APPENDIX T

Use Attainability Analysis Case Studies

APPENDIX T

WATER QUALITY STANDARDS HANDBOOK

SECOND EDITION

CASE STUDIES

Introduction

The Water Body Survey and Assessment Guidance for Conducting Use Attainability Analyses provides guidance on the factors that may be examined to determine if an aquatic life protection use is attainable in a given stream or river system. The guidance proposed that States perform physical, chemical and biological evaluations in order to determine the existing and potential uses of a water body. The analyses suggested within this guidance represent the type of analyses EPA believes are sufficient for States to justify changes in uses designated in a water quality standard and to show in Advanced Treatment Project Justifications that the uses are attainable. States are also encouraged to use alternative analyses as long as they are scientifically and technically supportable. Furthermore, the guidance also encourages the use of existing data to perform the physical, chemical and biological evaluations and whenever possible States should consider grouping water bodies having similar physical and chemical characteristics to treat several water bodies or segments as a single unit.

Using the framework provided by this guidance, studies were conducted to (1) test the applicability of the guidance, (2) familiarize State and Regional personnel with the procedures and (3) identify situations where additional guidance is needed. The results of these case studies, which are summarized in this Handbook, pointed out the following:

(1) The Water Body Surveys and Assessment guidance can be applied and provides a good framework for conducting use attainability analyses;
(2) The guidance provides sufficient flexibility to the States in conducting such analyses; and,
(3) The case studies show that EPA and States can cooperatively agree to the data and analyses needed to evaluate the existing and potential uses.

Upon completion of the case studies, several States requested that EPA provide additional technical guidance on the techniques mentioned in the guidance document. In order to fulfill these requests, EPA has developed a technical support manual on conducting attainability analyses and is continuing research to develop new cost effective tools for conducting such analyses. EPA is striving to develop a partnership with States to improve the scientific and technical bases of the water quality standards decision-making process and will continue to provide technical assistance.

The summaries of the case studies provided in this Handbook illustrate the different methods States used in determining the existing and potential uses. As can be seen, the specific analyses used were dictated by (1) the characteristics of the site, (2) the

States capabilities and technical expertise using certain methods and (3) the availability of data. EPA is providing these summaries to show how use attainability analyses can be conducted. States will find these case studies informative on the technical aspects of use attainability analyses and will provide them with alternate views on how such analyses may be conducted.

WATER BODY SURVEY AND ASSESSMENT
Assabet River, Massachusetts

I. INTRODUCTION

A. Site Description

The drainage basin of the Assabet River comprises 175 square miles located in twenty towns in East-Central Massachusetts. The Assabet River begins as the outflow from a small wildlife preservation impoundment in the Town of Westborough and flows northeast through the urban centers of Northborough, Hudson, Maynard and Concord to its confluence with the Sudbury River, forming the Concord River. Between these urbanized centers, the river is bordered by stretches of rural and undeveloped land. Similarly, the vast majority of the drainage basin is characterized by rural development. Figure 1 presents a schematic diagram of the drainage basin.

The Assabet River provides the opportunity to study a repeating sequence of water quality degradation and recovery. One industrial and six domestic wastewater treatment plants (WWTP) discharge their effluents into this 31-mile long river. All of the treatment plants presently provide secondary or advanced secondary treatment, although many of them are not performing to their design specifications. Most of the treatment plants are scheduled to be upgraded in the near future.

Interspersed among the WWTP discharges are six low dams, all but one of which were built at least a half century ago. All are "run-of-the-river" structures varying in height from three to eleven feet. The last dam built on the river was a flood control structure completed in 1980.

The headwaters of the Assabet River are formed by the discharge from a wildlife preservation impoundment, and are relatively "clean" except for low dissolved oxygen (DO) and high biochemical oxygen demand (BOD) during winter and summer. Water is discharged from the preserve through the foot of the dam that forms the impoundment, and therefore, tends to be low in DO. DO and BOD problems in the impoundment are attributed to winter ice cover and peak algal growth in summer. After the discharge of effluents from the Westborough and Shrewsbury municipal wastewater treatment plants, the river enters its first degradation/recovery cycle. The cycle is repeated as the river receives effluent from the four remaining domestic treatment plants. Water quality problems in the river are magnified when the effluents are discharged into the head of an impoundment. However, the flow of water over the dams also serves as a primary means of reaeration in the river, and thus, the dams also become a major factor in the recovery segment of the cycle. Water quality surveys performed in 1979 showed violations of the fecal coliform, phosphorus, and dissolved oxygen criteria throughout the river.

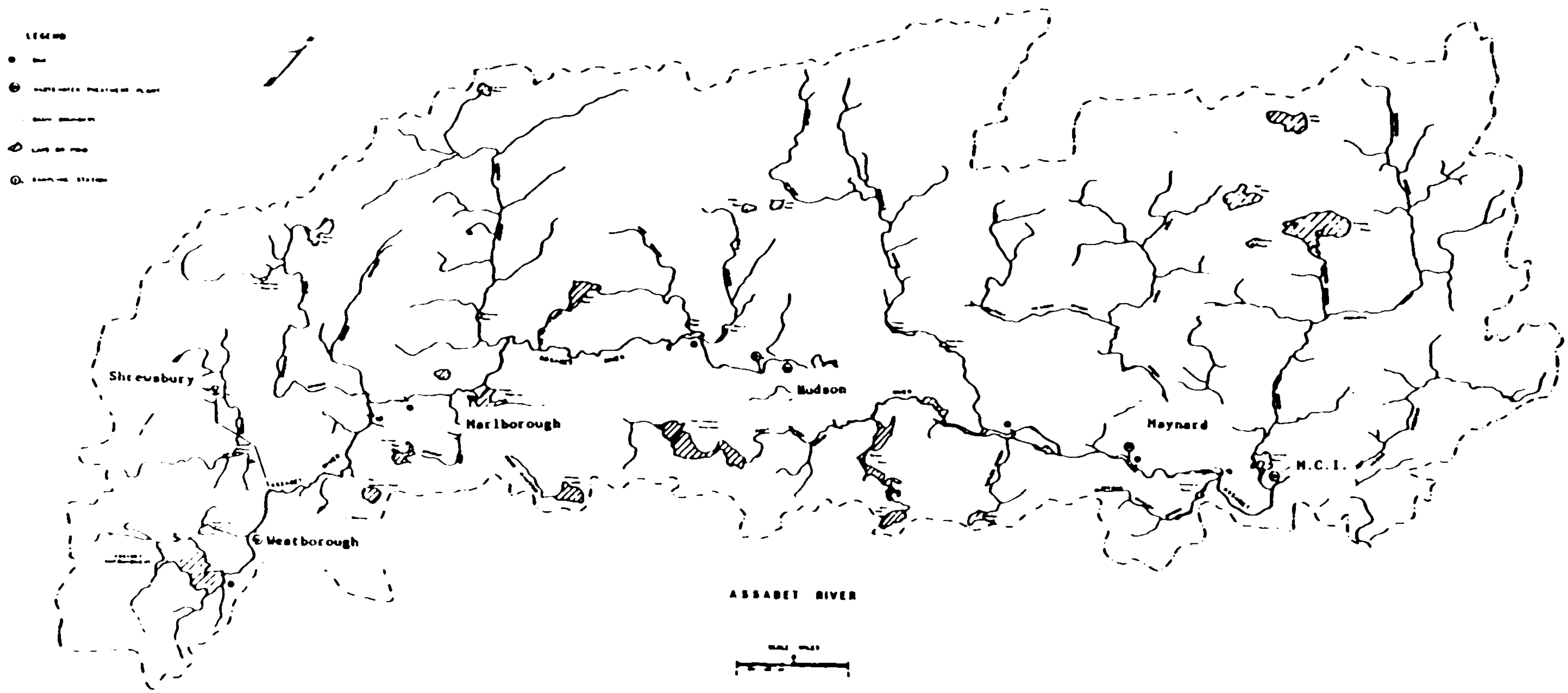

Figure 1 ASSABET RIVER DRAINAGE SYSTEM

At present, the entire length of the Assabet River is classified B, which is designated for the protection and propagation of fish, other aquatic life and wildlife, and for primary and secondary recreation. Two different uses have been designated for the Assabet River--from river mile 31.8 to 12.4 the designated use is "aquatic life" and from river mile 12.4 to the confluence with the Sudbury River the designated use is a "warm water fishery". The difference in these designated uses is that maintenance of a warm water fishery has a maximum temperature criterion of 83 degrees F, and a minimum DO of 5 mg/l. There are no temperature or DO criteria associated with the aquatic life use. These designations seem contrary to the existing data, which document violations of both criteria in the lower reaches of the river where warm water fishery is the designated use.

B. Problem Definition

The Assabet River was managed as a put and take trout fishery prior to the early 1970s when the practice was stopped on advisement of the MDWPC because of poor water quality conditions in the river. While the majority of the water quality problems are attributable to the wastewater treatment plant discharges, the naturally low velocities in the river, compounded by its impoundment in several places, led to the examination of both factors as contributors to the impairment of aquatic life uses. This combination of irreversible physical factors and wastewater treatment plant-induced water quality problems led to the selection of the Assabet River for this water body survey.

C. Approach to Use Attainability Analysis

Assessment of the Assabet River is based on the previously mentioned site visits and discussions among representatives of the Massachusetts Division of Water Pollution Control (MDWPC); the U.S. Environmental Protection Agency (EPA); and the Massachusetts Fish and Wildlife Division. This assessment is also based in part upon findings reported in the field and laboratory analyses on the Assabet River in early June, 1979, and again in early August, 1979. These surveys are part of the on-going MDWPC monitoring program, which included similar water quality assessments of the Assabet in 1969 and 1974. The water quality monitoring includes extensive information on the chemical characteristics of the Assabet River.

Analyses Conducted

A review of physical, chemical and biological information was conducted to determine which aquatic life use designations would be appropriate.

A. Physical Factors

The low flow condition of the river during the summer months may have an impact on the ability of certain fish species to survive. Various percentages of average annual flow (AAF) have been used to describe stream regimens for critical fisheries flow. As reported in

Cortell (1977), studies conducted by Tennant indicate that 10%, 30%, and 60% of AAF describe the range of fisheries flows from absolute minimum (10% AAF) to optimum (60% of AAF). The average annual flow of the Assabet River, as calculated from 39 years of record at the USGS gauge at river mile 7.7, is 183 cfs. Flow measurements taken at the USGS gauge on four consecutive days in early August, 1979, were 43, 34, 27, and 33 cfs. These flows average about 19 percent of the AAF indicating that some impairment of the protection of fish species may occur due to low flow in the river. The 7-day 10-year low flow for this reach of the river is approximately 18 to 20 cfs.

The outstanding physical features of the Assabet River are the dams, which have a significant influence on the aquatic life of the river. Most fish are incapable of migrating upstream of the dams, thus limiting their ability to find suitable (sufficient) habitats when critical water quality conditions occur. The low flow conditions downstream of the dams during dry periods also result in high water temperatures, further limiting fish survival in the river.

B. Biological Factors

As with data on the physical parameters for the Assabet River, biological data are sparse. The last fish survey of the Assabet River was conducted by the Massachusetts Fish and Wildlife Division in 1952. Yellow perch, bluegills, pickerel, sunfish, and bass were all observed. The Assabet River was sampled by the MDWPC for macroinvertebrates at five locations in June, 1979, as part of an intensive water quality survey.

The data were reviewed and analyses performed to determine whether conditions preclude macroinvertebrate habitats. The results were inconclusive.

C. Chemical Factors

Of all the chemical constituents measured in the June and August, 1979, water quality surveys, dissolved oxygen, ammonia nitrogen, and temperature have the greatest potential to limit the survival of aquatic life. Ammonia toxicity was investigated using the criteria outlined in Water Quality Criteria 1972. The results of this analysis indicate that the concentration of un-ionized ammonia would need to be increased approximately three times before acute mortality in the species of fish listed would occur. Therefore, ammonia is not a problem.

Temperatures in the lower reaches of the Assabet frequently exceed the maximum temperature criteria (83 degrees F) for maintenance of a warm water fishery. However, temperature readings were taken in early and late afternoon and are believed to be surface water measurements. They are short-term localized observations and should not preclude the maintenance of a warm water fishery in those reaches. Dissolved oxygen concentrations above Maynard are unsuitable for supporting cold or warm water fisheries, but are sufficient to support a fishery below this point.

The impoundments may exhibit water quality problems in the form of high surface temperatures and low bottom DO. Surface temperatures have been found to be similar to those in the remainder of the river. The only depth sample was at 13 feet in the wildlife impoundment, where the temperature was 63 degrees F, while 83 degrees F at the surface. While such bottom temperatures are likely to be sufficient to support a cold water fishery, it is likely that the DO at the bottom of the impoundments will be near zero due to benthic demands and lack of surface aeration, which would preclude the survival of any fish.

Findings

The data, observations, and analyses as presented herein lead to the conclusion that there are four possible uses for the Assabet: aquatic life, warm water fishery, cold water fishery, and seasonal cold water fishery. The seasonal fishery would be managed by stocking the river during the spring.

These uses were analyzed under three water quality conditions: existing, existing without the wastewater discharges, and inclusion of the wastewater effluent discharges with treatment at the levels stipulated in the 1981 Suasco Basin Water Quality Management Plan. The no discharge condition is included as a baseline that represents the quality under "natural" conditions.

A. Existing Uses

A limited number of warm water fish species predominate in the Assabet River under existing conditions. The species should not be different from those observed during the 1952 survey. The combination of numerous low-level dams and wastewater treatment plants with low flow conditions in the summer results in dissolved oxygen concentrations and temperatures which place severe stress on the metabolism of the fish.

The observed temperatures are most conducive to support the growth of coarse fish, including pike, perch, walleye, smallmouth and largemouth bass, sauger, bluegill and crappie.

The minimum observed DO concentrations are unacceptable for the protection of any fish. Water Quality Criteria establishes the values 6.8, 5.6, and 4.2 mg/l of DO for high, moderate, and low levels of protection of fish for rivers with the temperature characteristics of the Assabet. The Draft National Criteria for Dissolved Oxygen in Freshwater establishes criteria as 3.0 mg/l for survival, 4.0 mg/l for moderate production impairment, 5.0 mg/l for slight impairment, and 6.0 for no production impairment. The upper reaches will not even support a warm water fishery at the survival level, except in the uppermost reach. On the other hand, the lower reaches can support a warm water fishery under existing conditions.

B. Potential Uses

The potential aquatic life uses of the Assabet River would be restricted by temperature and low flow, and by physical barriers that would exist even if water quality (measured in terms of DO and bacteria) is significantly improved. Despite an overall improvement in treated effluent quality, the river would be suitable for aquatic life, as it is currently, and would continue to be too warm to support a cold water fishery in the summertime. The possibility of maintaining the cold water species in tributaries during the summer was investigated, but there are no data on which to draw conclusions. Water quality observations in the only tributary indicate temperatures similar to those in the mainstem. Therefore, the maintenance of a cold water fishery in the Assabet is considered unfeasible.

The attainable uses in the river without discharges or at planned levels of treatment are warm water fishery and seasonal cold water fishery. These uses are both attainable throughout the basin, but may be impaired in Reach 1, as the water naturally entering Reach 1 from the wildlife preservation impoundment is low in DO. The seasonal cold water fishery is attainable because the discharge limits are established to maintain a DO of 5 mg/l under 7Q10 conditions. If the DO is 5 mg/l under summer low flow conditions, it will certainly be 6 mg/l or greater during the colder, higher flow spring stocking period, and a seasonal cold water fishery would be attainable.

According to the Fish and Wildlife Division, the impoundments of the Assabet River have the potential to be a valuable warm water fishery. The reaches of the river that have a non-vegetated gravel bottom also have a high potential to support a significant fishery because these habitats allow the benthic invertebrates that comprise the food supply for the fish to flourish. It was further suggested that if the dissolved oxygen concentration could be maintained above 5 mg/l, the river could again be stocked as a put and take trout fishery in the spring.

Summary and Conclusions

The low flow conditions of the Assabet River have been exacerbated by the low dams which span its course. In the summer months, the flow in the river is slowed as the river passes through its impoundments and flow below the dams is often reduced to a relative trickle. When flow is reduced, temperatures in the shallow river (easily walkable in many places) can exceed the maximum temperature criterion for protection and propagation of a warm water fishery. Additionally, the dams limit the mobility of fish. At present, most of the river reaches also undergo extensive degradation due to the discharge of wastewater treatment plant effluent which is manifest in low dissolved oxygen concentrations. All of these factors impair the aquatic life potential of the Assabet River.

