations. The organic material discharges reflect an effect on the stream as Biochemical Oxygen Demand (B.O.D.) which taxes the residual oxygen content of a body of water.

The industries and municipalities all approach a level of secondary treatment; in the past, generally considered adequate. However, the magnitude of the raw waste loads from industry is such that the residual after a generally high degree of treatment is still very significant. This situation is further compounded by the existence of navigation structures which reduce the natural assimilative capacity of the river, particularly under low flow conditions.

This lessening of assimilative capacity has resulted in a historical condition of low D. O. values often times recorded at zero levels during the critical flow months. Recent mathematical modeling of the river indicates that a maximum BOD_u (ultimate Biochemical Oxygen Demand) load of 35,000 pounds can be tolerated to achieve a daily average dissolved oxygen level of 5.0 mg/l in the critical reach. As recent as 1972, loads have been evaluated after secondary treatment to be in the 378,000 lb/day BOD_u range. In consideration of these needs, significant agency and national attention has evolved over the need for water quality storage.

WATER QUALITY TRENDS

New River and major tributaries

A comprehensive water quality survey of the Kanawha-New River basin was conducted in 1964 by the Wheeling Field Office, Ohio Basin Region, Federal Water Pollution Control Administration.[1] During

[1] Now the Wheeling Field Office, Surveillance & Analysis Division, U. S. Environmental Protection Agency, Region III.

this study, some 50 stream locations on the New River and major tributaries were sampled an average of 16 times each during the four month summer period. In addition, the West Virginia Division of Water Resources has maintained a network of approximately ten water quality monitoring stations in the west Virginia portion of this area since 1967.

The data from the 1964 study and the State monitoring network was used in preparing portions of Table II and the maps accompanying this report.

Additional special studies have been conducted by the Wheeling Field Office in specific areas in recent years but these were of a limited nature and the data is not sufficient for an adequate assessment of present conditions of water quality trends.

In predicting water quality in the years to come, it is assumed that a large, coordinated effort will be undertaken by the Federal, State and local governments to improve water quality by 1983.

Some municipalities and industries, including mining, have already made significant progress in reducing water pollution. The construction and efficient operation of adequate municipal and industrial waste treatment facilities throughout the basin will go a long way toward achieving the desired water quality by 1983.

Pollution from abandoned mines and non-point sources, resulting from poor land-use practices, will be a continuing problem and is expected to be the dominant factor affecting water quality for many years to come.

Kanawha River main stem and tributaries

Beginning in 1958, a phased program was developed to clean up the Kanawha River, spearheaded by the State and with the full cooperation of the industries and municipalities. The target pollutant was BOD and load allocations were assessed on those involved in three stages with the most recent goal due in January 1973. Three phases progressively led to 85 percent BOD_5 or first stage removals. There is probably no other major river basin in the country showing the progress achievement as has been demonstrated in the Kanawha valley.

The Wheeling Field Office of EPA and its various predecessors have completed substantial surveys of the river during alternating years beginning in 1965. Other groups have also completed studies with the most recent being a major pre-enforcement conference study conducted by the National Field Investigations Center, Cincinnati, in 1972. All of these efforts have indicated a positive trend toward water improvement and higher average levels of dissolved oxygen below the industrial complex. A privately owned water company serving Nitro, West Virginia, which has relied on carbon filtration to augment drinking water treatment for removal of taste and odor constituents, has found its need to recharge these units considerably lessened.

As technology allows a greater removal of the BOD components, which are readily degradable, the emphasis will shift to the more resistant or lesser degradable components. Little is known as yet in the treatment of these as well as their possible synergistic effects.

Due to the complexity of the organics discharged and their unknown interactions in addition to the results of recent bioassay surveys, it is known that toxic effects are present. This area of technology remains as one of the most troublesome to define and predictions of future water use become clouded in light of this.

EPA is yet to define the legally mandated best practicable treatment (BPT) levels. Without this determination, it is difficult, at best, to project the future cleanup which may occur in the Kanawha. It is, however, widely recognized that levels of attainment will surely go beyond those presently achieved resulting in the predictions of the water quality in the maps for 1977 and 1983. It is also assumed that a toxic element list will be promulgated by EPA requiring the removal of many heretofore undealt with items.

