EFFECTS OF POLLUTION ON WATER RESOURCE DEVELOPMENT IN THE PASCAGOULA BASIN

by

Gordon E. Stone and John W. Wakefield
Federal Water Pollution Control Administration

INTRODUCTION

The Southeastern Comprehensive Water Pollution Control Project has been making a careful, deliberate study of the Pascagoula River Basin since 1964. The study and its resultant plan for controlling water pollution is only one of eighteen such studies of southeastern river basins in various stages of completion; and the Southeastern Project is only one of twenty similar projects which the Federal Water Pollution Control Administration has or soon will have underway, covering all major river basins of the country.

The projects are created under the Federal Water Pollution Control Act "....in cooperation with other Federal agencies, with State water pollution control agencies and interstate agencies and with the municipalities and industries involved...." to develop comprehensive programs to control water pollution. The initial charge is directed at pollution of interstate waters and their tributaries, but the phrase "and improving the sanitary condition of surface and underground waters" extends the cooperative effort to any waters subject to sanitary degradation.

The Pascagoula River Basin study is being made in cooperation with the Mobile, Alabama office of the U. S. Army Corps of Engineers and numerous other Federal and State agencies under the further authority of a 1961 resolution by the United States Senate Committee on Public Works. This latter authority is for a comprehensive basin study (Type II) of water resource and related land resource needs and development. The Southeastern Project's contribution to this coordinated effort in the Pascagoula Basin is virtually complete, and this paper is based on the findings.

BASIN CHARACTERISTICS

The Pascagoula River Basin comprises most of Southeastern Mississippi and a small part of Southwestern Alabama. The basin is roughly oval in shape with a maximum length of 164 miles and a maximum width of 84 miles, draining an area of 9,700 square miles.

The Pascagoula River is formed by the confluence of the Leaf and Chickasawhay Rivers near Merrill in George County, Mississippi. It flows south 83 miles to the Mississippi Sound. The Leaf River rises near Forest, Mississippi; flows south about 90 miles where it joins the Bowie River at Hattiesburg; and then southeasterly about 71 miles to its junction with the Chickasawhay. The Chickasawhay is formed by the Chunky River and Okatibbee Creek in Clark County, Mississippi, near Meridian, flowing south about 164 miles to its junction with the Leaf.

The third largest tributary of the Pascagoula River is the Escatawpa River, which rises in Washington County, Alabama, flowing south and west about 111 miles to its junction with the Pascagoula River about 7 miles upstream from Mississippi Sound. The lower 15 miles of the Pascagoula River and the lower 10 miles of the Escatawpa River are normally brackish and should be considered tidal estuaries.

Another important tributary from the standpoint of water supply and water pollution control is Tallahala Creek, which rises north of Laurel in Jasper County, Mississippi, and joins the Leaf River about 25 miles below Hattiesburg. These and other important streams of the basin are listed and their physical characteristics summarized in Table I. Their flow characteristics are summarized in Table II.

Table I
DRAINAGE CHARACTERISTICS
MAJOR TRIBUTARIES OF THE PASCAGOULA RIVER

Stream	Drainage Area (sq. mi.)	Length (mi.)	Average Fall (ft./mi.)
PASCAGOULA RIVER			
Escatawpa River	1,060	114	1.75
Red Creek	478	93	3.20
Black Creek	764	122	3.23
Leaf River	3,580	160	2.10
Chickasawhay River	2,970	160	1.20
LEAF RIVER			
Bowie Creek	665	47	4.94
Oakohay Creek	250	57	3.44
Tallahala Creek	649	101	2.28
Bogue Homo Creek	422	63	5.49
Thompson Creek	236	45	6.22
CHICKASAWHAY RIVER			
Chunky River	544	41	4.39
Okatibbee Creek	371	56	3.21
Bucatunna Creek	591	59	2.14