Three use levels corresponding with three alternative actions related to the wastewater discharges are possible in the Assabet. The no action alternative would result in very low dissolved oxygen concentrations in many reaches which are appropriate only for the use designation of aquatic life and warm water fishery. In this scenario, fish would only survive in the lowest river reaches, and aquatic life would be limited to sludge worms and similar invertebrates in the upper reaches. The remaining two alternatives are related to upgrading treatment plants in the basin. If the discharges are improved sufficiently to raise the instream DO to 5 mg/l throughout, as stipulated in the 1981 Water Quality Management Plan, it will be suitable as a warm water or seasonal cold water fishery. Should the discharge be elimInted altogether, the same uses would be attainable.

The treatment plant discharges inhibit the protection and propagation of aquatic life. Most of the treatment plants are scheduled to be upgraded in the near future, which would relieve the existing dissolved oxygen problems. Even if the river is returned to relatively pristine conditions, the type of fish that would be able to propagate there would not change, due to the existing physical conditions. However, the extent of their distribution, their abundance, and the health of the biota would be likely to increase.

The present use designations of the Assabet River are sufficient to characterize the aquatic life use it is capable of supporting, while physical barriers prevent the year-round attainment of a "higher" aquatic life use. The potential aquatic life uses could include extension of the warm water and seasonal cold water fishery classifications to the entire length of the river, should the planned improvements to the wastewater treatment plants be implemented.

WATER BODY SURVEY AND ASSESSMENT
Blackwater River
Franklin, Virginia

I. INTRODUCTION

A. Site Description

The area of the Blackwater River which was chosen for this study extends from Joyner's Bridge (Southampton County, Route 611) to Cobb's Wharf near its confluence with the Nottoway River (Table 1 and Figure 1). In addition, data from the USGS gaging station near Burdette (river mile 24.57) provided information on some physical characteristics of the system.

TABLE 1

Sampling Locations for Blackwater River Use Attainability Survey

Station No.	Location	River Mile
1	Vicinity Joyner's Bridge, Route 611	20.90
2	Below Franklin Sewage Treatment Plant Discharge	13.77
3	Vicinity Cobb's Wharf, Route 687	2.59

The mean annual rainfall is 48 inches, much of which occurs in the summer in the form of thunderstorms. The SCS has concluded that approximately 41,000 tons of soil are transported to streams in the watershed due to rainfall induced erosion. Seventy (70) percent of this originates from croplands, causing a potential pollution problem from pesticides and from fertilizer based nutrients. In addition, 114,000 pounds of animal waste are produced annually, constituting the only other major source of non-point pollution.

There are two primary point source discharges on the Blackwater River. The Franklin Sewage Treatment Plant at Station 2 discharges an average of 1.9 mgd of municipal effluent. The discharge volume exceeds NPDES permit levels due to inflow and infiltration problems. The plant has applied for a federal grant to upgrade treatment. The second discharge is from Union Camp Corporation, an integrated kraft mill that produces bleached paper and bleached board products. The primary by-products are crude tall oil and crude sulfate turpentine. Union Camp operates at 36.6 mgd but retains its treated waste in lagoons until the winter months when it is discharged. The

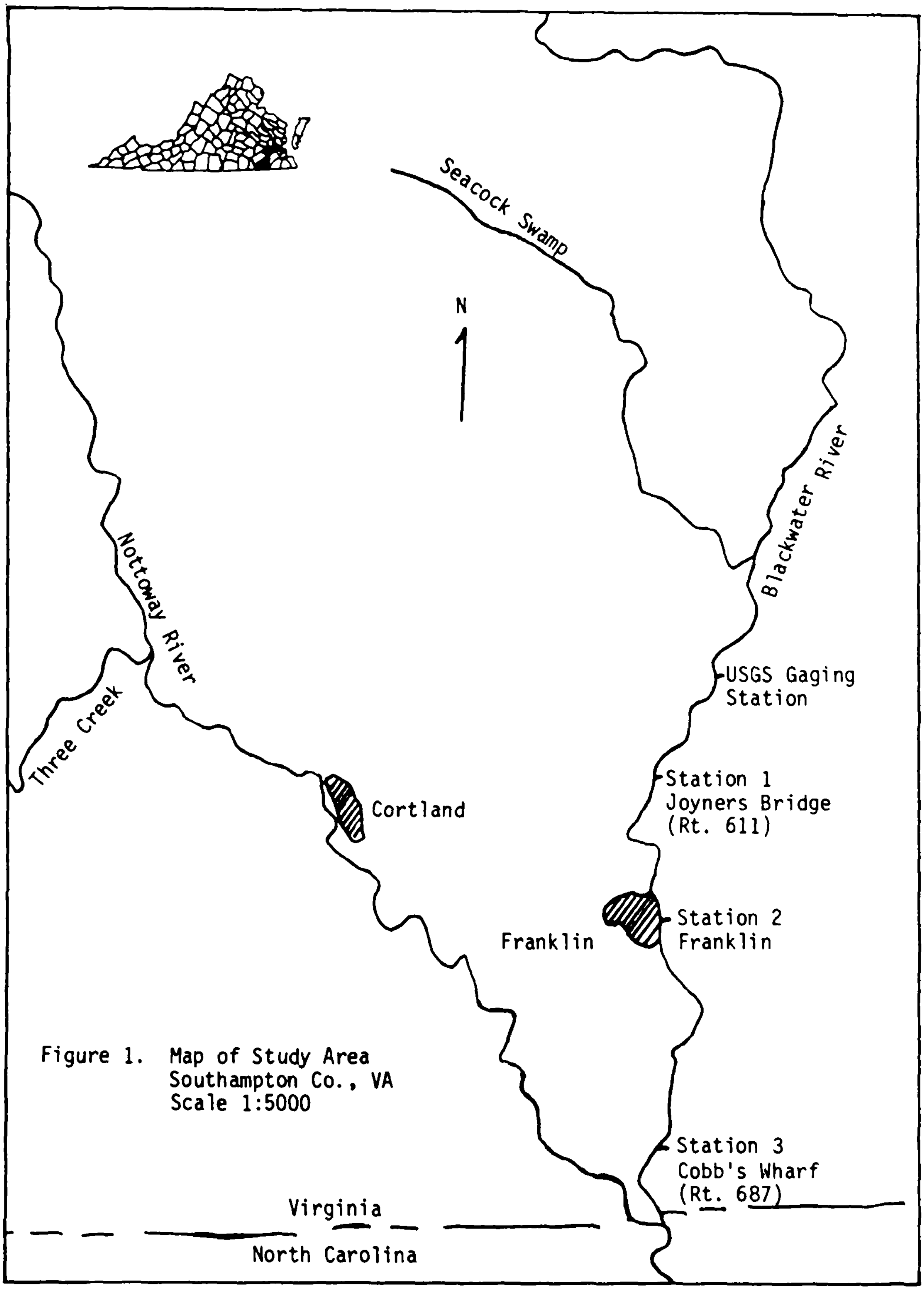

Figure 1. Map of Study Area
Southampton Co., VA
Scale 1:5000

Union Camp discharge point is downstream from Station 3 just above the North Carolina State line at river mile 0.70.

The topography surrounding the Blackwater River is essentially flat and the riparian zone is primarily hardwood wetlands. There is a good surface water supply from several swamps. At the USGS gaging station near Burdette, Virginia, the discharge for calendar year 1980 averaged 430 cfs.

The Blackwater River from Joyner's Bridge (Station 1) to Franklin is classified by the State Water Control Board (SWCB) as a Class III free flowing stream. This classification requires a minimum dissolved oxygen concentration of 4.0 mg/l and a daily average of 5.0 mg/l. Other applicable standards are maintenance of pH from 6.0 to 8.5 and a maximum temperature of 32°C. The riparian zone is heavily wooded wetlands with numerous channel obstructions. Near Franklin the canopy begins to open and there is an increasing presence of lily pads and other macrophytes. The water is dark, as is characteristic of tannic acid water found in swamplands.

Below Franklin the Blackwater River is dredged and channelized to permit barge traffic to reach Union Camp. The channel is approximately 40m wide and from 5m to 8m in depth. This reach of stream is classified by the SWCB as a Class II estuarine system requiring the same dissolved oxygen and pH limitation as in Class III but without a temperature requirement.

B. Problem Definition

The study area on the Blackwater River includes a Class III free-flowing stream and a Class II estuarine river. Part of the Class III section is a freshwater cypress swamp. The water is turbid, nutrient enriched and slightly acidic due to tannins.

In response to the EPA request for Virginia's involvement in the pilot Use Attainability studies, the State Water Control Board chose to examine the Blackwater River in the vicinity of Franklin, Virginia. There were several reasons for this choice. First, the major stress to the system is low dissolved oxygen (DO) concentrations which occur from May through November. Surveys conducted by SWCB staff, and officials from Union Camp in Franklin, found that during certain periods "natural" background concentrations of dissolved oxygen fell below the water quality standard of 4.0 mg/l. This has raised questions as to whether the current standard is appropriate. Virginia's water quality standards contain a swamp water designation which recognizes that DO and pH may be substantially different in some swamp waters and provides for specific standards to be set on a case by case basis. However, no site specific standards have been developed in Virginia to date. One of the goals of this project was to gather information which could lead to possible development of a site specific standard for the Blackwater River. Second, the Franklin STP has applied for a federal grant to provide for improved BOD removals from its effluent.

C. Approach to Use Attainability

On 20 April, 1982, staff of the SWCB met with several EPA officials and their consultant. After visiting the study area on the Blackwater River and reviewing the available information, it was determined that further data should be collected, primarily a description of the aquatic community. The SWCB staff has scheduled four quarterly surveys from June 1982, through March 1983, to collect physical, chemical, and biological information. Interim results are reported herein to summarize data from the first collection. Final conclusions will not be drawn until the data has been compiled for all four quarters.

II. ANALYSES CONDUCTED

A. Physical Analysis

Data on the physical characteristics of the Blackwater River were derived primarily from existing information and from general observations. The entire reach of the Blackwater River from Joyner's Bridge to Cobb's Wharf was traveled by boat to observe channel and riparian characteristics. A sediment sample was collected at each station for partical size analysis.

B. Chemical Analysis

Water samples were collected at Stations 1-3 for analysis of pH, alkalinity, solids, hardness, nutrients, five-day BOD, chemical oxygen demand, total organic carbon, phenols, pesticides, and heavy metals. In addition, previous data on dissolved oxygen concentrations collected by the SWCB and Union Camp were used to examine oxygen profiles in the river. The USGS Water Resources Data for Virginia (1981) provided some chemical data for the Blackwater River near Burdette.

C. Biological Analysis

Periphyton sampling for chlorophyll-a, biomass, and autotrophic index determination was conducted using floating plexiglass samplers anchored by a cement weight. The samplers were placed in the field in triplicate and remained in the river for 14 days. They were located in run areas in the stream. At the end of this two-week period, the samplers were retrieved and the slides removed for biomass determinations and chlorophyll analysis.

Both a cursory and a quantitative survey of macroinvertebrates were conducted at each station. The purpose of the cursory study was to rapidly identify the general water quality of each station by surveying the presence of aquatic insects, molluscs, crustaceans and worms and classifying them according to their pollution tolerance. A record was kept of all organisms found and these were classified to the family level as dominant, abundant, common, few or present. The cursory survey was completed with a qualitative evaluation of the density and diversity of aquatic organisms.

General knowledge of the pollution tolerance of various genera was used to classify the water quality at each station. The benthic macroinvertebrate samples were collected with Hester-Dendy multiplate artificial substrates. The substrates were attached to metal fence posts and held vertically at least 15 cm above the stream bottom. The substrates were left in place for six weeks to allow for colonization by macroinvertebrate organisms. In the laboratory the organisms were identified to the generic level whenever possible. Counts were made of the number of taxa identified and the number of individuals within each taxon.

Fish populations were surveyed at each station by electrofishing. Each station was shocked for 1,000 seconds: 800 seconds at the shoreline and 200 seconds at midstream. Fish collected were identified to species and the total length of each fish was recorded. In addition, general observations were made about the health status of the fish by observing lesions, hemorrhaging, and the presence of external parasites.

Diversity of species was calculated using the Shannon-Weaver index. Additionally, the fish communities were evaluated using an index proposed by Karr (1981) which classifies biotic integrity based on 12 parameters of the fish community.

III. FINDINGS

There are few physical factors which limit aquatic life uses. The habitat is characteristic of a hardwood wetland with few alterations. The major alteration is dredging and channelization below Franklin which eliminates much of the macrophyte community and the habitat it provides for other organisms. The substrate at each station was composed mostly of sand with a high moisture content. This is characteristic of a swamp but is not ideal habitat for colonization by periphyton and macroinvertebrates.

DO concentrations are typically below the Virginia water quality standards during the months of May through November. This is true upstream as well as downstream from the Franklin STP and appears to occur even without the impact of BOD loadings from Franklin. This phenomenon may be typical of enriched freshwater wetlands. However, during the winter months, DO concentrations may exceed 10 mg/l. Another survey conducted by SWCB showed that there were only small changes in DO concentration with depth.

Representatives from 17 families of macroinvertebrates were observed during a cursory investigation. These included mayflies, scuds, midges, operculate and non-operculate snails, crayfish, flatworms, and a freshwater sponge. The majority of these organisms were facultative at Stations 1 and 2. However, there were a few pollution sensitive forms at Station 1, and Station 3 was dominated by pollution sensitive varieties.

Twelve (12) species from seven families of fish were observed during the June 1982 study. Several top predators were present including the bowfin, chain pickerel, largemouth bass and longnose gar. Other fish collected were the American eel, shiners, pirate perch, yellow perch, and five species of sunfish. None of the species are especially pollution sensitive. Results of the fish population survey are presented in Table 2.

TABLE 2

Results of Fish Population Survey in Blackwater River, 9 June 1982

Station	Number Collected	No. of Species	Diversity d	Proportion of Omnivores	Proportion of Carnivores
1. Joyner's Bridge	19	7	2.30	.000	.157
2. Franklin STP	51	6	2.35	.000	.098
3. Cobb's Wharf	44	6	2.35	.000	.114

Based on the EPA 304(a) criteria, low seasonal DO concentrations measured in the river should present a significant stress to the biotic community. Large fish tend to be less resistant to low DO yet large species such as the largemouth bass, American eel and some sunfishes were present in an apparently healthy condition. The explanation for this is unclear. The low dissolved oxygen concentrations are near the physiological limit for many species. Fish may be able to acclimate to low DO to a limited extent if the change in oxygen concentration occurs gradually. The fact that fish are present in a healthy condition suggests that there is a lack of other significant stressors in the system which might interact with low DO stress. It is worth noting that spawning probably occurs in most species before the summer months when dissolved oxygen concentration become critically low.

The autotrophic index determinations show the Joyner's Bridge and Franklin STP stations as having relatively healthy periphyton communities. In each case over 80 percent of the periphytic community was autotrophic in nature. Based on the autotrophic index, both of these stations were in better biological health than the most downstream station, Cobb's Wharf. At Cobb's Wharf the autotrophic index characterized an autotrophic community which was experiencing a slight decline in biological integrity (74 percent autotrophic as compared to greater than 80 percent upstream).

Chemical analyses conducted on water from the Blackwater River did not reveal any alarming concentration of toxicants when compared to EPA Water Quality Criteria Documents, although the zinc concentration at Station 1 was slightly above the 24-hour average recommended by EPA. One sample collected by the USGS had a zinc concentration which was twice this number. The source of this zinc is unknown. Any impact which exists from this problem should be sublethal, affecting growth and reproduction of primarily the most sensitive species. The actual impact of zinc concentrations at Joyner's Bridge is unknown.

Analyses of the periphyton data as well as the water chemistry data indicate that the Blackwater River is nutrient enriched. Some of this nutrient load comes from inadequately protected crop lands and from domestic animal wastes. The Franklin STP also contributes to higher nutrient concentrations. Additionally, an SWCB report estimated that between river mile 20.0 and 6.0, 1,600 lb per day of non-point source carbonaceous BOD_u (ultimate) are added to the river. Consequently, these point and non-point sources appear to be contributing to both organic enrichment and lower dissolved oxygen concentrations.