As for the tributaries, if Paint Creek and Cabin Creek are subjected to unforeseen remedial measures, it would be possible for their restoration to primary warm water recreational areas.

The fish population of the Kanawha River, as reflected by annual sampling upstream and downstream of the industrial complex, indicates a decline of pollution sensitive fishes at the Winfield sample point (downstream of pollution sources) in comparison with the sampling at London, West Virginia (upstream of pollution).

However, the samples collected in 1967-1970, in comparison with one sample collected in 1958 by the ORSANCO-University of Louisville study, indicates the fishery quality and quantity has significantly

improved at the location downstream of the pollution source complex.

The fishery composition at Winfield has included several species considered pollution sensitive and, although not in abundance, their consistent presence during the sampling period (1967-1970) certainly indicates a trend of water quality improvement.

Also, fish kills have been less frequent and sport fishing has shown improvement during the early 1970's. However, fish kills could be more common as water quality improves because of greater number of fish than in the past.

Table 1

Water Quality Requirements for

Recreational and Fishery Uses

PRIMARY RECREATION AND COLD WATER FISHERY	-	Swimming, diving, water skiing, wading and dabbling by children. Involves considerable risk of ingesting water in quantities sufficient to pose a significant health hazard. Protection and propagation of cold water fish species (Trout).
Fecal Coliform	-	geometric mean not over 200/100 ml.
pH	-	6.5 to 8.3 standard units.
Dissolved Oxygen	-	minimum 6.0 mg/l daily average.
Temperature	-	maximum of 68° F or 5° F rise over natural temperature.
Color and Turbidity	-	minimum to allow Secchi disc to be visible at one meter or maximum of ten (10) Jackson Turbidity Units.
Dissolved Solids	-	maximum of 500 mg/l or 1/3 above characteristics of natural conditions, whichever is less.
Taste and Odor	-	none present in such amount which will interfere with water contact use or in amount which will impart taste to fish flesh.
Total Dissolved Gases	-	not to exceed 110 percent of existing atmospheric conditions.
PRIMARY RECREATION AND WARM WATER FISHERY	-	Swimming, diving, water skiing, wading and dabbling by children. Involves considerable risk of ingesting water in quantities sufficient to pose a significant health hazard. Protection and propagation of warm water fish species, i.e., gasses, catfish, etc.

Table 1 (continued)

Fecal Coliform	-	geometric mean not over 200/100 ml.
pH	-	6.5 to 8.3 standard units.
Dissolved Oxygen	-	minimum 5.0 mg/l as daily average minimum 4.0 mg/l.
Temperature	-	maximum 90° F or 5° F rise over natural conditions.
Color and Turbidity	-	minimum to allow Secchi disc to be visible at one meter or maximum of (10) ten Jackson Turbidity Units.
Dissolved Solids	-	maximum of 500 mg/l or 1/3 above characteristics of natural conditions, whichever is lesser.
Taste and Odor	-	none present in such amount which will interfere with water contact use, or in an amount which will impart taste to fish flesh.
Total Dissolved Gases	-	not to exceed 110 percent of existing atmospheric conditions.
SECONDARY RECREATION AND COLD WATER FISHERY	-	All other recreational uses except Primary Recreation. Protection and propagation of cold water fish species (Trout).
Total Coliform	-	maximum geometric mean of 10,000 per 100 ml.
pH	-	6.0 to 9.0 standard units.
Dissolved Oxygen	-	minimum of 6.0 mg/l daily average.
Temperature	-	maximum 68° F or 5° F rise over natural temperature.
Color and Turbidity	-	maximum of ten (10) Jackson Turbidity Units.

Dissolved Solids	-	1/3 above characteristics of natural conditions.
Taste and Odor	-	none which will impart taste to fish flesh.
Total Dissolved Gases	-	not to exceed 110 percent of existing atmospheric conditions.
SECONDARY RECREATION AND WARM WATER FISHERY	-	All other recreational uses except for Primary Recreation. Protection and propagation of warm water fish species i.e. basses, catfish, etc.
Total Coliform	-	maximum geometric mean of 10,000 per 100 ml.
pH	-	6.0 to 9.0 standard units.
Dissolved Oxygen	-	minimum 5.0 mg/l daily average. minimum 4.0 mg/l.
Temperature	-	maximum 90° F or no more than 5° F rise over natural conditions.
Color and Turbidity	-	maximum of fifty (50) Jackson Turbidity Units.
Dissolved Solids	-	1/3 above characteristics of natural conditions.
Taste and Odor	-	none of which will impart taste to fish flesh.
Total Dissolved Gases	-	not to exceed 110 percent of existing atmospheric conditions.