Table II

FLOW CHARACTERISTICS
PASCAGOULA RIVER AND PRINCIPAL TRIBUTARIES

	Expected Annual Low Flow in cfs for 7 Consecutive Days			Extreme Flows in cfs				
Location	Once in 5 yrs	Once in 10 yrs	Once in 20 yrs	Period of Record	Maximum Momentary Flow	Minimum Momentary Flow	Minimum Daily Flow	Average Flow cfs
Pascagoula River at Merrill, Miss.	962	861	774	1930 to 1965	178,000	696	704	9,529 (35 yrs)
Escatawpa River at Harleston, Miss.*	110	88	70	1945 to 1965	52,000	61	63	979** (20 yrs)
Chickasawhay River at Enterprise, Miss.	28	23	19	1938 to 1965	61,700	18	18	3,691*** (27 yrs)
Leaf River at Hattiesburg, Miss.	372	340	314	1938 to 1965	72,000	318	322	5,319**** (26 yrs)

* Expected maximum and minimum flows have been interpolated from records for Wilmer, Ala., and Hurley, Miss.

** At Wilmer, Alabama.

*** At Leakesville, Miss., in lower reach.

**** At McLain, Miss., in lower reach.

DEMOGRAPHY AND ECONOMICS

The cities of Hattiesburg and Laurel in the Leaf River sub-basin, Meridian in the Chickasawhay River sub-basin, and Pascagoula on the coast, with their environs, are the population and industrial centers of the basin. These are also the centers expected to show the greatest growth.

The basin has an estimated (1965) population of 397,900 of which 46,900 is rural farm. By 1980, this population is projected to grow to 478,600 of which 29,800 will be rural farm.

Table III
PROJECTED POPULATION
Pascagoula River Basin

Area	1965 (thousands)	1980 (thousands)	Percent of Increase
Basin	397.9	478.6	20.3
Leaf River Sub-Area	181.3	203.4	12.2
Chickasawhay River Sub-Area	128.8	138.5	7.5
Coastal Sub-Area*	87.8	136.7	56.8
Pascagoula Complex	56.1	91.0	62.2

*Pascagoula, Moss Point, Kreole, Escatawpa, Eastside, Gautier, Ocean Springs, D'Iberville, and other related communities.

The basin's principal industries are wood products manufacture, crude oil mining, oil refining, poultry and meat processing, synthetic rubber manufacture, fish (menhaden) reduction, and fertilizer manufacturing. The wood products industry includes the manufacture of pulp and paper, plywood, particle board, fiber board and lumber.

The present and projected employment in industries which are dischargers of waste water in the several centers of industrial activity are given in Table IV.

Table IV
PROJECTED EMPLOYMENT
IN WASTE-DISCHARGING INDUSTRIES
Pascagoula Basin

Area	1965	1980	Percent of Increase
Hattiesburg	1,320	1,630	23.5
Laurel	3,990	5,140	28.9
Meridian	950	1,260	32.7
Pascagoula Complex	3,580	6,010	68.0

WATER USES AND USAGE

Surface waters in this basin are used for municipal and industrial supplies, stock watering, fish and game propagation, a small freshwater commercial fishery, sports fishing, other recreation, disposal of municipal and industrial wastes, and some navigation on the lower Pascagoula and Escatawpa Rivers.

The present use of fresh water in the basin totals 126 mgd, not considering the large-scale use for cooling water. Of this, 66 mgd is from surface sources and 60 mgd from ground water. The greatest number of single supplies is from ground-water sources. The average daily use for municipal water supplies in 1965 was 28.8 mgd, with a per capita use of 130 gallons per day. Industry uses 86.2 mgd, not including large-scale use for cooling by one power plant.

Economic projections indicate that the four major water-using areas will have requirements as shown in Table V.