IV. SUMMARY AND CONCLUSIONS

The Blackwater River from river mile 2.59 to 20.90 has been characterized as a nutrient enriched coastal river much of which is bordered by hardwood wetlands. Periphytic, macroinvertebrate, and fish communities are healthy with fair to good abundance and diversity. The major limitation to aquatic life appears to be low DO concentrations which are enhanced by point and non-point sources of nutrients and BOD. A secondary limitation may be elevated zinc concentrations at Joyner's Bridge.

The primary difficulty in assessing the attainability of aquatic life uses is locating a suitable reference reach to serve as an example of an unaffected aquatic community. Originally, Joyner's Bridge (Station 1) was selected for this purpose, but few major differences occur between populations at all three stations. However, the widespread non-point pollution in Southeastern Virginia makes the location of an undisturbed reference reach impossible. The only alternative, then, is to make the best possible judgment as to what organisms might reasonably be expected to inhabit the Blackwater.

In reference to the Blackwater River, it is probable that most fish species are present that should reasonably be expected to inhabit the river, although possibly in lower numbers. (No attempt has yet been made to assess this with regard to algal and invertebrate communities.) However, based on the 304(a) criteria, the low DO concentrations represent a significant stress of the ecosystem and the introduction of additional stressors could be destructive. It is also probable that higher oxygen concentrations during winter months play a major role in reducing the impact of this stress. Removal of point and non-point source inputs may alleviate some problems. However, DO concentrations may still remain low. The increased effect of oxygen concentrations should be an increase in fish abundance and increased size of individuals. Diversity would probably be unaffected. Nevertheless, no attempt has been made to estimate the magnitude of these changes.

Cairns (1977) has suggested a method for estimating the potential of a body of water to recover from pollutional stress. Although this analysis is only semi-quantitative and subjective, it suggests that the chances of rapid recovery following a disturbance in the Blackwater River are poor.

The absence of an undisturbed reference reach and the difficulty in quantifying changes in dissolved oxygen, population structure, and population abundance make a definite statement regarding attainability of aquatic life uses difficult. However, to summarize, several points stand out. First, the aquatic communities in the Blackwater River are generally healthy with fair to good abundance and distribution. Dissolved oxygen concentrations are low for about half of the year which causes a significant stress to aquatic organisms. Oxygen concentrations are higher during the reproductive periods of many fishes. Because of these stresses and the physical characteristics of the river, the system does not have much resiliency or capacity to withstand additional stress. Although a quantitative statement of changes in the aquatic community with the amelioration of DO stress has not been made, it is probable that additional stresses would degrade the present aquatic community.

The occurrence of low dissolved oxygen concentrations throughout much of the Blackwater is, in part, a "natural" phenomenon and could argue for a reduction in the DO standard. However, if this standard were reduced on a year round basis it is probable that the aquatic community would steadily degrade. This may result in a contravention of the General Standard of Virginia State Law which requires that all waters support the propagation and growth of all aquatic life which can reasonably be expected to inhabit these waters. Because of the lack of resiliency in the system, a year round standards change could irreversibly alter the aquatic community.

WATER BODY SURVEY AND ASSESSMENT
Cuckels Brook
Bridgewater Township, New Jersey

I. INTRODUCTION

A. Site Description

Cuckels Brook, a small tributary of the Raritan River, is located entirely within Bridgewater Township in Somerset County, New Jersey. It is a perennial stream approximately four miles long, having a watershed area of approximately three square miles. The entire brook is classified as FW-2 Nontrout in current New Jersey Department of Environmental Protection (NJDEP) Surface Water Quality Standards.

Decades ago, the downstream section of Cuckels Brook (below the Raritan Valley Line Railroad, Figure 1), was relocated into an artificial channel. This channelized section of Cuckels Brook consists of an upstream subsection approximately 2,000 feet in length and a downstream subsection approximately 6,000 feet in length, with the Somerset-Raritan Valley Sewerage Authority (SRVSA) municipal discharge being the point of demarcation between the two. The downstream channelized subsection (hereinafter referred to as "Lower Cuckels Brook") is used primarily to convey wastewater to the Raritan River from SRVSA and the American Cyanamid Company, which discharges approximately 200 feet downstream of SRVSA. At its confluence with the Raritan River, flow in Lower Cuckels Brook is conveyed into Calco Dam, a dispersion dam which distributes the flow across the Raritan River. Except for railroad and pipeline rights-of-way, all the land along Lower Cuckels Brook is owned by the American Cyanamid Company. Land use in the Cuckels Brook watershed above the SRVSA discharge is primarily suburban but includes major highways.

B. Problem Definition

Lower Cuckels Brook receives two of the major discharges in the Raritan River Basin. SRVSA is a municipal secondary wastewater treatment plant which had an average flow in 1982 of 8.8 mgd (design capacity = 10 mgd). The American Cyanamid wastewater discharge is a mixture of process water from organic chemical manufacturing, cooling water, storm water, and sanitary wastes. This mixed waste receives secondary treatment followed by activated carbon treatment. In 1982 American Cyanamid's average flow was 7.0 mgd (design capacity 20 mgd). These two discharges totally dominate the character of Lower Cuckels Brook.

Over 90 percent of the flow in Cuckels Brook is wastewater (except after heavy rainfall). The mean depth is estimated to be between 1 and 2 feet, and the channel bottom at observed locations is covered with deposits of

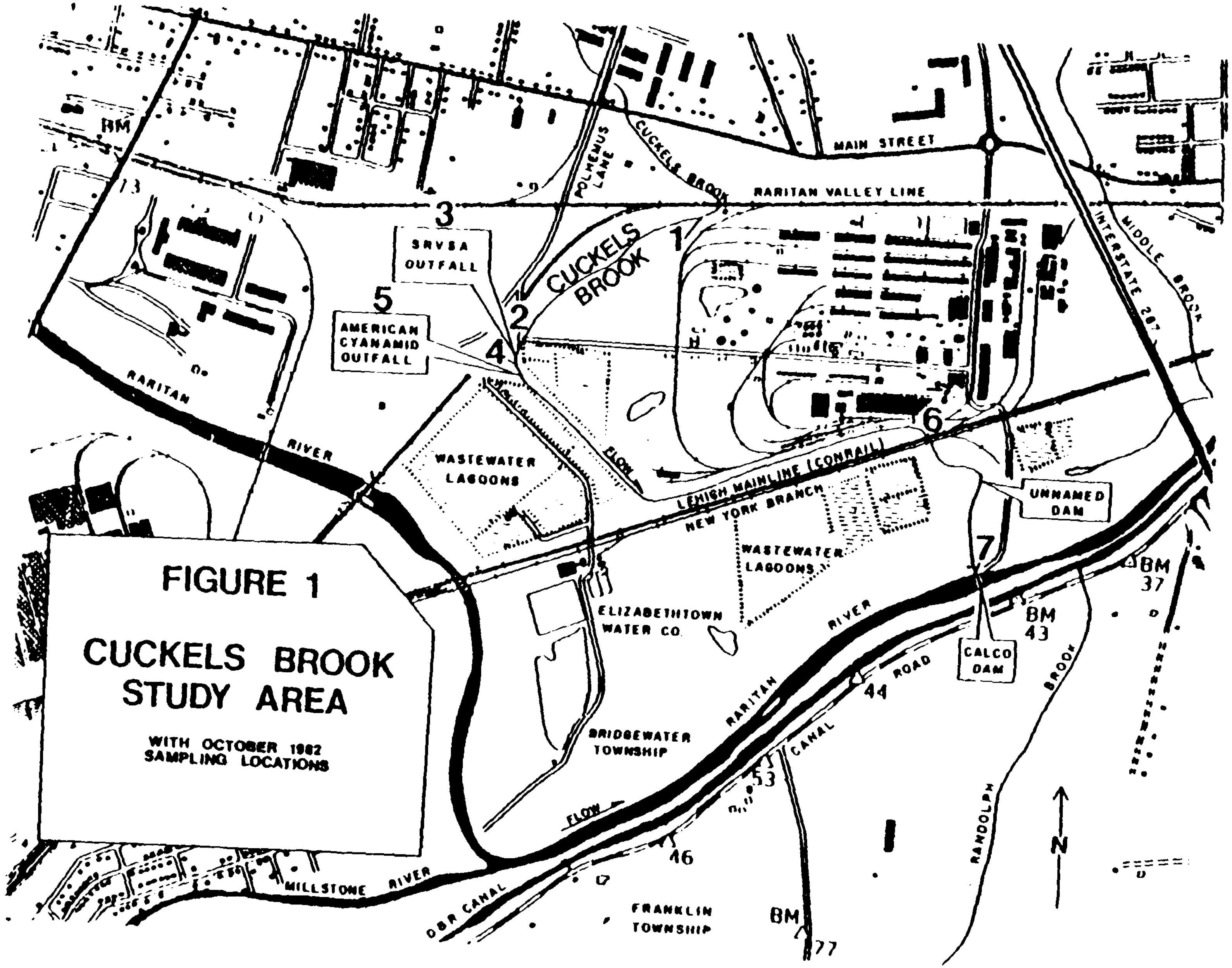
FIGURE 1
CUCKELS BROOK STUDY AREA
WITH OCTOBER 1982 SAMPLING LOCATIONS
MAIN STREET
RARITAN VALLEY LINE
CUCKELS BROOK
POLHEMUS LANE
SRVSA OUTFALL
AMERICAN CYANAMID OUTFALL
WASTEWATER LAGOONS
LEHIGH MAINLINE (CONRAIL)
NEW YORK BRANCH
UNNAMED DAM
CALCO DAM
ELIZABETHTOWN WATER CO.
BRIDGEWATER TOWNSHIP
FRANKLIN TOWNSHIP
RARITAN RIVER
MILLSTONE RIVER
D&R CANAL
CANAL ROAD
RANDOLPH BROOK
MIDDLE BROOK
INTERSTATE 287
FLOW
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black sludge, apparently derived from solids in the SRVSA and Cyanamid discharges (primarily the SRVSA discharge). In contrast, the channelized subsection of Cuckels Brook above the SRVSA discharge is often only inches deep with a bottom of bedrock, rubble, gravel and silt.

Cuckels Brook (including Lower Cuckels Brook) is classified as FW-2 Non-trout in the NJDEP Surface Water Quality Standards. The FW-2 classification provides for the following uses:

1. Potable water supply after such treatment as shall be required by law or regulation;

2. Maintenance, migration, and propagation of natural and established biota (not including trout);

3. Primary contact recreation;

4. Industrial and agricultural water supply; and

5. Any other reasonable uses.

The attainment of these uses is currently prevented by the strength and volume of wastewaters currently discharged to Cuckels Brook. The size of the stream also limits primary contact recreation and other water uses, and physical barriers currently prevent the migration of fish between Cuckels Brook and the Raritan River.

C. Approach to Use Attainability

In response to an inquiry from EPA, Criteria and Standards Division, the State of New Jersey offered to participate in a demonstration Water Body Survey and Assessment. The water body survey of Cuckels Brook was conducted by the New Jersey Department of Environmental Protection, Bureau of Systems Analysis and Wasteload Allocation; with assistance from the EPA Region II Edison Laboratory.

The assessment is based primarily on the results of a field sampling program designed and conducted jointly by NJDEP and EPA-Edison in October 1982. Additional sources of information include self-monitoring reports furnished by the dischargers, and earlier studies conducted by the NJDEP on Cuckels Brook and the Raritan River. Based on this assessment, NJDEP developed a report entitled "Lower Cuckels Brook Water Body Survey and Use Attainability Analysis, 1983."

II. ANALYSES CONDUCTED

A. Chemical Analysis

The major impact of the SRVSA discharge is attributed to un-ionized ammonia and TRC levels, whose concentrations at Station 4, 100 feet below the discharge point were 0.173 and 1.8 mg/l respectively, which are 3.5 and 600 times higher than the State criteria. The un-ionized ammonia concentration of the Cyanamid effluent was low, but stream concentrations at Stations 6 and 7 were relatively high (though below the State criterion of 0.05 mg/l).

The Cyanamid discharge contained 0.8 mg/l TRC. Concentrations at both Stations 6 and 7 were 0.3 mg/l TRC, lower than at Station 4 but still 100 times the State criterion of 0.003 mg/l. The other major impact of the Cyanamid effluent was on instream filterable residue levels. Concentrations at Stations 6 and 7 exceeded 1,100 mg/l, over three times the State criterion (133 percent of background).

The effluents apparently buffered the pH of Lower Cuckels Brook which was approximately pH 7 at Stations 4, 6 and 7, and the pH of the upstream reference stations was markedly alkaline. Dissolved oxygen concentrations decreased in the downstream direction despite low BOD5 concentrations both in the effluents and instream. This suggests an appreciable sediment oxygen demand in Lower Cuckels Brook. Dissolved oxygen levels were greater in the two effluents than in the stream at Stations 6 and 7. The dissolved oxygen concentration at Station 7 of 4.1 mg/l nearly violated the State criterion of 4.0 mg/l; this suggests the potential for unsatisfactory dissolved oxygen conditions during the summer.

The results of the water body survey are generally in good agreement with other available data sources. Recent self-monitoring data for both American Cyanamid and SRVSA agree well with the data collected in this survey. In particular they show consistantly high TRC concentrations in both effluents. High average dissolved solids (filterable residue) concentrations are reported for the Cyanamid effluent. Total ammonia levels as high as 33.5 mg/l NH3 (27.6 mg/l N) were reported for the SRVSA effluent. The pH of the Cyanamid and SRVSA effluents is sometimes more alkaline than the water body survey values indicating that toxic un-ionized ammonia concentrations may sometimes be higher than measured during the water body survey.

B. Biological Analysis

Fish and macroinvertebrate surveys were conducted in the channelized subsection of Cuckels Brook above the SRVSA discharge. Only three fish species were found: the banded killifish, the creek chub and the blacknose dace. One hundred and eighty-six (186) out of the total 194 specimens collected were banded killifish. Killifish are very hardy and are common in both estuarine and freshwater systems. The largest fish found, a creek chub, was 146 mm long.

The results of the macroinvertebrate survey are discussed in detail in a separate report (NJDEP, 1982). Four replicate surber samples were collected at Stations 1 and 2 above the SRVSA discharge. Diversity indices indicate the presence of similar well-balanced communities at both stations. Species diversity and equitability were 3.9 and 0.7 respectively at Station 1, and 4.3 and 0.7 respectively at Station 2. Productivity at Stations 1 and 2 was low, with mean densities of 59 and 89 individuals per square foot, respectively. The majority of species found at both stations have organic pollution tolerance classifications of tolerant (dominant at Station 1) or facultative (dominant at Station 2).

Overall, the biological data indicate that the upstream channelized subsection of Cuckels Brook supports a limited fish community and a limited macroinvertebrate community of generally tolerant species. The water quality data indicates nothing that would limit the community. One possible limiting factor is that, as a result of channelization, the substrate consists of unconsolidated gravel and rubble on bedrock, which might easily be disturbed by high flow conditions.

Both the chemical data and visual observations at various locations suggest that virtually no aquatic life exists along Lower Cuckels Brook: not even algae were seen. The discharges have seriously degraded water quality. Unionized ammonia concentrations at Station 4 were close to acute lethal levels, while concentrations of TRC were above acute levels at Stations 4, 6 and 7 (EPA, 1976). The sludge deposits which apparently cover most of the bottom of lower Cuckels Brook could exert negative physical (i.e. smothering) and chemical (i.e. possible toxics) effects on any benthic organisms. No biological survey of the lower brook was made because of concern about potential hazards to sampling personnel. Supplemental sampling of the sediments is planned to ascertain levels of toxics accumulation.

As part of their self-monitoring requirements, American Cyanamid performs weekly 96-hour modified flow-through bioassays with fathead minnows using unchlorinated effluent. Of 63 bioassays conducted between 1 May, 1981 and 31 August, 1982, results from eight bioassays had 96-hour LC50 values at concentrations of effluent less than 100 percent (i.e. 26 percent, 58 percent, 77 percent, 83.5 percent, 88 percent, 92 percent, and 95.5 percent). These results suggest that the American Cyanamid effluent would not be extremely toxic if it were reasonably diluted by its receiving waters. Within Lower Cuckels Brook, however, the effluent receives only approximately 50 percent dilution and the potential exists for toxic effects on any aquatic life that may be present. These effects would be in addition to the toxicity anticipated from the TRC concentrations which result from the chlorination of the effluent.