KEY TO TABLE II AND III

SYMBOL	
★	Primary Recreation and Cold Water Fishery
▲	Primary Recreation and Warm Water Fishery
■	Secondary Recreation and Cold Water Fishery
●	Secondary Recreation and Warm Water Fishery
—	Not suitable for recreation and/or fishery
○	No data

SYMBOL	
EPA	U. S. Environmental Protection Agency
WV	West Virginia Department of Natural Resources

TABLE II

New River and Major Tributaries

Stream Water Quality Table

STREAM	DRAINAGE AREA (Sq. Mi)	LENGTH (Miles)	MEETING STANDARDS FOR RECREATIONAL USES				COMMENTS
			Pre-1970	Present	1977	1983	
NEW RIVER							
Gauley Bdge to Hinton	690	62	●	●	▲ *	▲	EPA data
Hinton - Glen Lynn	2489	32.1	●	●	▲ *	▲	EPA-WV data
Glen Lynn to Eggleston	827	26.4	●	●	▲ *	▲	EPA-WV data Intermittent fish kills due to acids, wastes.
Eggleston to Radford	193	23.8	-	-	-	▲ *	EPA data -RARE
Radford to Claytor Dam	366	5.5	-	-	▲ *	▲	EPA data
Claytor Dam to Allisonia	180	21.1	-	-	▲ *	▲	EPA data
Allisonia to Ivanhoe	862	17.0	●	●	▲ *	▲	EPA data
Ivanhoe to Galax	209	18.0	●	●	▲ *	▲	EPA data
Galax to Va-N.C. line	490	30.3	-	-	▲ *	▲	EPA data
TRIBUTARIES							
Piney Creek-mouth to							
M. P. 12.0	82.7	12.0	-	-	▲ *	▲	EPA data
M.P. 12.0 to 33.5	52.2	21.5	▲	▲	▲	▲	EPA data
Indian Creek	190.9	26.6	○	○	▲ *	▲	Cold water stream in headwaters
East River	76.1	21.2	-	-	● *	▲ *	EPA-WV; cold water in headwaters
Wolf Creek	238.6	21.7	●	●	●	●	EPA data; cold water in headwaters
Walker Creek	269.1	70.0	-	●	●	●	EPA data
Little River	349.1	66.9	-	●	●	●	EPA data
Peak Creek	100.0	24.7	-	▲ *	▲	▲	Lower 5 miles does not meet criteria; EPA data

*Estimated

TABLE II (continued)

STREAM	DRAINAGE AREA (Sq. Mi)	LENGTH (Miles)	MEETING STANDARDS FOR RECREATIONAL USES				COMMENTS
			Pre-1970	Present	1977	1983	
Big Reed Island Creek	356.0	35.2	●	●	▲	▲	EPA data
Little Reed Island Cr.	81.4	32.0	○	○	▲*	▲	
Reed Creek	259.0	40.0	-	●	●	●	EPA data
Cripple Creek	166.0	31.0	○	●	▲*	▲	EPA data; cold water in headwaters.
Chestnut Creek	57.3	22.4	-	-	▲*	▲	EPA data
Elk Creek	96.5	16.0	○	●	▲*	▲	EPA data; cold water in headwaters
Little River	139.5	29.4	●	●	▲*	▲	EPA data; cold water in headwaters
POCATALICO RIVER -							
mouth to Rocky Fork	91.0	12.0	▲	▲	▲	▲	EPA data
Rocky Fork to headwaters	268.0	53.8	-	-	-	●*	Brine pollution from oil well ope
COAL RIVER-							
mouth to Ashford	120.0	29.5	●	●	▲*	▲	EPA-WV data
Ashford to Whitesville	168.0	27.5	-	-	▲*	▲	EPA data
Whitesville to headwaters	225.0	39.0	○	○	-	▲*	Intermittent fish kills-mine drai
Marsh Fork	163.0	40.0	○	○	-	▲*	Mine drainage
LITTLE COAL RIVER-							
mouth to Madison	121.0	25.6	-	-	-	●*	EPA data; mine drainage
Pond Fork	140.0	35.5	○	-	-	●*	Intermitten fish kills-mine drai
Spruce Fork	125.0	31.0	○	-	-	●*	Intermittent fish kills-mine dra