Table V
PRESENT AND PROJECTED WATER USE
Pascagoula River Basin
(mgd)

Area	1965		Projected for 1980	
	Municipal	Industrial	Municipal	Industrial
Pascagoula	4.58	59	13.5	109
Meridian	6.08	2	7.1	7.92
Laurel	5.5	9.6	8.5	15
Hattiesburg	6.5	14.1*	7.1	91**

* An additional 75 mgd is used for cooling by a power generating plant.
** Includes 72 mgd for a proposed pulp and paper mill. The use of 75 mgd for cooling mentioned in note above will be continued.

LONG-RANGE PROJECTIONS

Both the Comprehensive Water Pollution Control Project and the Comprehensive Water Resources Study are required to plan for as much as 50 years in the future. Obviously, with a dynamic economy as outlined here, sub-basin areas can vary widely from historic projections in even a few years and projections for as much as 50 years become largely speculation. On the other hand, structures such as dams and reservoirs may easily last far beyond 50 years; and the quantities of water available 50 years from now for water supplies and water quality control may well depend on the margin of safety provided in structures to be planned in 1967. The following projections of domestic and industrial water supply needs by 2015 are subject to the inherent errors of all long-range projections for small areas but are cushioned by a fairly large factor of safety. For example, the domestic requirements are based on projections of whole-county urban and rural non-farm population, assuming that rural non-farm areas will be the populated suburbs of tomorrow.

WATER QUALITY AND THE ECONOMY

The projections described were based on historical growth in local areas coupled with production factors derived from regional and national economic projections. It was assumed that ample supplies of water of suitable quality would be available when needed. The water supply requirements listed in Table VI are the quantity expected to be withdrawn from surface and underground supplies to meet these needs. If waters of suitable quality are not available in the quantities needed, water-sensitive industries will seek other locations. A sizable part of the economic growth projected for this basin is based on a proportionate growth of water-sensitive industry. While segments of industry having no requirement for high quality water supplies may substitute to support an equal economic growth, this would not be anticipated in the projections herein. Additionally, and of equal importance, most of the water-sensitive industries generate liquid wastes which eventually return to the surface waters. In almost every instance residual polluting materials remain in such wastes and require dilution by relatively clean water to produce a mixture capable of being assimilated by the stream without interfering with downstream water uses. Again, if upstream water quality and quantity are not satisfactory at a given site, water-sensitive industry will go elsewhere.

PLANNING GOALS

The Congressional mandate to the Secretary of the Interior and, through him, to the FWPCA comprehensive projects is to "eliminate or reduce pollution of interstate waters and improve the sanitary condition of surface and underground waters". Certainly this requires action now where pollution exists; but obviously today's actions must be coupled with concurrent planning for the future if the sanitary conditions of our waters are to remain in their improved status. Therefore, with the cooperation and participation of Federal and State agencies (both the State Board of Health and the State Game and Fish Commission have been participants, Mississippi State University has economic studies underway, and the State Air and Water Pollution Control Commission is now participating.), the Comprehensive Project has undertaken to project not only the municipal and industrial water supply requirements but also minimum streamflow requirements to assimilate adequately treated wastes in the year 2015.

If we assume that municipal waste characteristics in the year 2015 will be similar, albeit more voluminous, to those of 1967, and that waste treatment will be at least as effective as today's good secondary treatment (85 to 90 percent stabilization of organic wastes and 90 to 95 percent removal of harmful bacteria), our problem can be defined. It is not too difficult to determine the minimum flow requirements to assimilate the residual polluting materials without degrading the water

Table VI
PROJECTED MUNICIPAL AND INDUSTRIAL WATER SUPPLY
REQUIREMENTS FOR SELECTED LOCATIONS
Pascagoula River Basin

Area	Projected 2015 Population	Projected 2015 Requirements Municipal (mgd)	Industrial (mgd)	Expected Source	Quantity of Available Ground Water (mgd)	Future Surface Supply Requirement (mgd)
Pascagoula Complex 1/	258,000	----	5	Ground	20 2/	None
	---	39	300	Surface	--	339
Meridian	104,900	15.7	9.2	Surface	--	Reservoir under construction
Laurel 3/	108,000	16.0	29.0	Surface	--	Reservoir Proposed
Hattiesburg 4/	76,800	11.5	12.5	Ground	50	None
	---	----	88	Surface	--	88

1/ Includes Pascagoula, Escatawpa, Moss Point, Kreole and Bayou Casotte.