III. FINDINGS

Practically none of the currently designated uses are now being achieved in Lower Cuckels Brook. The principal current use of Lower Cuckels Brook is the conveyance of treated wastewater and upstream runoff to the Raritan River. Judging from the indirect evidence of chemical data and visual observations, virtually no aquatic life is maintained or propagated in Lower Cuckels Brook. It has been well documented that fish avoid chlorinated waters (Cherry and Cairns, 1982; Fava and Tsai, 1976). Any aquatic life that does reside in Lower Cuckels Brook would be sparse and stressed. Migration of aquatic life through Lower Cuckels Brook would probably only occur during periods of high storm water flow when some flow occurs over the un-named dam (Figure 1) which is designed to direct the flow of Cuckels Brook toward Calco Dam. Calco Dam and its associated structures, including the un-named dam, normally prevent the migration of fish between Cuckels Brook and the Raritan River.

Lower Cuckels Brook currently does not support any primary or secondary contact recreation. No water is currently diverted from Lower Cuckels Brook for potable water supply, industrial or agricultural water supply, or any other purpose.

Because Lower Cuckels Brook receives large volumes of wastewater and because there is practically no dilution, water quality in Lower Cuckels Brook has been degraded to the quality of wastewater. Moreover, the bottom of Lower Cuckels Brook has been covered at observed locations with wastewater solids. As a result, Lower Cuckels Brook is currently unfit for aquatic life, recreation, and most other water uses. The technology-based effluent limits required by the Clean Water Act are not adequate to protect the currently designated water uses in Lower Cuckels Brook. SRVSA already provides secondary treatment (except for bypassed flows in wet weather), and American Cyanamid already provides advanced treatment with activated carbon. Because the Raritan River provides far more dilution than does Cuckels Brook, effluent limits which may be developed to protect the Raritan River would not be adequate to protect the currently designated water uses in Lower Cuckels Brook. The only practical way to restore water quality in Lower Cuckels Brook would be to remove the wastewater discharges. However, there are several factors that would limit the achievement of currently designated uses even if the wastewater discharges were completely separated from natural flow.

If it were assumed that the wastewater discharges and sludge were absent, and that the seepage of contaminated groundwater from the American Cyanamid property was insignificant or absent, then the following statements could be made about attainable uses in Lower Cuckels Brook:

> Aquatic Life - The restoration of aquatic life in Lower Cuckels Brook would be limited to some extent by the small size and lower flow of the stream, by channelization, and by contaminants in suburban and highway runoff from the upstream watershed. Lower Cuckels Brook could support a limited macroinvertebrate community of generally tolerant species, and some small fish as were found in the reference channelized subsection above the SRVSA discharge (Stations 1 and 2). Unless it were altered or removed, the Calco Dam complex would continue to prevent fish migration.
>
> Wildlife typical of narrow stream corridors could inhabit the generally narrow strips of land between Lower Cuckels Brook and nearby railroad tracks and waste lagoons. Restoration of aquatic life in Lower Cuckels Brook would be expected to have little impact on aquatic life in the Raritan River.

Recreation - Lower Cuckels Brook would be too shallow for swimming or boating, and its small fish could not support sport fishing. The industrial surroundings of Lower Cuckels Brook, including waste lagoons and active manufacturing facilities and railroads, severely reduces the potential for other recreational activities such as streamside trails and picnic areas, wading, and nature appreciation. As Lower Cuckels Brook is on private industrial property, trespassing along this brook and in the surrounding area is discouraged.

It would appear unlikely that any of the landowners, or any government agency, would develop recreational facilities along lower Cuckels Brook or even remove some of the brush which impairs access to most of the Brook. Recreation along Lower Cuckels Brook would be limited, occasional, and informal.

Other Water Uses - Although water quality in Lower Cuckels Brook would generally meet FW-2 Nontrout criteria, the volume of natural flow in Lower Cuckels Brook would be insufficient for potable water supply or for industrial or agricultural water use.

In general, Lower Cuckels Brook would become a small channelized tributary segment flowing through a heavily industrialized area, free of gross pollution and capable of supporting a modest aquatic community and very limited recreational use.

IV. SUMMARY AND CONCLUSIONS

This use-attainability analysis has discussed the present impairment of the currently designated uses of Lower Cuckels Brook, the role of wastewater discharges in such impairment, and the extent to which currently designated water uses might be achieved if the wastewater discharges were removed. Further analysis, outside the scope of this survey, will be required: to document the costs of removing SRVSA and American Cyanamid effluent from Lower Cuckels Brook, and to evaluate the impact of the SRVSA and American Cyanamid discharges on the Raritan River. These analyses may lead to the development of site-specific water quality standards for Lower Cuckels Brook (designated uses limited to the conveyance of wastewater and the prevention of nuisances), or to the removal of the wastewater discharges from Lower Cuckels Brook. In either case, effluent limits would be established to protect water quality in the Raritan River.

WATER BODY SURVEY AND ASSESSMENT
Deep Creek And Canal Creek
Scotland Neck, North Carolina

I. INTRODUCTION

A. Site Description

The Town of Scotland Neck is located in Halifax County in the lower coastal plain of North Carolina. The Town's wastewater, made up mostly of domestic waste with a small amount of textile waste, is treated in an oxidation ditch of 0.6 mgd design capacity. The treatment plant is located two-tenths of a mile southwest of Scotland Neck off U.S. Highway 258, as seen in Figure 1. The effluent (0.323 mgd average) is discharged to Canal Creek which is a tributary to Deep Creek.

Canal Creek is a channelized stream which passes through an agricultural watershed, but also receives some urban runoff from the western sections of Scotland Neck. It is a Class C stream with a drainage area of 2.4 square miles, an average stream flow of 3.3 cfs, and a 7Q10 of 0.0 cfs. The Creek retains definite banks for about 900 feet below the outfall at which point it splits into numerous shifting channels and flows 800 to 1400 feet through a cypress swamp before reaching Deep Creek. During dry periods the braided channels of Canal Creek can be visually traced to Deep Creek. During wet periods Canal Creek overflows into the surrounding wetland and flow is no longer restricted to the channels.

Deep Creek is a typical tannin colored Inner Coastal Plain stream that has a heavily wooded paludal flood plain. The main channel is not deeply entrenched. In some sections streamflow passes through braided channels, or may be conveyed through the wetland by sheetflow. During dry weather flow periods the main channel is fairly distinct and the adjacent wetland is saturated, but not inundated. During wet weather periods the main channel is less distinct, adjacent areas become flooded and previously dry areas become saturated.

B. Problem Definition

The Town of Scotland Neck is unable to meet its final NPDES Permit limits and is operating with a Special Order by Consent which specifies interim limits. The Town is requesting a 201 Step III grant to upgrade treatment by increasing hydraulic capacity to 0.675 mgd with an additional clarifier, an aerobic digestor, tertiary filters, a chlorine contact chamber, post aeration and additional sludge drying beds. The treated effluent from Scotland Neck is discharged into Canal Creek. The lower reaches of Canal Creek are part of the swamp through which Deep Creek passes.

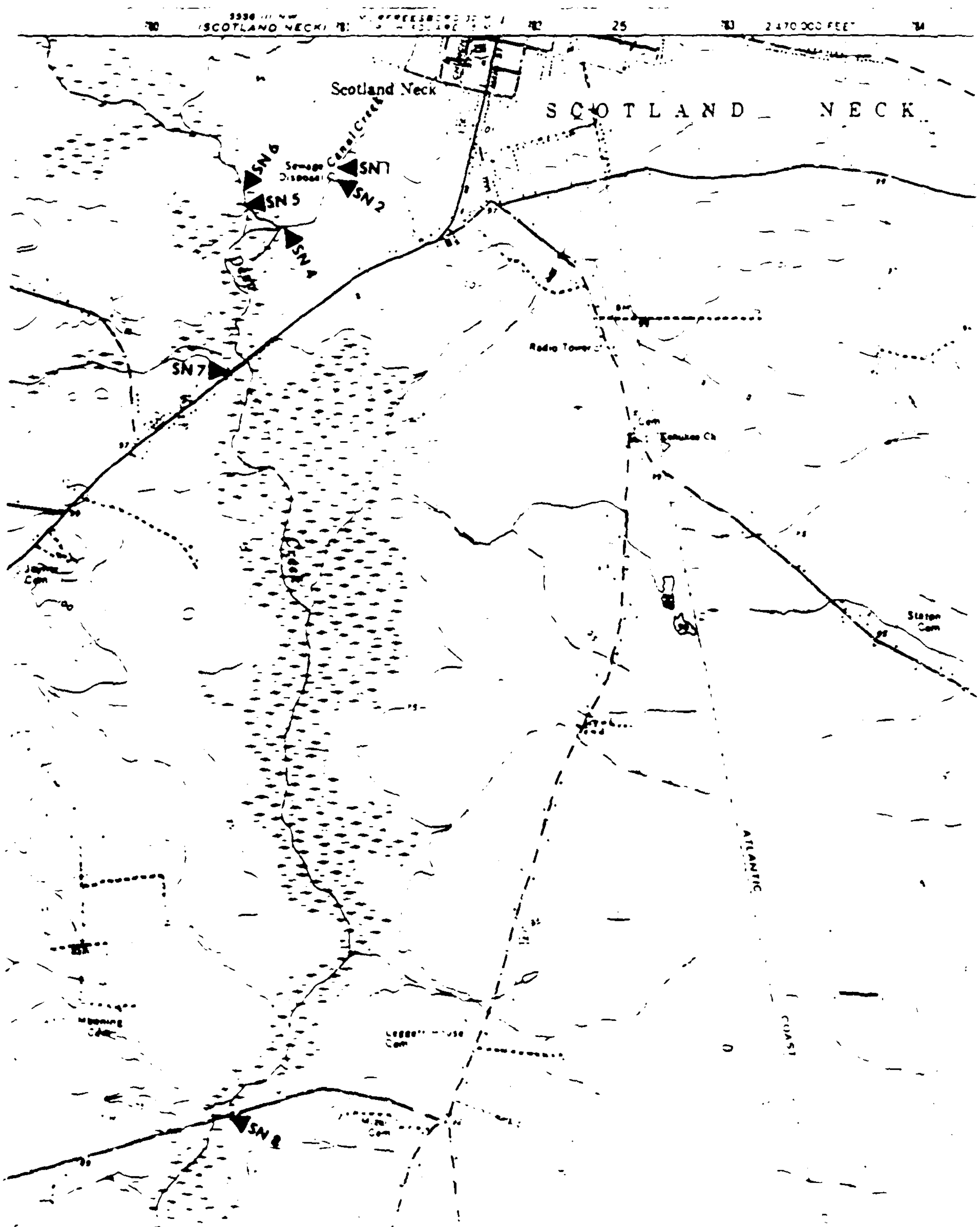


Figure 1. Study Area, Deep Creek and Canal Creek

Deep Creek carries a "C" classification, but due to naturally low dissolved oxygen and other conditions imposed by the surrounding swamp, it is felt that reclassification to "C-Swamp" should be considered. Deep Creek should be classified C-Swamp because its physical characteristics meet the C-Swamp classification of the North Carolina Administrative Code for Classifications and Water Quality Standards. The Code states: Swamp waters shall mean those waters which are so designated by the Environmental Management Commission and which are topographically located so as to generally have very low velocities and certain other characteristics which are different from adjacent streams draining steeper topograpy. The C-Swamp classification provides for a minimum pH of 4.3 (compared to a range of pH 6.0 to pH 8.5 for C waters), and allows for low (unspecified) DO values if caused by natural conditions. DO concentrations in Deep Creek are usually below 4.0 mg/l.

C. Approach to Use Attainability Analysis

1. Data Available

1. Self Monitoring Reports from Scotland Neck.
2. Plant inspections by the Field Office.
3. Intensive Water Quality Survey of Canal Creek and Deep Creek at Scotland Neck in September, 1979. Study consisted of time-of-travel dye work and water quality sampling.

2. Additional Routine Data Collected

Water quality survey of Canal Creek and Deep Creek at Scotland Neck in June 1982. Water quality data was collected to support a biological survey of these creeks. The study included grab samples and flow measurements.

Benthic macroinvertebrates were collected from sites on Canal Creek and Deep Creek. Qualitative collection methods were used. A two-member team spent one hour per site collecting from as many habitats as possible. It is felt that this collection method is more reliable than quantitative collection methods (kicks, Surbers, ponars, etc.) in this type of habitat. Taxa are recorded as rare, common, and abundant.

II. ANALYSES CONDUCTED

A. Physical Factors

Sampling sites were chosen to correspond with sites previously sampled in a water quality survey of Canal and Deep Creeks. Three stations were selected on Canal Creek. SN-1 is located 40 feet above the Town of Scotland Neck Wastewater Treatment Plant outfall. This site serves as a reference station. The width at SN-1 is 7.0 feet and the average discharge (two flows were recorded in the September 1979 survey and one flow in the June 1982 survey) is 0.65 cubic feet per second. Canal Creek at SN-1 has been channelized and has a substrate composed of sand and silt. SN-4 is located on Canal Creek 900 feet below the discharge point. This section of Canal Creek has an average cross-sectional area of 11.8 feet and an average flow of 1.33 cubic feet per second. The stream in this section is also channelized and also has a substrate composed of sand and silt. There is a canopy of large cypress at SN-4 below the plant, while the canopy above SN-1 is reduced to a narrow buffer zone. The potential uses of Deep Creek are limited by its inaccessability in these areas.

A third station (SN-5) was selected on one of the lower channels of Canal Creek at the confluence with Deep Creek 3200 feet upstream of the U.S. Highway 258 bridge. Discharge measurements could not be accomplished at this site during this survey because of the swampy nature of the stream with many ill-defined, shallow, slow moving courses. Benthic macroinvertebrates were collected from this site.

Three stations were chosen on Deep Creek. SN-6 is approximately 300 feet upstream of SN-5 on Canal Creek at its confluence with Deep Creek and is a reference site. SN-7 is located at the U.S. Highway 258 bridge and SN-8 is located further downstream at the SR 1100 bridge. SN-7 and SN-8 are below Canal Creek. There are some differences in habitat variability among these three sites. The substrate at both SN-6 and SN-7 is composed mostly of a deep layer of fine particulate matter. Usable and productive benthic habitats in this area are reduced because of the fine particulate layer. It is possible that the source of this sediment is from frequent overbank flows and from upstream sources. Productive benthic habitats include areas of macrophyte growth, snags, and submerged tree trunks. Discharge measurements were not taken at any of these three sites during this survey.

B. Chemical Factors

Chemical data from two water quality surveys show that the dissolved oxygen in Canal Creek is depressed while BOD_5, solids and nutrient levels are elevated. The 1982 study indicates, however, that the water quality is better than it was during the 1979 survey. Such water quality improvements may be due to the addition of chlorination equipment and other physical improvements as well as to the efforts of a new plant operator.

Both above and below its confluence with Canal Creek, Deep Creek shows poor water quality which may be attributed to natural conditions, but not to any influence from the waste load carried by Canal Creek. Canal Creek exhibited higher DO levels than Deep Creek.

C. Biological Factors

The impact of the effluent on the fauna of Canal Creek is clear. A 63 percent reduction in taxa richness from 35 at SN-1 to only 13 at SN-4 indicates severe stress as measured against criteria developed by biologists of the Water Quality Section. The overwhelming dominance of *Chironomus* at SN-4 is indicative of a low DO level and high concentrations of organic matter. To what extent this condition is attributable to the effluent or to natural swamp conditions is not clear. No impact to the benthos of Deep Creek was discerned which could be attributed to the effluent.

III. FINDINGS

Deep Creek is currently designated as a class C warm water fishery but due to naturally low dissolved oxygen concentrations may not be able to satisfy the class C dissolved oxygen criteria. The DO criterion for class C waters stipulates a minimum value of 4 ppm, yet the DO in Deep Creek, in both the 1979 and the 1982 studies, was less than 4 ppm. Thus from the standpoint of aquatic life uses, Deep Creek may not be able to support the forms of aquatic life which are intended for protection under the class C standards. Because of prevailing natural conditions, there are no higher potential uses of Deep Creek than now exist; yet because of prevailing natural conditions and in light of the results of this water body assessment, the C-swamp use designation appears to be a more appropriate designation under existing North Carolina Water Quality Standards.