TABLE II (Continued)

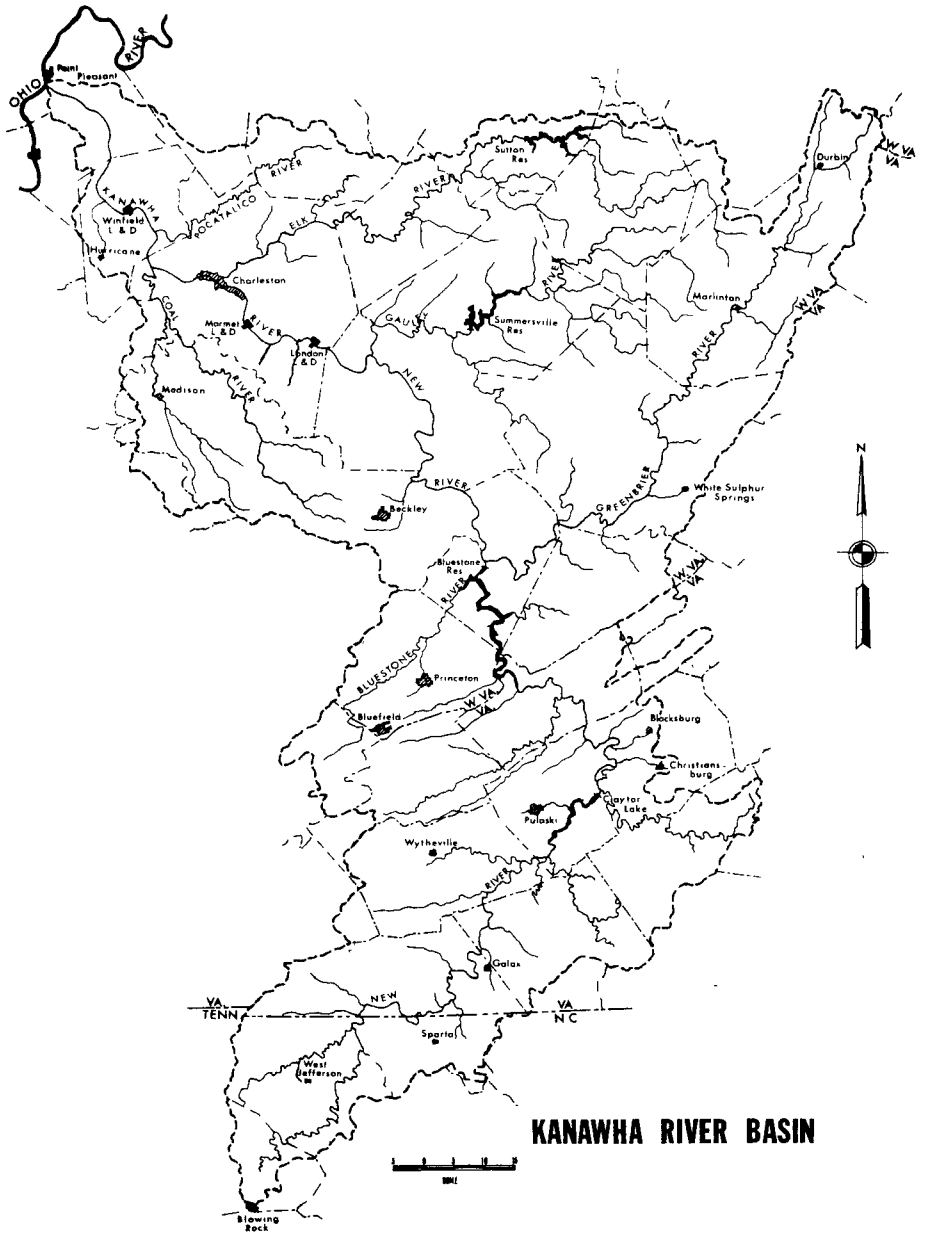
STREAM	DRAINAGE AREA (Sq. Mi)	LENGTH (Miles)	MEETING STANDARDS FOR RECREATIONAL USES				COMMENTS
			Pre-1970	Present	1977	1983	
ELK RIVER -							
mouth to Queen Shoals	387.0	23.4	▲	▲	▲	▲	EPA data
Queen Shoals to Clay	361.0	26.7	▲	▲	▲	▲	EPA-WV data
Clay to Frametown	243.0	28.2	▲	▲	▲	▲	EPA data
Frametown to Sutton	209.0	19.1	▲	▲	▲	▲	EPA data; cold water below Sutton
Sutton to Webster Springs	275.0	22.6	○	▲	▲	▲	
Webster Springs to headwaters	268.0	88.3	○	★*	★	★	
Big Sandy Creek	133.5	17.5	○	○	★*	▲	
Buffalo Creek	114.4	23.4	○	○	-	▲ *	Mine drainage pollution
Birch River	141.6	22.5	▲	▲	▲	▲	EPA data; cold water in headwater
Holly River	148.2	3.5	○	★*	★	★	
GAULEY RIVER -							
mouth to Belva	105.3	6.7	●	●	●	●	EPA data
Belva to Meadow River	147.0	27.4	▲	▲	▲	▲	EPA-WV data
Meadow River to Craigsville	276.0	25.8	-	-	●	●	EPA data
Craigsville to Gauley Camden-on-	292.0	9.6	●	●	●	●	EPA data
Camden-on-Gauley to headwaters	236.0	32.3	○	-	-	■ *	Non-point source sediment problem
Meadow River	364.8	52.5	-	-	-	▲ *	EPA data; mine drainage
Hominy Creek	103.9	22.0	○	○	▲ *	▲	EPA data; mine drainage
Cherry River	164.5	21.9	-	-	▲ *	▲	EPA data; cold water in headwater