2/ Future use of ground water may be affected by saltwater intrusion.

3/ Includes Laurel, Ellisville, Sandersville and other concentrations of population in vicinity.

4/ Includes Petal and other adjacent concentrations of population.

quality to the point of interfering with uses downstream. The matter of industrial wastes, however, is not so simple. The planner not only must estimate the characteristics and quantities of treated wastes that a constantly changing technology may produce in the future, but he is also confronted with the probability of new products and new processes yet unknown. The saving element is the automatic adjustment previously mentioned--that new industry will go where water of adequate quantity and quality is available.

We are, therefore, developing a plan for water pollution control that will allow continuation of reasonable uses of the water while the economy develops at least as fast as it has in the past and with built-in escalator provisions in case more water should be needed than we anticipate. Our plan includes alternatives by which these goals can be accomplished together with factors, such as costs and benefits, which must be considered in making a wise choice.

PRESENT WATER QUALITY

The waters of the Pascagoula River Basin, with some notable exceptions which will be discussed, have been found to be of suitable quality for most present or anticipated uses. A notable exception is that most of the waters, even in isolated localities, have a high concentration of coliform organisms. These indicator organisms are always found in untreated sewage and also in the feces of all warm-blooded animals. Their presence should be considered a danger signal where the waters are used for water contact sports or where shellfish which may be consumed raw are harvested. The significance of these bacteria is being intensively studied by numerous groups and more definitive relationships between the members of bacteria and the uses of the waters should be forthcoming. Meantime, the known sources of sewage pollution upstream of recreational areas, water supplies, and shellfish growing areas should be disinfected by chlorination, subjected to long storage periods, or both.

The specific areas of the Pascagoula River Basin where organic pollution is severe correspond with the growth areas previously discussed. People, production and pollution are still the order of the day, as in the past. The most intensely polluted water of the basin is the reach of Tallahala Creek below Laurel to its junction with the Leaf River. This results from discharges from one very large industrial installation and a number of relatively small cities and industries. At the present time, this 50-mile reach of stream is frequently polluted to the extent that the oxygen content is below the minimum considered necessary for fish and fish food and the bacterial content is extremely high.

Although no definite plans for waste treatment and pollution abatement have been made public, it is known that studies are underway for the treatment of industrial wastes, and treatment measures have already been initiated for municipal wastes. A special report on Tallahala Creek has been prepared by the Federal and State agencies cooperating in the Comprehensive Water Resources Study of the basin, and the Federal Water Pollution Control Administration was able to recommend water storage in a proposed upstream reservoir both for water supply and for regulating streamflow for water quality control.

The second area of very severe pollution lies in the estuaries of the Escatawpa River and the Pascagoula River. The Escatawpa's upstream portions, in both Alabama and Mississippi, are virtually undefiled. The stream's one small sewered community in Alabama is in the process of constructing treatment facilities. Man has, however, changed the flow regimen by diverting some 78 million gallons per day for municipal and industrial water supplies. Of this diversion, 45 mgd is returned as waste water at downstream points and 33 mgd is diverted to an adjacent basin. Since dry weather flow in the Escatawpa would normally be critically short, this diversion aggravates the pollution problems of the downstream estuary.

The severely polluted tidal estuaries of the Escatawpa and the Pascagoula receive both municipal and industrial wastes. The organic load discharged to the Escatawpa River varies from a population equivalent (estimated at 0.18 to 0.2 pounds of 5-day BOD per person per day) of 448,400 in the winter months to 623,400 during the spring and summer when fish processing plants are in operation. The Pascagoula Estuary receives the Escatawpa discharge plus additional municipal and industrial wastes with an organic equivalent of more than 5,000 persons.