Canal Creek is degraded by the effluent from the Scotland Neck wastewater treatment plant. The BOD_5, fecal coliform, solids and nutrient levels are elevated while the DO concentration is depressed. The reach immediately below the outfall is affected by an accumulation of organic solids, by discoloration and by odors associated with the wastewater.

IV. SUMMARY AND CONCLUSIONS

The water body survey of Deep Creek and Canal Creek included a consideration of physical, chemical and biological factors. The focus of interest was those factors responsible for water quality in Deep Creek, including possible deliterious effects of the Scotland Neck wastewater on this water body. The analyses indicate that the effluent does not appear to affect Deep Creek. Instead, the water quality of Deep Creek reflects natural conditions imposed by seasonal low flow and high temperature, and reflects the nutrient and organic contribution of the surrounding farmland and wetland. It is concluded that the C-Swamp designation more correctly reflects the uses of Deep Creek than does the C designation.

In contrast to Deep Creek, Canal Creek is clearly affected by the treated effluent. Further examination would be required to determine the extent of recovery that might be expected in Canal Creek if the plant were to meet current permit requirements or if the proposed changes to the plant were incorporated into the treatment process.

WATER BODY SURVEY AND ASSESSMENT
Malheur River
Malheur County, Oregon

I INTRODUCTION

A. Site Description

The Malheur River, in southeastern Oregon, flows eastward to the Snake River which separates Oregon from Idaho. Most of Malheur County is under some form of agricultural production. With an average annual precipitation of less than 10 inches, the delivery of irrigation water is essential to maintain the high agricultural productivity of the area.

The Malheur River system serves as a major source of water for the area's irrigation requirements (out of basin transfer of water from Owyhee Reservoir augments the Malheur supply). Reservoirs, dams, and diversions have been built on the Malheur and its tributaries to supply the irrigation network. The first major withdrawal occurs at the Namorf Dam and Diversion, at Malheur River Mile 69. Figure 1 presents a schematic of the study area.

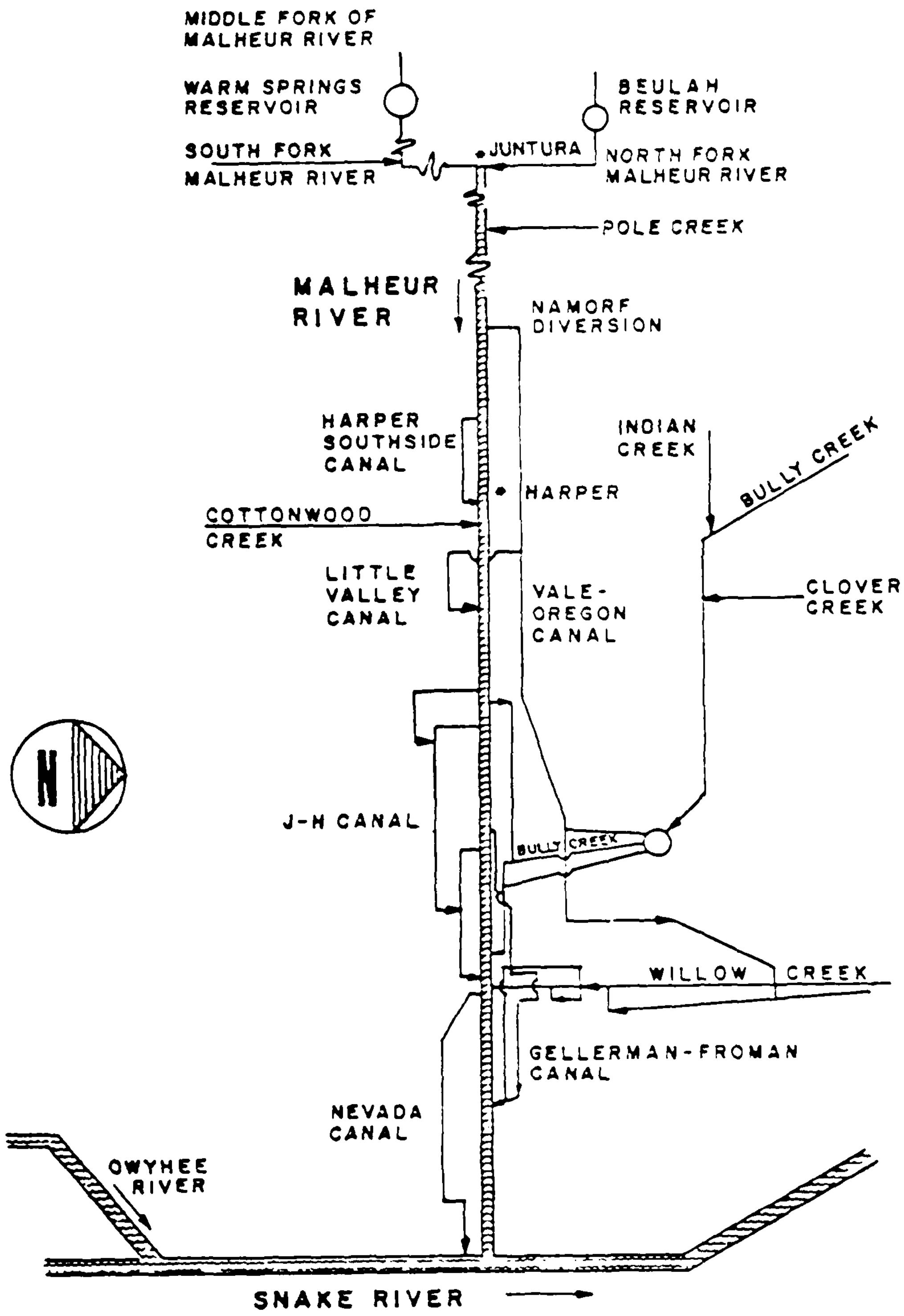
Irrigation water is delivered to individual farms by a complicated system of canals and laterals. Additional water is obtained from drainage canals and groundwater sources. An integral part of the water distribution system is the use and reuse of irrigation return flows five or six times before it is finally discharged to the Snake River.

B. Problem Definition

The Malheur River above Namorf Dam and Diversion is managed primarily as a trout fishery, and from Namorf to the mouth as a warm-water fishery. The upper portion of the river system is appropriately classified. Below Namorf Dam, however, the river is inappropriately classified as supporting a cold-water fishery, and therefore was selected for review. This review was conducted as part of the U.S. Environmental Protection Agency's field test of the draft "Water Body Survey and Assessment Guidance" for conducting a use attainability analysis. The guidance document supports the proposed rule to revise and consolidate the existing regulation governing the development, review, and approval of water quality standards under Section 303 of the Clean Water Act.

C. Approach to Use Attainability Analysis

Assessment of the Malheur River is based on a site visit which included meetings with representatives of the Malheur County Citizen's Water Resources Committee, the USDA-Soil Conservation Service, the Oregon Department of Environmental



SIMPLIFIED FLOW SCHEMATIC
MALHEUR RIVER IRRIGATION SYSTEM

- FIGURE 1 -

Quality (ODEQ), the Oregon Department of Fish and Wildlife (ODFW), and the U.S. Environmental Protection Agency (EPA): and upon the findings reported in two studies:

Final Report, Two Year Sampling Program, Malheur County Water Quality Management Plan, Malheur County Planning Office, Vale, Oregon, 1981.

Bowers, Hosford and Moore, Stream Surveys of the Lower Owyhee and Malheur Rivers, A Report to the Malheur County Water Resources Committee, Oregon Department of Fish and Wildlife, January, 1979.

The first report, prepared under amendments to Section 208 of the Clean Water Act, contains extensive information on the quantity, quality and disposition of the areas' water resources. The second document gives the fish populations found in the lower 69 miles of the Malheur River during June and July, 1978. Information in the ODFW report is incorporated in the 208 report. Additional fisheries information supplied by ODFW was also considered.

A representative of ODEQ, Portland, and the Water Quality Standards Coordinator, EPA Region X, Seattle, Washington, agreed that the data and analyses contained in these two reports were sufficient to re-examine existing designated uses of the Malheur River.

II ANALYSES CONDUCTED

Physical, chemical, and biological data were reviewed to determine: (1) whether the attainment of a salmonid fishery was feasible in the lower Malheur; and (2) whether some other designated use would be more appropriate to this reach. The elements of this review follow:

A. Physical Factors

Historically, salmonid fish probably used the lower Malheur (lower 50 miles) mainly as a migration route, because of the warm water and poor habitat. The first barrier to upstream fish migration was the Nevada Dam near Vale, constructed in 1880. Construction of the Warm Springs Dam in 1918, ended the anadromous fish runs in the Middle Fork Malheur. The construction of Beulah Dam in 1931, befell the remainder of anadromous fish runs on the North Fork Malheur. Finally, the construction of Brownlee Reservoir in 1958 completely blocked salmonid migrants destined for the upper Snake River System.

With the construction of the major irrigation reservoirs on the Malheur River and its tributaries, the natural flow characteristics in the lower river have changed. Instead of high early summer flows, low summer and fall flows and steady winter flow, the peak flows may occur in spring, if and when the upstream reservoirs spill. Also, a high sustained flow exists all summer as water is released from the dams for irrigation. A significant change limiting fish production in the Malheur River below Namorf is the extreme low flow that occurs when the reservoirs store water during the fall and winter for the next irrigation season.

Two other physical conditions affect the maintenance of salmonids in the lower Malheur. One is the high suspended solids load carried to the river by irrigation return flows. High suspended solids also occur during wet weather when high flows erode the stream bank and re-suspend bottom sediments. The seasonal range of suspended solids content is pronounced, with the highest concentrations occurring during irrigation season and during periods of wet weather. Observed peaks in lower reaches of the river, measured during the two-year 208 Program, reached 1300 mg/l, while background levels rarely dropped below 50 mg/l. A high suspended solids load in the river adversely affects the ability of sight-feeding salmonids to forage, and may limit the size of macroinvertebrate populations and algae production which are important to the salmonid food chain. A second factor is high summer water temperature which severely stresses salmonids. The high temperatures result from the suspended particles absorbing solar radiation.

B. Biological Factors

The biological profile of the river is mainly based on fisheries information, with some macroinvertebrate samples gathered by the Oregon Department of Fish and Wildlife (ODFW) in 1978. During the site visit, the participants agreed additional information on macroinvertebrates and periphyton would not be needed because the aquatic insect numbers and diversity were significantly greater in the intensively irrigated reach of the river than for the upper river where agricultural activity is sparse.

Although the Malheur River from Namorf to the mouth is managed as a warm water fishery, ODFW has expended little time and few resources on this stretch of the river because it is not a productive fish habitat. Survey results in summer of 1978 showed a low ratio of game fish to rough fish over the lower 69 miles of the Malheur River.

In the section between Namorf and the Gellerman-Froman Diversion Dam there was little change in water quality although water temperatures were elevated. Only three game fish were captured but non-game fish sight-feeders were common. Low winter flows over a streambed having few deep pools for overwinter survival appears to limit fish production in this reach of river.

In the stretch from the Gellerman-Froman Diversion to the mouth, the river flows through a region of intensive cultivation. The river carries a high silt load which affects sight-feeding fish. Low flows immediately below the Gellerman-Froman Dam also limit fish production in this area.

C. Chemical Factors

A considerable amount of chemical data exist on the Malheur River. However, since the existing and potential uses of the river are dictated largely by physical constraints, dissolved oxygen was the only chemical parameter considered in the assessment.

The Dissolved Oxygen Standard established for the Malheur River Basin calls for a minimum of 75 percent of saturation at the seasonal low and 95 percent of saturation in spawning areas or during spawning, hatching, and fry stages of salmonid fishes. One sample collected at Namorf fell below the standard to 73 percent of saturation or 8.3 mg/l in November, 1978. All other samples were above this content, reaching as high as 170 percent of saturation during the summer due to algae. Data collected by the ODEQ from Malheur River near the mouth between 1976 and 1979 showed the dissolved oxygen content ranged from 78 to 174 percent saturation. The dissolved oxygen content in the lower Malheur River is adequate to support a warm-water fishery.

III FINDINGS

A. Existing Uses

The lower Malheur River is currently designated as a salmonid fishery, but it is managed as a warm water fishery. Due to a number of physical constraints on the lower river, conditions are generally unfavorable for game fish, so rough fish predominate. In practice, the lower Malheur River serves as a source and a sink for irrigation water. This type of use contributes to water quality conditions which are unfavorable to salmonids.

B. Potential Uses

Salmonid spawning and rearing areas generally require the highest criteria of all the established beneficial uses. It would be impractical, if not impossible in some areas, to improve water quality to the level required by salmonids. However, even if this could be accomplished, high summer temperatures and seasonal low flows would still prevail. While salmonids historically moved through the Malheur River to spawn in the headwater areas, year-round resident fish populations probably did not exist in some of these areas at the time.

The Malheur River basin can be divided into areas, based upon differing major uses. Suggested divisions are: (1) headwater areas above the reservoirs; (2) reservoirs; (3) reaches below the reservoirs and above the intensively irrigated areas: (4) intensively irrigated areas; and (5) the Snake River.

In intensively irrigated areas, criteria should reflect the primary use of the water. Higher levels of certain parameters (i.e., suspended solids, nutrients, temperature, etc.) should be allowed in these areas since intensively irrigated agriculture, even under ideal conditions, will unavoidably contribute higher levels of these parameters. Criteria, therefore, should be based on the conditions that exist after Best Management Practices have been implemented.

IV SUMMARY AND CONCLUSIONS

Malheur River flows have been extensively altered through the construction of several dams and diversion structures designed to store and distribute water for agricultural uses. These dams, as well as others on the Snake River, to which the Malheur is tributary, block natural fish migrations in the river and, thus, have permanently altered the river's fisheries. In addition, water quality below Namorf Dam has been affected, primarily through agricultural practices, in a way which severely restricts the type of fish that can successfully inhabit the water. One important factor which affects fish populations below Namorf is the high suspended solids loading which effectively selects against sight-feeding species. Other conditions which could affect the types and survival of fish species below Namorf include low flow during the fall and winter when reservoirs are being filled in preparation for the coming irrigation season, as well as high suspended solids, and high temperatures during the summer irrigation season.

Realistically, the Malheur River could not be returned to its natural state unless a large number of hydraulic structures were removed. Removal of these structures would result in the demise of agriculture in the region, which is the mainstay of the county's economy. Furthermore, removal of these structures is out of the question due to the legal water rights which have been established in the region. These water rights can only be satisfied through the system of dams, reservoirs, and diversions which have been constructed in the river system. Thus, the changes in the Malheur River Basin are irrevocable.

Physical barriers to fish migration coupled with the effects of high sediment loads and the hydraulics of the system have for years established the uses of the river. Given the existing conditions and uses of the Malheur River below the Namorf Diversion, classification of this river each should be changed from a salmonid fishery, a use that cannot be achieved, to achievable uses which are based on the existing resident fish populations and aquatic life to reflect the present and highest future uses of the river. Such a change in designated beneficial uses would not further jeopardize existing aquatic life in the river, nor would it result in any degradation in water quality.

WATER BODY SURVEY AND ASSESSMENT
Pecan Bayou
Brownwood, Texas

I. INTRODUCTION

A. Site Description

Segment 1417 of the Colorado River Basin (Pecan Bayou) originates below the Lake Brownwood Dam and extends approximately 57.0 miles to the Colorado River (Figure 1). The Lake Brownwood Dam was completed in 1933. Malfunction of the dam's outlet apparatus led to its permanent closure in 1934. Since that time, discharges from the reservoir occur only infrequently during periods of prolonged high runoff conditions in the watershed. Dam seepage provides the base flow to Pecan Bayou (Segment 1417). The reservoir is operated for flood control and water supply. The Brown County WID transports water from the reservoir via aqueduct to Brownwood for industrial distribution, domestic treated water distribution to the Cities of Brownwood and Bangs and the Brookesmith Water System, and irrigation distribution. Some irrigation water is diverted from the aqueduct before reaching Brownwood.

Pecan Bayou meanders about nine miles from Lake Brownwood to the City of Brownwood. Two small dams impound water within this reach, and Brown County WID operates an auxilliary pumping station in this area to supply their system during periods of high demand.