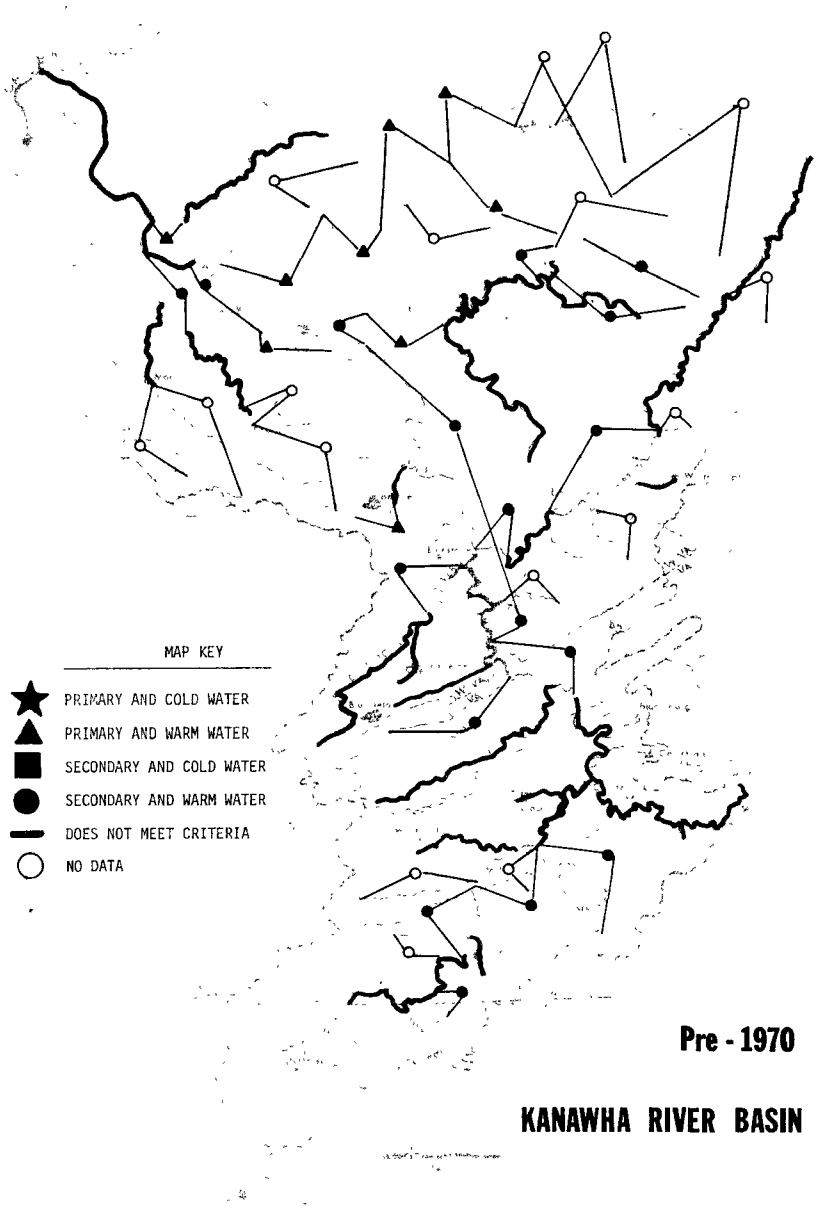
TABLE II (continued)