These estuaries are natural nurseries for many saltwater fish species. Marine biologists have estimated that one-fourth of the $8.0 million annual commercial fish catch in Mississippi Sound is nurtured in the relatively clean portion of the Pascagoula Estuary. The grossly polluted areas would, if productive, increase the nurturing area by about one-fourth. Thus, it appears that income from commercial fish production has been reduced some $500,000 a year. The coliform bacteria content of the heavily polluted area is extremely high, averaging from over one million per 100 ml in the Escatawpa Estuary to a few thousand at the mouth of the Pascagoula Estuary. Here the heavily laden river water is discharged into Mississippi Sound immediately adjacent to some potentially productive oyster-growing areas which have been closed for years.

An analysis of the data collected during rather brief field studies and, in addition, a much larger volume of data contributed by one of the major industries in the area revealed that waste treatment alone would not be sufficient to restore the estuaries sufficiently to nurture fish and fish food. Under minimum flow conditions such as might occur for a 7-day period once in ten years, even 95 percent removal of organic pollutants would be insufficient to assure as much as 4.0 ppm dissolved oxygen during the warmest summer months. Therefore, augmented dry-weather flow is indicated. This was made known to the Mobile office of the U. S. Army Corps of Engineers; and after much study, it was found that a multi-purpose reservoir can be justified in the upper Escatawpa River Basin, designed to provide dry-weather flow regulation as well as water supply storage and other benefits. With the assured flow after regulation and a high, but attainable, degree of municipal and industrial wastes treatment, the Escatawpa Estuary can be restored to the minimum condition required for the fish and fish food, recreation, and navigation. (It is reported that steel-hulled ships suffer considerable corrosion damage attributable to existing pollution.)

The high degree of treatment called for in this plan for the Escatawpa Estuary will require each of the industries and municipalities discharging to the Escatawpa or the Pascagoula Estuaries to provide the equivalent of high grade secondary treatment. It has been roughly estimated that for each installation to provide its own treatment works may cost as much as six to eight million dollars. It is believed, however, that a combined treatment works, possibly of the long detention, aerated lagoon type, could be provided at considerable saving in both construction and operating costs and subject to a substantial grant from the Federal Water Pollution Control Administration under the terms of P. L. 660. Additionally, the storage of all wastes, including effluent from all sewage treatment works, for a period of 8 to 10 days, followed by post-chlorination will very substantially reduce the number of coliform bacteria presently being discharged into the rivers and should go far toward restoring the oyster-producing areas of Mississippi Sound to good sanitary condition.

It should be noted that the maximum reservoir storage that the Corps of Engineers could reasonably assure for streamflow control will provide sufficient water only for existing waste sources after rather complete stabilization of organic matter. Further expansion of industrial production tributary to the Escatawpa or the Pascagoula Estuaries will require even higher degrees of treatment of all wastes if the benefits of a clean stream are to be continued. This would be expensive but not impossible at this time, and the state of knowledge of methods for organic stabilization should be considerably improved in years to come by research already underway. This outlook and the availability of alternative plant sites tributary to immediately adjacent waters allow the proposed planning to proceed in the face of anticipated growth with some assurance for the future.

The Meridian area and the upper tributaries of the Chickasawhay River had been studied prior to the creation of the Southeastern Comprehensive Project. Although Meridian had provided secondary treatment for municipal wastes, it had been found that present and anticipated waste loads, after reasonable treatment, would require more water than the low flow of the streams could be expected to produce. Accordingly, the Corps of Engineers included substantial storage for low flow augmentation in a multi-purpose reservoir on Okatibbee Creek upstream from Meridian.