Two tributaries normally provide inflow to Pecan Bayou. Adams Branch enters Pecan Bayou in Brownwood. The base flow consists of leaks and overflow in the Brown County WID storage reservoir and distribution system. Willis Creek enters Pecan Bayou below Brownwood. The base flow in Willis Creek is usually provided by seepage through a soil conservation dam.

The main Brownwood sewage treatment plant discharges effluent to Willis Creek one mile above its confluence with Pecan Bayou. Sulfur Draw, which carries brine from an artesian salt water well and wastewater from the Atchison, Topeka and Santa Fe Railroad Co., enters Willis Creek about 1,700 feet below the Brownwood sewage treatment plant. Below the Willis Creek confluence, Pecan Bayou meanders about 42.6 miles to the Colorado River, and receives no additional inflow during dry weather conditions. Agricultural water withdrawals for irrigation may significantly reduce the streamflow during the growing season.

The Pecan Bayou drainage basin is composed primarily of range and croplands. The stream banks, however, are densely vegetated with trees, shrubs and grasses. The bayou is typically 10-65 feet wide, 2-3 feet deep, and is generally sluggish in nature with soft organic sediments.

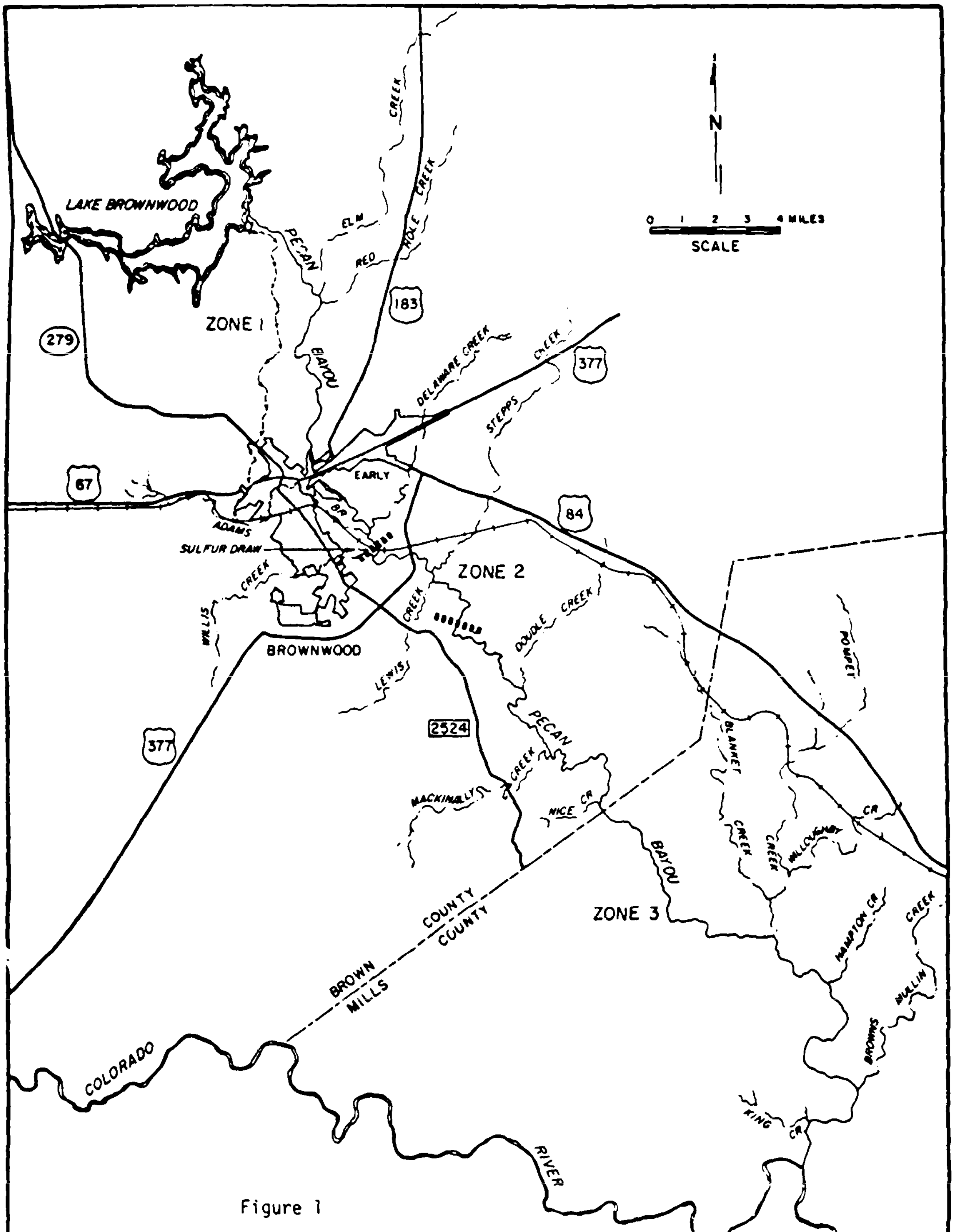


Figure 1

PECAN BAYOU SEGMENT MAP

B. Problem Definition

The designated water uses for Pecan Bayou include noncontact recreation, propagation of fish and wildlife, and domestic raw water supply. Criteria for dissolved oxygen (minimum of 5.0 mg/l), chlorides, sulfates, and total dissolved solids (annual averages not to exeed 250, 200, and 1000 mg/l, respectively), pH (range of 6.5 to 9.0) fecal coliform (log mean not to exceed 1000/100 ml), and temperature (maximum of 90°F) have been established for the segment.

Historically, Pecan Bayou is in generally poor condition during summer periods of low flow, when the Brownwood STP contributes a sizeable portion of the total stream flow. During low flow conditions, the stream is in a highly enriched state below the sewage outfall.

Existing data indicate that instream dissolved oxygen concentrations are frequently less than the criterion, and chloride and total dissolved solids annual average concentrations occasionally exceed the established criteria. The carbonaceous and nitrogenous oxygen deficencies in Pecan Bayou. The major cause of elevated chlorides in Pecan Bayou is the artesian brine discharge in to Sulfur Draw.

Toxic compounds (PCB, DDT, DDD, DDE, Lindane, Heptachlor epoxide, Dieldrin, Endrin, Chlordane, Pentachlorophenol, cadmium, lead, silver, and mercury) have been observed in water, sediment and fish tissues in Pecan Bayou (mainly below the confluence with Willis Creek). It has been determined that the major source was the Brownwood STP, but attempts to specifiy the points of origin further have been unsuccessful. However, recent levels show a declining trend.

C. Approach to Use Attainability

Assessment of Pecan Bayou is based on a site visit which included meetings with representatives of the State of Texas, EPA (Region VI and Headquarters) and Camp Dresser & McKee Inc., and upon information contained in a number of reports, memos and other related materials.

It was agreed by those present during the site visit that the data and analyses contained in these documents were sufficient for an examination of the existing designated uses of Pecan Bayou.

II. ANALYSES CONDUCTED

An extensive amount of physical, chemical, and biological data has been collected on Pecan Bayou since 1973. Most of the information was gathered to assess the impact of the Brownwood STP on the receiving stream. In order to simplify the presentation of these data, Pecan Bayou was divided into three zones (Figure 1): Zone 1 is the control area and extends from the Lake Brownwood Dam (river mile 57.0) to the Willis Creek confluence (river mile 42.6); Zone 2 is the impacted area and extends 9.0 miles below the Willis Creek confluence.

A. Physical Evaluation

With the exception of stream discharge, the physical characteristics of Pecan Bayou are relatively homogeneous by zone. Average width of the stream is about 44-50 feet, and average depth ranges from 2.1 to 3.25 feet. The low gradient (2.8 to 3.9 ft/mile) causes the bayou to be sluggish (average velocity of about 0.1 ft/sec), reaeration rates to be low (K_2 of 0.7 per day at 20°C), and pools to predominate over riffles (96% to 4%). Stream temperature averages about 18°C and ranges from 1-32°C. The substrate is composed primarily of mud (sludge deposits dominate in Zone 2), with small amounts of bedrock, gravel and sand being exposed in riffle areas.

Base flow in Pecan Bayou is provided by dam seepage (Zone 1) and the treated sewage discharge from the City of Brownwood (Zones 2 and 3). Median flow increases in a downstream direction from 2.5 cfs in Zone 1 to 17.4 cfs in Zone 3. Significantly higher mean flows (118 cfs in Zone 1 and 125 cfs in Zone 3) are the result of periodic high rainfall runoff conditions in the watershed.

B. Chemical Evaluation

Existing chemical data of Pecan Bayou characterize the degree of water quality degradation in Zone 2. Average dissolved oxygen levels are about 2.0 mg/l lower in the impact zone, and approximately 50% of the observations have been less than 5.0 mg/l. BOD_5, ammonia, nitrite, nitrate, and phosphorus levels are much higher in the impact zone as compared to the control and recovered zones. Un-ionized ammonia levels are also higher in Zone 2, but most of the concentrations were below the reported chronic levels allowable for warm water fishes. None of the levels exceeded the reported acute levels allowable for warm water fishes, and less than 4% of the levels were between the acute and chronic levels reported. Total dissolved solids, chlorides and sulfates were higher in Zones 2 and 3, mainly as a result of the brine and sewage discharges into Sulfur Draw and Willis Creek.

PCB, DDT, DDD, DDE and Lindane in water, and PCB, DDD, and DDE, Heptachlor epoxide, Dieldrin, Endrin, Chlordane, and Pentachlorophenol in sediment have been detected in Zone 2. PCB, DDT, DDD, and DDE concentrations in water have exceeded the criteria to protect freshwater aquatic life. The Brownwood STP was the suspected major source of these pesticides. Most of the recent levels, however, show a declining trend. PCB was detected also in Zones 1 and 3.

Heavy metals have not been detected in the water. Heavy metals in the sediment have shown the highest levels in Zone 2 for arsenic (3.7 mg/kg), cadmium (1.1 mg/kg), chromium (17.4 mg/kg), copper (9.5 mg/kg), lead (25.1 mg/kg), silver (1.5 mg/kg), zinc (90 mg/kg), and mercury (0.18 mg/kg).

C. Biological Evaluation

Fish samples collected from Zone 1 are representative of a fairly healthy population of game fish, rough fish and forage species. Zone 2 supported a smaller total number of fish which were composed primarily of rough fish and forage species. A relatively healthy balance of game fish, rough fish and forage species reappeared in the recovered zone.

Macrophytes were sparse in Zones 1 and 3. They were most abundant in Zone 2 below the Willis Creek confluence and were composed of vascular plants (pondweed, coontail, false loosestrife and duckweed) and filamentous algae (Cladophora and Hydrodictyon). Macrophyte abundance below Willis Creek is most likely due to nutrient enrichment of the area from the Brownwood STP.

Zone 1 is represented by a fairly diverse macrobenthic community characteristic of a clean-water mesotrophic stream. Nutrient and organic enrichment in Zone 2 has a distinct adverse effect as clean-water organisms are replaced by pollution-tolerant forms. Some clean-water organisms reappeared in Zone 3 and pollution-tolerant forms were not as prevalent; however, recovery to baseline conditions (Zone 1) was not complete.

Net phytoplankton desnities are lowest in Zone 1. Nutrient and organic enrichment in Zone 2 promotes a marked increase in abundance. Peak abundance was observed in the upper part of Zone 3. The decline below this area was probably caused by biotic grazing and/or nutrient deficiencies.

Fish samples for pesticides analyses have revealed detectable levels of PCB, DDE and DDD in Zone 1. Fish collected from zone 2 contained markedly higher amounts of DDE, DDD, DDT, Lindane and Chlordane than Zones 1 or 3. PCB in fish tissue was highest in ZOne 3, and measureable concentrations of DDE and DDD have also been observed. Concentrations of total DDT in whole fish tissues from Zone 2 have exceeded the USFDA Action Level of 5.0 mg/kg for edible fish tissues. Species representing the highest concentrations.

Computer modeling simulation were made to predict the dissolved oxygen profile in the impact zone during the fish spawning season. The results indicate that about three miles of Pecan Bayou in April and May and about 4 1/2 miles in June will be unsuitable for propogation, considering a minimum requirement of 4.0 mg/l. The model predicts a minimum D.O. of 0.8 mg/l in April, 1.2 mg/l in May, and 0 mg/l in June.

D. Institutional Evaluation

Two institutional factors exist which constrain the situation that exists in Pecan Bayou. These are the irrigation water rights and the Brownwood sewage treatment plant discharge permits. Although the sewage treatment plant discharge permits will expire and the problems created by the effluent could be eliminated in the future, there is a need for the flow provided by the discharge to satisfy the downstream water rights used for irrigation. Currently, there are eight water users on Pecan Bayou downstream of the Brownwood STP discharge with water rights permits totaling 2,957 acre-feet/year. Obviously, the 0.1 cfs base flow which exists in Pecan Bayou upstream of the STP discharge is not sufficient to fulfill these downstream demands. Therefore, it appears that the STP flow may be required to supplement the base flow in Pecan Bayou to meet the downstream demands for water unless it could be arranged that water from Lake Brownwood could be released by the Brown Co. WID #1 to meet the actual downstream water needs.

Modeling studies show that although there would be some improvement in water quality as a result of the sewage treatment plant going to advanced waste treatment (AWT), there would still be D.O. violations in a portion of Pecan Bayou in Zone 2. The studies also show that there is minimal additional water quality improvement between secondary and advanced waste treatment, although the costs associated with AWT were significantly higher than the cost for secondary treatment. In this case, the secondary treatment alternative would be the recommended course of action.

III. FINDINGS

A. Existing Uses

Pecan Bayou is currently being used in the following ways:

- Domestic Raw Water Supply
- Propagation of Fish and Wildlife
- Noncontact Recreation
- Irrigation
- City of Brownwood STP discharge (not an acceptable or approved use designation)

Use as a discharge route for the City of Brownwood's sewage treatment plant effluent has contributed to water quality conditions which are unfavorable to the propagation of fish and wildlife in a portion of Pecan Bayou.

B. Potential Uses

The Texas Department of Water Resources has established water uses which are deemed desirable for Pecan Bayou. These uses include: noncontact recreation, propagation of fish and wildlife, and domestic raw water supply.

Of these uses, propagation of fish and wildlife is unattainable in a portion of Pecan Bayou due to the effects of low dissolved oxygen levels in the bayou primarily during the spawning season. If the Brownwood sewage treatment plant effluent could be removed from Pecan Bayou, the persistently low dissolved oxygen conditions which exist and are unfavorable to fish spawning could be alleviated and the propagation of fish and wildlife could be partially restored to Pecan Bayou.

Public hearings held on the proposed expansion of the sewage treatment plant indicate a reluctance from the public and the City to pay for higher treatment levels, since modeling studies show minimal water quality improvement in Pecan Bayou between secondary and advanced waste treatment. In addition, an affordability analysis performed by the Texas Department of Water Resources (Construction Grants) indicates excessive treatment costs per month would result at the AWT level.

It appears that the elimination of the waste discharge from Pecan Bayou is not presently a feasible alternative, since the Brownwood STP currently holds a discharge permit and the water rights issue seems to be the overriding factor. Therefore, in the future, the uses which are most likely to exist are those which exist at present.

IV. SUMMARY AND CONCLUSIONS

A summary of the findings from the use attainability analysis are listed below:

- ° The designated use "propagation of fish and wildlife" is impaired in Zone 2 of Pecan Bayou.
- ° Advanced Treatment will not attain the designated use in Zone 2, partially because of low dilution, naturally sluggish characteristics (X velocity 0.1 ft/sec) and as a result, low assimlitive capacity of the bayou (K_2 reaeration rate 0.7 per day at 20°C).
- ° Downstream water rights for agricultural irrigation are significant.
- ° Dissolved oxygen levels are frequently less than the criterion of 5.0 mg/l in Pecan Bayou.
- ° Total DDT in whole fish from Zone 2 exceeded the U.S. Food and Drug Administration's action level of 5.0 mg/kg for edible fish tissues.
- ° Annual average chloride concentrations in Pecan Bayou are occasionally not in compliance with the numerical criteria.