STREAM	DRAINAGE AREA (Sq. Mi)	LENGTH (Miles)	MEETING STANDARDS FOR RECREATIONAL USES				COMMENTS
			Pre-1970	Present	1977	1983	
Cranberry River	97.4	32.5	●	■	★ *	★	EPA data
Williams River	129.6	31.6	●	■	★ *	★	EPA data
GREENBRIER RIVER -							
mouth to Hillsdale	31.0	5.6	●	●	▲ *	▲	EPA data
Hillsdale to Alderson	268.0	22.8	-	-	▲ *	▲	EPA-WV data
Alderson to Anthony Creek	220.0	29.3	●	●	▲ *	▲	EPA data
Anthony Creek to Duckeye	587.0	45.4	-	-	▲ *	▲	EPA-WV data
Duckeye to Durbin	406.0	47.9	-	-	● *	▲	EPA-WV data; intermittent fish k
Muddy Creek	127.6	20.9	○	○	▲ *	▲	
Second Creek	120.5	23.7	○	○	▲ *	▲	Cold water in headwaters
Howard Creek	91.2	22.7	-	-	▲ *	▲	EPA data; cold water in headwaters
Anthony Creek	148.0	29.0	○	★	★	★	EPA data
Knapp Creek	110.0	24.2	○	★	★	★	EPA data
BLUESTONE RIVER -							
mouth to Camp Creek	185.0	22.8	●	●	▲ *	▲	EPA-WV data
Camp Creek to headwaters	275.7	60.2	-	-	▲ *	▲	EPA-WV data; intermittent fish kills
Brush Creek	73.5	11.0	-	-	▲ *	▲	EPA data