Construction on that reservoir is now well along; and with reasonably complete treatment of existing and future industrial and municipal wastes, the Meridian area should be able to grow at a moderate rate without interference with desired water uses. Here again, however, the economy of the region is dependent on the prosperity of a group of industries. It may be well to consider the possibility for a public facility to serve the several industries and to provide for future municipal growth rather than for each to go its own way. The conversion from capital outlay for treatment works to an annual fee to amortize and operate the publicly-owned works should be attractive to industry, and the Federal grant program available for public works may make this approach less expensive for all concerned without loss of effectiveness.

The Hattiesburg area is in a somewhat more advantageous position than the other three growth areas. The city has provided municipal waste treatment, and the stream has sufficient dry-weather flow to receive present and anticipated waste loads after reasonable treatment. A substantial portion of the present load is from a single large industry for which waste treatment is being planned. Another large industry is reported to be locating some distance downstream from the city. As previously stated, these and other industrial establishments, existing or anticipated within 50 years, representing a projected growth of employment in water-sensitive industries of 200 percent by 2015, will be expected to provide the equivalent of secondary treatment for organic wastes. With such treatment, the Leaf River, without controlled flow, should have sufficient water to assimilate the residual wastes without difficulty. Water is to be stored, however, in the proposed Bowie Creek multi-purpose reservoir to provide a source of industrial water supply, leaving the already developed ground-water supply for municipal use.

Here again, a large, combined waste treatment facility in public ownership may have advantages; this is questionable, however, due to the size of the industries involved and their dispersion in the Leaf River Basin.

FEASIBILITY OF DEVELOPMENTS

Throughout this paper, we have referred to "reasonable treatment of industrial and municipal wastes". What this term implies is treatment that is technically and economically feasible. Engineering know-how is available to treat almost any non-toxic, organic waste to whatever degree of stability is desired. Economic feasibility, however, is not so simple. The cost of treating most organic wastes increases quite sharply if a degree of treatment in excess of 90 percent is desired. For an added 5 percent over 80 percent removal for a 50 mgd plant, the added annual cost is about $75,000. To obtain another 5 percent removal, the added annual cost is $150,000; and for the 5 percent above 90 percent removal, the increment is $200,000. For the next $200,000 expended per year, only 3 percent added removal can be expected.

The economic worth of clean water is not readily evaluated. No one has yet put a dollar value on a satisfactory day of fishing or an esthetically pleasing stream. But the public has amply demonstrated its interest in clean waters and its willingness to pay its share of the cost. One can only state that clean water is worth the least cost of achieving it, and it is on this basis that these proposals are made.

Having reconciled engineering and economic feasibility, one more hurdle remains before we can launch a project. Political feasibility is probably the most important determination of all. By political feasibility we do not mean--do the ward heelers want the project? Rather, we mean--is there a governmental unit with the desire and the authority to undertake the project and can it be adequately financed?

What is suggested here is a water management body with legislative authority and the financial capability to construct and/or operate water and waste treatment and control devices as required to fit the particular situation. If only a single city is involved, there is no need to change the existing pattern; if several cities are involved, if cities are involved with industries outside the city limits, or if water quantity as well as water quality is to be controlled, then the agency should have jurisdiction to cross city, county, or state lines as required. The important feature is that the political body be capable of coping with the problems involved for the benefit of all the people of the region.

Where several cities, or industries located beyond the limits of cities, are involved, the management agency should be able to finance, construct, and operate central treatment works. The cities and industries would individually provide such pre-treatment as desired or required and would transport their wastes to the central facility. The State pollution control commission, through its establishment and enforcement of stream standards, would set the goals to be achieved and provide the muscles to set the process in motion. The Federal government, through the Federal Water Pollution Control Administration and the Corps of Engineers, would furnish support in the forms of grants, water quality data, technical assistance, research, and construction of water control works to aid the State, the water management agency, the municipalities, and the industries involved in getting the job done.

We must break the pattern of people, production, and pollution; or we, like microbes, may grow ourselves to death. Surely, the technical know-how that can put a man in space can devise systems for people to live together on earth without fouling our own or our neighbor's nest. The will to achieve is the major need. Let us all learn to sojourn together.