Dissolved oxygen levels less than 5.0 mg/l (about 50% of the measurements) observed in Zone 2 of Pecan Bayou result from the organic and nutrient loading contributed by the Brownwood STP and the corresponding low waste assimilative capacity of the bayou. As previously mentioned, the major source of toxics found in the water, sediment and fish tissues was also determined to be the Brownwood STP. PCB and DDT in water have exceeded the criteria to protect freshwater aquatic life in Zone 2. Although the toxics appear to be declining in the water and sediment, the levels of total DDT found in whole fish exceed the U. S. Food and Drug Administration's action level (5.0 mg/k) for DDT in edible fish tissue. Investigations are underway by the Texas Department of Water Resources to further evaluate the magnitude of this potential problem.

Primarily as a result of the oxygen deficiencies and possibly be cause of the presence of toxic substances, the designated use "propagation of fish and wildlife" is not currently attained in Zone 2 of Pecan Bayou. These problems could be eliminated only if the Brownwood STP ceased to discharges into Pecan Bayou because even with advanced waste treatment the water quality of the receiving stream is not likely to improve sufficiently to support this designated use. Other treatment alternatives such as land treatment or overland flow are not feasible because of the current discharge is necessary to satisfy downstream water rights for agricultural irrigation. If the flow required to meet the water rights could be augmented from other sources, then the sewage treatment plant discharge could be eliminated in the future.

The annual average chloride level in Pecan Bayou are occasionally not in compliance with the established criterion. The primary source has been determined to be a privately owned salt water artesian well. Since efforts to control this discharge have proved futile, some consideration should be given to changing the numerical criterion for chlorides in Pecan Bayou.

In conclusion, it appears that either the Brownwood STP discharge into Pecan Bayou should be eliminated (if an alternative water source could be found to satisy the downstream water rights) or the numerical criterion for dissolved oxygen and the propogation of fish and wildlife use designation should be changed to reflect attainable conditions.

WATER BODY SURVEY AND ASSESSMENT
Salt Creek
Lincoln, Nebraska

I. INTRODUCTION

A. Site Description

The Salt Creek drainage basin is located in east central Nebraska. The mainstem of Salt Creek originates in southern Lancaster County and flows northeast to the Platte River (Figure 1). Ninety percent of the 1,621 square mile basin is devoted to agricultural production with the remaining ten percent primarily urban. The basin is characterized by moderately to steeply rolling uplands and nearly level to slightly undulating alluvial lands adjacent to major streams, primarily Salt Creek. Drainage in the area is usually quite good with the exception of minor problems sometimes associated with alluvial lands adjacent to the larger tributaries. Soils of the basin are of three general categories. Loessial soils are estimated to make up approximately 60 percent of the basin, glacial till soils 20 percent, and terrace and bottomland soils 20 percent.

Frequent high intensity rainfalls and increased runoff from land used for crop production has, in past years, contributed to flood damage in Lincoln and smaller urbanized areas downstream. To help alleviate these problems, flood control practices have been installed in the watershed. These practices, including several impoundments and channel modifications to the mainstream of Salt Creek, were completed during the late 1960's. Channel realignment of the lower two-thirds of Salt Creek has decreased the overall length of Salt Creek by nearly 34 percent (from 66.9 to 44.3 miles) and increased the gradient of the stream from 1.7 feet/mile to 2.7 feet/mile.

Salt Creek is currently divided into three classified segments: (upper reach) LP-4, (middle reach) LP-3a, and (lower reach) LP-3b. (Figure 1). Segments LP-4 and LP-3b are designated as Warmwater Habitats whereas segment LP-3a is designated as a Limited Warmwater Habitat.

B. Problem Definition

"Warmwater Habitat" and "Limited Warmwater Habitat" are two subcategories of the Fish and Wildlife Protection use designation in the Nebraska Water Quality Standards. The only distinction between these two use classes is that for Limited Warmwater Habitat waters, reproducing populations of fish are "...limited by irretrievable man-induced or natural background conditions." Although segment LP-3a is classified Limited Warmwater Habitat and segment LP-3b as Warmwater Habitat, they share similar physical characteristics. Since the existing fisheries of both segments were not thoroughly evaluated when the standard was revised, it is possible that the use designation for one or other segments is incorrect. This study was initiated to determine (1) if the Warmwater Habitat use is attainable for segment LP-3a and (2) what, if any, physical habitat or water quality constraints preclude the attainment of this use.

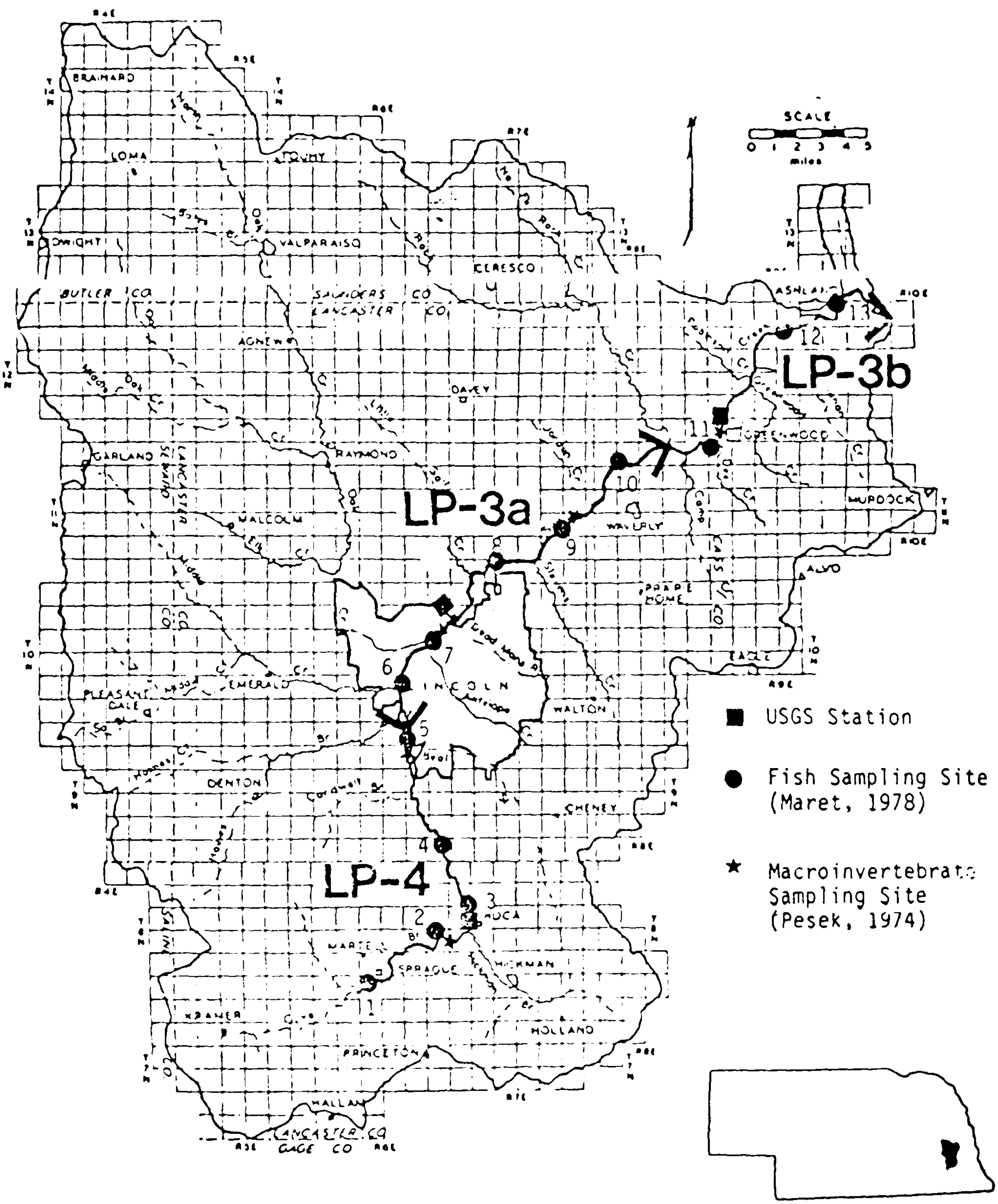


Figure 1. Monitoring sites from which data were used for Salt Creek attainability study.

C. Approach to Use Attainability Analysis

The analytical approach used in this study was a comparison of physical, chemical and biological parameters between the upper, middle, and lower Salt Creek segments with emphasis was on identifying limiting factors in the creek. The uppermost segment (LP-4) was used as the standard for comparison.

The data base used for this study included United States Geological Survey (USGS) and Nebraska Department of Environmental Control (NDEC) water quality data outlined in the US EPA STORET system, two Master of Science theses by Tom Pesek and Terry Maret, publications from the Nebraska Game and Parks Commission and USGS and personal observations by NDEC staff. No new data was collected in the study.

II. ANALYSES CONDUCTED

A review of physical, chemical and biological information was conducted to determine which aquatic life use designations would be appropriate. Physical characteristics for each of the three segments were evaluated and then compared to the physical habitat requirements of important warm water fish species. Characteristics limiting the fishery population were identified and the suitability of the physical habitat for maintaining a valued fishery was evaluated. General water quality comparisons were made between the upper reach of Salt Creek, and the lower reaches to establish water quality differences. A water quality index developed by the NDEC was used in this analysis to compare the relative quality of water in the segments. In addition, some critical chemical constituents required to maintain the important species were reviewed and compared to actual instream data to determine if water quality was stressing or precluding their populations.

The fish data collected by Maret was used to define the existing fishery population and composition of Salt Creek. This data was in turn used to determine the quality of the aquatic biota through the use of six biotic integrity classes of fish communities and the Karr Index tentative numerical index for defining class boundaries.

Macroinvertebrate data based on the study conducted by Pesek was also evaluated for density and diversity.

III. FINDINGS

Chemical data evaluated using the Water Quality Index indicated good water quality above Lincoln and degraded water quality at and below Lincoln. Non-point source contributions were identified as a cause of water quality degradation and have been implicated in fish kills in the stream. Dissolved solids in Salt Creek were found to be considerably higher than in other streams in the State. Natural background contributions are the major source of dissolved solids load to the stream. Water quality criteria violations monitored in Salt Creek during 1980 and 1981 were restricted to unionized ammonia and may have adversely impacted the existing downstream fishery. Toxics which occasionally approach or exceed the EPA criteria are chromium and lindane. Since EPA criteria for both parameters are based on some highly sensitive organisms which are not representative of indigenous populations typically found in Nebraska, the actual impact of these toxics is believed to be minimal.

Channelization was found to be a limiting factor in establishing a fishery in middle and lower Salt Creek. Terry Maret, in his 1977 study, found that substrate changes from silt and clay in the upper non-channelized area to primarily sand in the channelized area causing substantial changes in fish communities. The Habitat Suitability Index (HSI) developed by the Western Energy and Land Use Team of the U.S. Fish and Wildlife Service was used to evaluate physical habitat impacts on one important species (Channel Catfish) of fish in Salt Creek. The results indicated that upper Salt Creek had the best habitat for the fish investigated and middle Salt Creek had the worst. These results support the conclusion that middle Salt Creek lacks the physical habitat to sustain a valued warm water fishery. The Karr numerical index used to evaluate the fish data revealed that none of the stations rated above fair, further indicating the fish community is significantly impacted by surrounding rural and urban land uses.

Analysis of the abundance and diversity of macroinvertebrates indicated that the water quality in Salt Creek became progressively more degraded going downstream. Stations in the upper reaches were relatively unpolluted as characterized by the highest number of taxa, the greatest diversity and the presence of "clean-water" organisms.

IV. SUMMARY AND CONCLUSIONS

Based on the evaluation of the physical, chemical and biological characteristics of Salt Creek, the following conclusions were drawn by the State for the potential uses of the various segments:

1) Current classifications adequately define the attainable uses for upper and middle Salt Creek.

2) The Warmwater Habitat designated use may be unattainable for lower Salt Creek.

3) Channelization has limited existing instream habitat for middle Salt Creek. Instream habitat improvement in middle Salt Creek could increase the fishery but would lessen the effectiveness of flood control measures. Since flood control benefits are greater than any benefits that could be realized by enhancing the fishery, instream physical habitat remained the limiting factor for the fishery.

4) Existing water quality does not affect the limited Warmwater Habitat classification of middle Salt Creek.

5) Uncontrollable background source impacts on existing water quality and the effects of channelization on habitat may preclude attainment of the classified use.

The recommendations of the State drawn from these conclusions are as follows:

1) Keep upper section classification of Warmwater Habitat and middle section classification of Limited Warmwater Habitat.

2) Consider changing the lower section to a Limited Warmwater Habitat because of limited physical habitat and existing water quality.

WATER BODY SURVEY AND ASSESSMENT
South Fork Crow River
Hutchinson, Minnesota

I. INTRODUCTION

A. Site Description

The South Fork Crow River, located in south-central Minnesota, drains a watershed that covers approximately 1250 square miles. This river joins with the North Fork Crow to form the mainstem Crow River which flows to its confluence with the Mississippi River (Figure 1). Within the drainage basin, the predominant land uses are agricultural production and pasture land. The major soil types in the watershed are comprised of dark-colored, medium-to-fine textured silty loams, most of which are medium to well drained in character.

The physical characteristics of the South Fork Crow River are typical of many Minnesota streams flowing through agricultural lands. The upper portions of the river have been extensively channelized and at Hutchinson a forty foot wide, 12 foot high dam forms a reservoir west of the city. Downstream of the dam the river freely meanders through areas with light to moderately wooded banks to its confluence with the North Fork River Crow River. The average stream gradient for this section of the river is approximately two feet per mile and the substrate varies from sand, gravel and rubble in areas with steeper gradients to a silt-sand mixture in areas of slower velocities.

The average annual precipitation in the watershed is 27.6 inches. The runoff is greatest during the spring and early summer, after snowmelt, when the soils are generally saturated. Stream flow decreases during late summer and fall and is lowest in late winter. Small tributary streams in the watershed often go dry in the fall and winter because they have little natural storage and receive little ground water contribution. The seven-day ten year low flow condition for the South Fork below the dam at Hutchinson is approximately 0.7 cubic feet per second.

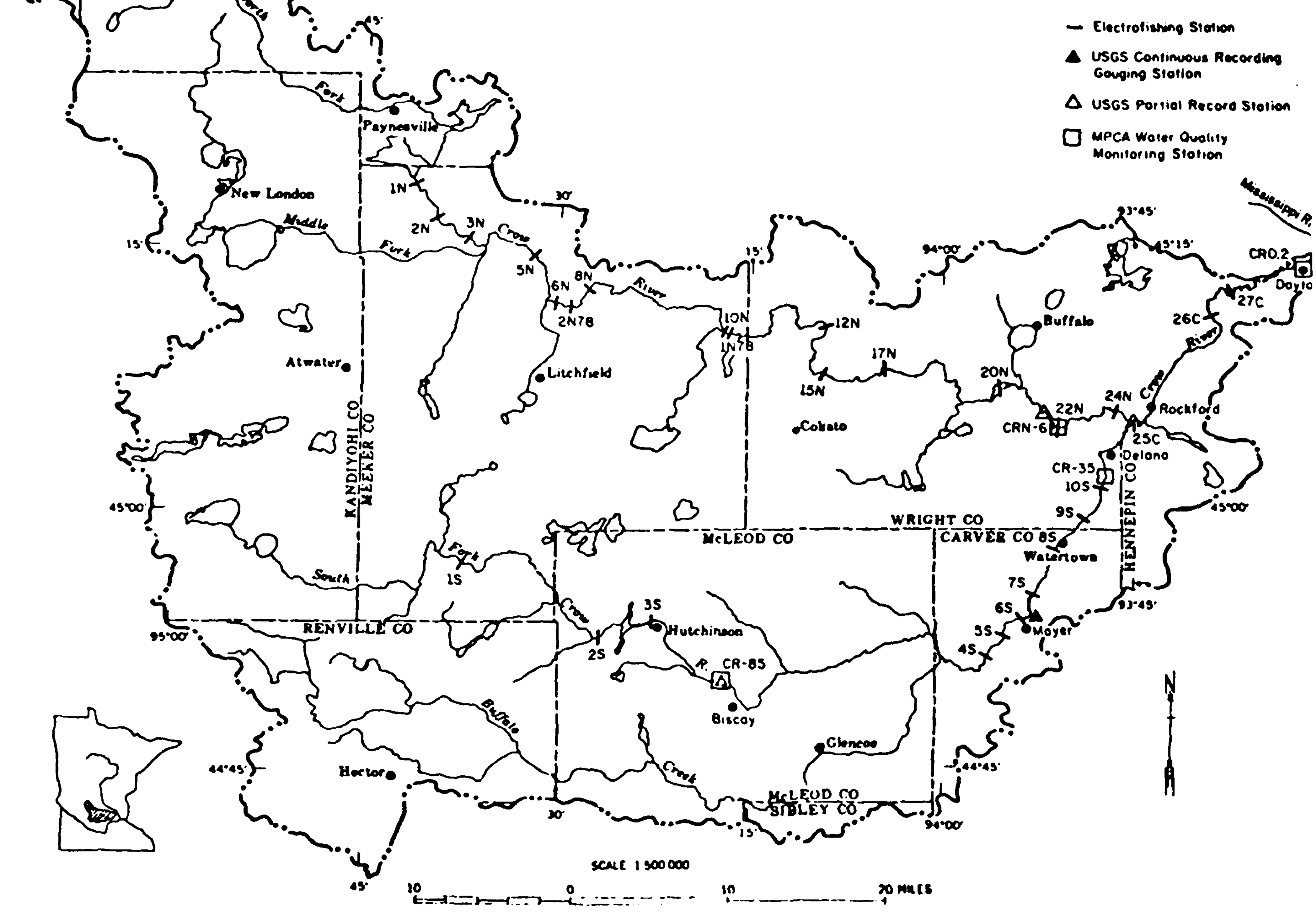
B. Problem Definition

The study on the South Fork Crow River was conducted in order to evaluate the existing fish community and to determine if the use designations are appropriate. At issue is the 2B fisheries and recreational use classification at Hutchinson. Is the water use classification appropriate for this segment?