Stream Water Quality Table

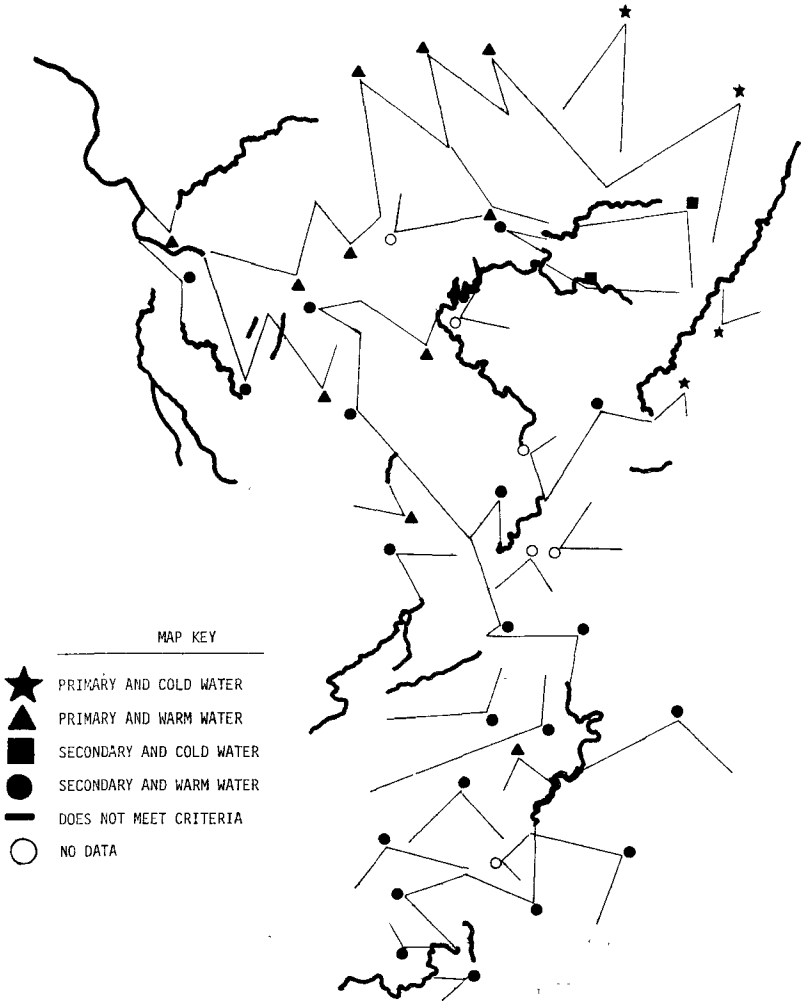
STREAM	DRAINAGE AREA (Sq. Mi)	LENGTH (Miles)	MEETING STANDARDS FOR RECREATIONAL USES				COMMENTS
KANAWHA RIVER			Pre-1970	Present	1977	1983	
MAIN STEM							
Kanawha River @ mouth	M.P.0.6	0.6	-	-	● *	▲ *	EPA-WV Costs, Iron, Dox, Chlorides, Temp.
Kanawha River @ Winfield	M.P.32.1	32.1	-	-	● *	● *	EPA-WV Costs, BOD5, Odor, Toxicity, Lgd. Over.
Kanawha River @ Pt.60 Bridge	M.P.56.4	24.3	-	-	● *	▲ *	EPA-WV Total Coli., Fec. Coli.,
Kanawha River @ Malden	M.P.72.3		●	●	▲ *	▲ *	
Kanawha River @Kanawha Falls	M.P.90.0	16.4	▲	▲	▲ *	▲	
TOTAL		90.0					
TRIBUTARIES							
Davis Creek M.P.53.0	45.5	13.5	-	-	●	●	EPA -- heavy industrial influence
Cabin Creek 74.0	73.1	20.5	-	-	-	-	Fec.Coli; ext. pollution - EPA
Paint Creek 80.3	123.6	30.1	-	-	-	-	Fec.Coli; low, acid mine drainage


OHIO RIVER
Point Pleasant
KANAWHA RIVER
Winfield L&D
Hurricane
COAL RIVER
Charleston
Marmet L&D
London L&D
Madison
VOCATALICO
ELK RIVER
Sutton Res
Durbin
GAULEY RIVER
Summersville Res
Marlinton
NEW RIVER
Beckley
GREENBRIER RIVER
White Sulphur Springs
Bluestone Res
BLUESTONE
Princeton
Bluefield
W. VA.
VA.
Blacksburg
Christiansburg
Claytor Lake
Pulaski
Wytheville
Galax
VA.
TENN.
NEW RIVER
VA.
NC
Sparta
West Jefferson
Blowing Rock
N
KANAWHA RIVER BASIN



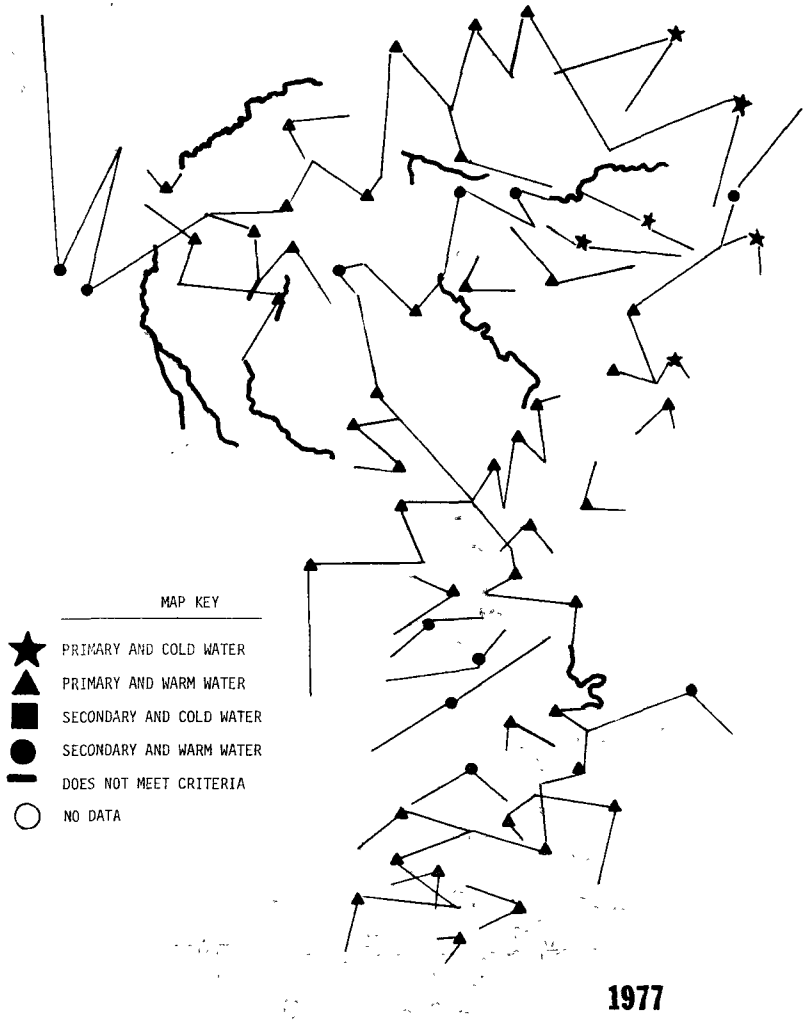
Pre - 1970

KANAWHA RIVER BASIN



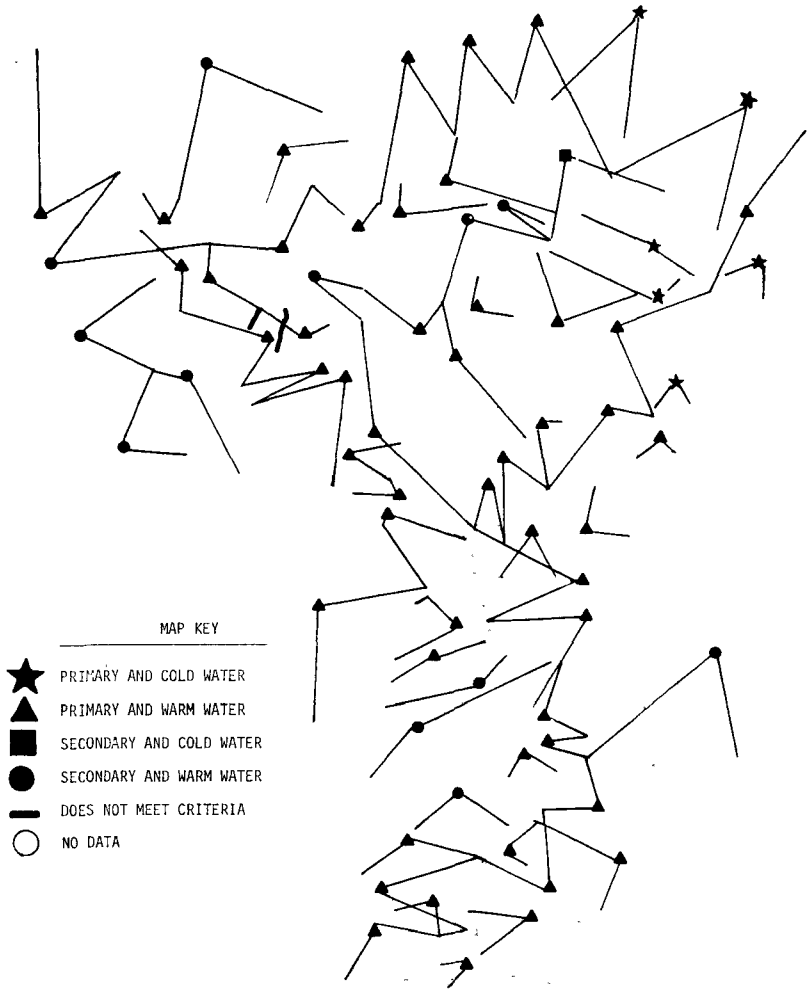
Present

KANAWHA RIVER BASIN



1977

KANAWHA RIVER BASIN



1983

KANAWHA RIVER BASIN

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