C. Approach to Use Attainability

The analysis utilized an extensive data base compiled from data collected by the Minnesota Pollution Control Agency (MPCA), Minnesota Department of Natural Resources (MDNR) and United States Geological Survey (USGS). No new data was collected as part of the study. The USGS maintains partial or continuous flow record stations on both forks

FIGURE 1. STATION LOCATIONS FOR THE SOUTH FORK CROW RIVER USE ATTAINABILITY STUDY



and the mainstem Crow River with a data base of physical and chemical parameters available on STORET. The USGS data was used in the physical evaluation of the river. MPCA has a water quality monitoring data base on STORET for five stations in the Crow River watershed. The MPCA data plus analytical data from a waste load allocation study on the South Fork below Hutchinson was used in the chemical evaluation of the river. MDNR fisheries and stream survey data, a MDNR report on the analysis of the composition of fish populations in Minnesota rivers, and personal observations of MDNR personnel was used to evaluate the biological characteristics of the river.

The analytical approach used by the MPCA sought to 1) compare instream fish community health of the South Fork to that of the North Fork, the mainstem Crow River, and other warm water rivers in the State and 2) evaluate physical and chemical factors affecting fisheries and recreational uses. The North Fork of the Crow River was used for comparison because of sufficient fisheries data, similar land uses and morphologies, similar non-point source impacts and the lack of any significant point source dischargers.

II. ANALYSES CONDUCTED

Physical, chemical and biological factors were considered in this use attainability analysis to determine the biological health of the South Fork and to define the physical and chemical factors which may be limiting. A general assessment of the habitat potentials of the South Fork Crow River was performed using a habitat evaluation rating system developed by the Wisconsin Department of Natural Resources. In addition, the Tennant method for determining instream flow requirements was also employed in this study.

Fish species diversity, equitability and composition were used to define the biological health of the South Fork relative to that of the North Fork, the mainstem Crow and other warmwater rivers in Minnesota. Water quality monitoring data from stations above and below the point source discharges at Hutchinson were used to compare beneficial use impairment values pertaining to the designated fisheries and recreational uses of the South Fork Crow River. A computer data analysis program developed by EPA Region VIII was used to compute these values.

III. FINDINGS

The comparison of species diversity values for the North Fork and mainstem Crow River to the South Fork showed higher values for the North Fork and mainstem Crow. On the other hand, the South Fork had higher species equitability values. The percent species composition compared favorably to Peterson's (1975) estimates for median species diversity for a larger Minnesota river. Recruitment from tributaries, marshes, lakes and downstream rivers has given the South Fork a relatively balanced community which compares well to other warmwater rivers in the State. The calculated species diversity and equitability indices coupled with the analysis of species composition indicated that the South Fork of the Crow River does support a warmwater fishery with evidence of some degree of environmental stress.

The MPCA employed the Wisconsin habitat rating system and the Tennant method designated to quantify minimum instream fisheries flow requirements to identify any physical limiting factors. Based on the Wisconsin habitat evaluation assessment, habitat rating score were fair. The limiting factors identified via this assessment were: 1) lack of diverse streambed habitat suitable for reproduction, food production and cover and 2) instream water fluctuations (low flow may be a major controlling factor).

The State utilized EPA Region VIII's data analysis program to express stream water quality as a function of beneficial use. The closest downstream station to Hutchinson had the highest warmwater aquatic life use impairment values. Warmwater aquatic life use impairment values declined further downstream indicating that the point source dischargers were major contributors to this use impairment. However, primary contact recreational use impairment values were high throughout the stream. This led the State to believe that the impairment of primary contact recreational use is attributable to non-point sources.

IV. SUMMARY AND CONCLUSION

The State concluded from the study that: 1) the South Fork of the Crow River has a definite fisheries value although the use impairment values indicate some stress at Hutchinson on an already limited resource and 2) although the South Fork of the Crow River has a dominant rough fish population, game and sport fish present are important component species of this rivers' overall community structure.

From these conclusions the State recommended that the South Fork of the Crow River retain its present 2B fisheries and recreational use classification. Furthermore, efforts should continue to mitigate controllable factors that contribute to impairment of use. The effort should entail a reduction of marsh tilling and drainage, acceptance and implementation of agricultural BMP's and an upgrade of point source dischargers in Hutchinson.

WATER BODY SURVEY AND ASSESSMENT

South Platte River
Denver, Colorado

I. INTRODUCTION

A. Site Description

Segment 14 of the South Platte River originates north of the Chatfield Lake at Bowles Avenue in Arapahoe County and extends approximately 16 miles, through metro Denver, in a northerly direction to the Burlington ditch diversion near the Denver County-Adams County line. A map of the study area is presented in Figure 1. Chatfield Lake was originally constructed for the purposes of Flood control and recreation. The reservoir is owned by the U.S. Army Corps of Engineers and is essentially operated such that outflow equals inflow, up to a maximum of 5,000 cfs. In addition, water is released to satisfy irrigation demands as authorized by the State Engineers Office. There is also an informal agreement between the State Engineers Office and the Platte River Greenway Foundation for timing releases of water to increase flows during periods of high recreational use. The Greenway Foundation has played an important role in the significant improvement of water quality in the South Platte River.

There are several obstructions throughout Segment 14 including low head dams, kayak chutes (at Confluence Park and 13th Avenue), docking platforms, and weir diversion structures which alter the flow in the South Platte River. There are four major weir diversion structures in this area which divert flows for irrigation; one is located adjacent to the Columbine Country Club, a second near Union Avenue, a third upstream from Oxford Avenue, and a fourth at the Burlington Ditch near Franklin Street.

Significant dewatering of the South Platte River can occur due to instream diversions for irrigation and water supply and pumping from the numerous ground water dwells along the river.

Eight tributaries normally provide inflow to the South Platte River in Segment 14. These include Big Dry Creek, Little Dry Creek, Bear Creek, Harvard Gulch, Sanderson Gulch, Weir Gulch, Lakewood Gulch, and Cherry Creek.

There are several municipal and industrial facilities which discharge either directly to or into tributaries of the South Platte River in this reach. The major active discharges into the segment are the Littleton-Englewood wastewater treatment plant (WWTP), the Glendale WWTP, the City Ice Company, two Public Service company power plants (Zuni and Arapahoe), and Gates Rubber.

The South Platte River drainage basin in this area (approximately 120,000 acres) is composed primarily of extensively developed urban area (residential, industrial, commercial, services, roads), parks and recreational areas, gravel mining areas, and rural areas south of the urban centers for farming and grazing.

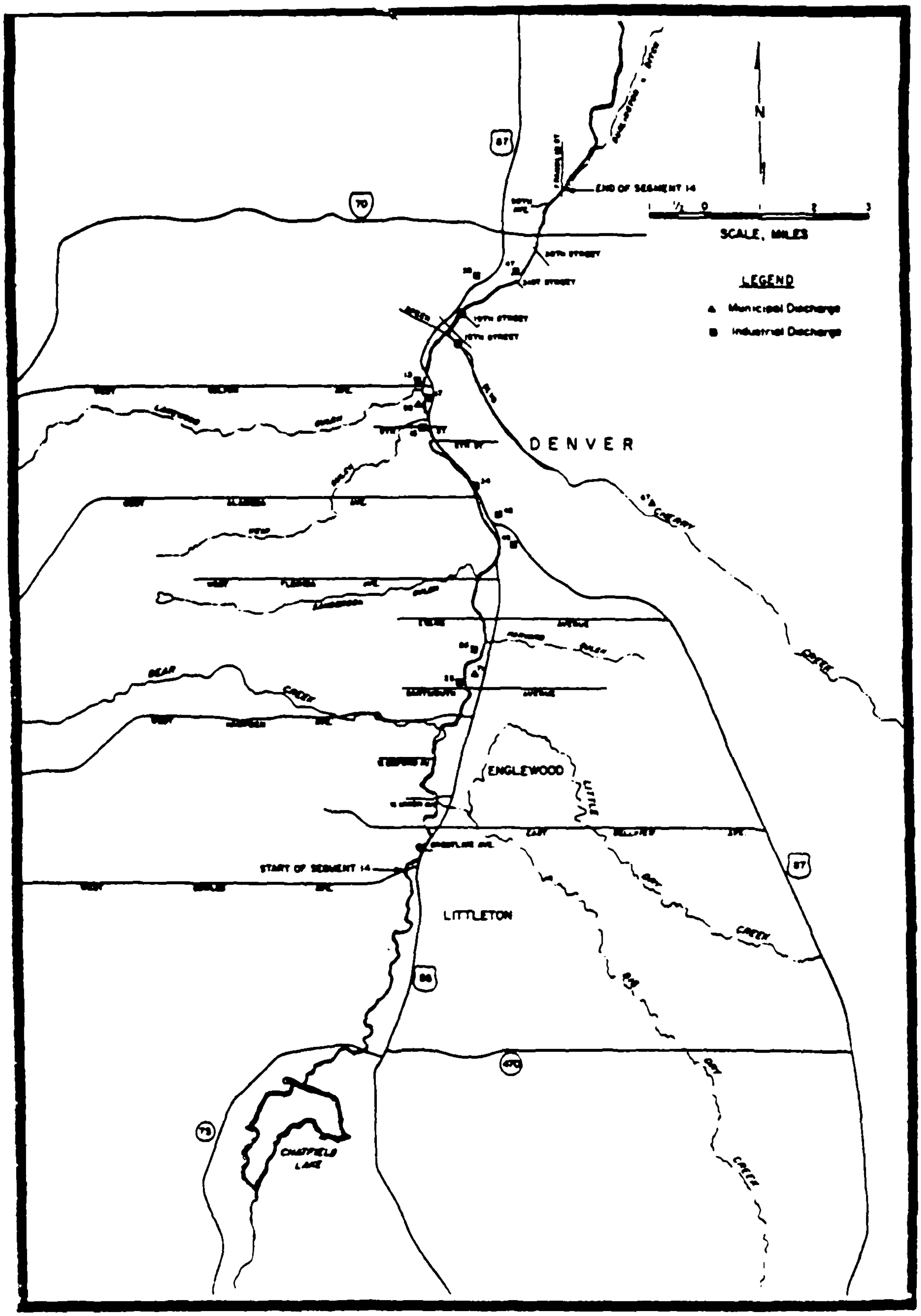


Figure 1

SOUTH PLATTE RIVER STUDY AREA MAP

In the study area, the South Platte River is typically 50-150 feet wide and 1-16 feet deep (typically 1-2 feet) and has an average channel bed slope of 12.67 feet per mile, with alternating riffle and pool reaches. The channel banks are composed essentially of sandy-gravelly materials that erode easily when exposed to high-flow conditions. The stream banks are generally sparsely vegetated with trees, shrubs, and grasses (or paving in the urban centers.)

B. Problem Definition

The following use classifications have been designated for Segment 14 of the South Platte River:

- Recreation - Class 2 - secondary contact
- Aquatic Life - Class 1 - warm water aquatic life
- Agriculture
- Domestic Water Supply

Following a review of the water quality studies and data available for Segment 14 of the South Platte River, several observations and trends in the data have been noted, including:

- Fecal coliform values exceeded the recommended limits for recreational uses in the lower portion of Segment 14.

- Un-ionized ammonia levels exceeded the water quality criterion for the protection of aquatic life in the lower portion of the segment.

- Levels of total recoverable metals (lead, zinc, cadmium, total iron, total manganese, and total copper) have been measured which exceed the water quality criteria for the protection of aquatic life.

Although the exact points of origin have not been specified, it is generally felt that the source of the ammonia is municipal point sources, and the sources of the metals are industrial point sources.

In addition, the cities of Littleton and Englewood have challenged the Class I warm water aquatic life use on the basis that the flow and habitat are unsuitable to warrant the Class I designation, and they have also challenged the apporopriateness of the 0.06 mg/l un-ionized ammonia criteria on the basis of new toxicity data. The Colorado Water Quality Control Commission in November, 1982 approved the Class I aquatic life classification and the 0.06 mg/l un-ionized ammonia criteria.

C. Approach to Use Attainability

Assessment of Segment 14 of the South Platte River was based on a site visit (May 3-4, 1982) which included meetings with representatives of the Colorado Department of Health, EPA (Region VIII and Headquarters) and Camp Dresser & McKee Inc., and upon information contained in a number of reports, hearing transcripts and the other related materials. Most of the physical, chemical and biological data was obtained from the USGS, EPA (STORET), DRURP, and from studies. It was agreed that there was sufficient chemical, physical and biological data to proceed with the assessment, even though physical data on the aquatic habitat was limited.

II. ANALYSES CONDUCTED

A. Physical Factors

Streamflow in the South Platte River (Segment 14) is affected by several factors including releases from Chatfield Dam, diversions for irrigation and domestic water supply, irrigation return flows, wastewater discharges, tributary inflows, pumping from ground water wells in the river basin, evaporation from once-through cooling at the two power plants in Segment 14, and natural surface water evaporation. Since some of these factors (particularly ground water pumping, evaporation and irrigation diversions) are variable, flow in the South Platte River is used extensively for irrigation and during the irrigation season diversions and return flows may cause major changes in streamflow within relatively short reaches. During the summer, low-water conditions prevail because of increased evaporation, lack of rainfall, and the various uses made of the river water (e.g. irrigation diversions). Municipal, industrial, and storm-water discharges also contributes to the streamflow in the South Platte River.

Natural pools in the South Platte River are scarce and the shifting nature of the channel bed results in temporary pools, a feature which has a tendency to greatly limit the capacity for bottom food production. There are approximately 3-4 pools per river mile with the majority being backwater pools upstream of diversion structures, bridge crossings, low head dams, docking platforms, drop-off structures usually downstream of wastewater treatment plant outfalls, kayak chutes, and debris. The hydraulic effect of each obstruction is generally to cause a backwater condition immediately upstream from the structure, scouring immediately downstream, and sandbar development below that. These pools act as settling basins for silt and debris which no longer get flushed during the high springs flows once Chatfield Lake was completed.

In the plains, channels of the South Platte River and lower reaches of tributaries cut through deep alluvial gravel and soil deposits. Sparse vegetation does not hold the soils, so stream bank erosion and channel bed degredation is common during periods of high flow, particularly during the spring snowmelt season. The high intensity - low duration rainstorms which occur during the summer (May, June, and July) also temporarily muddy the streams.

An evaluation of the physical streambed characteristics of Segment 14 to determine the potential of the Segment to maintain and attract warm water aquatic life was conducted by Keeton Fisheries Consultants, Inc. The study concluded that the sediment loads in this reach of the South Platte River could pose a severe problem to the aquatic life forms present, however, further study needs to be conducted to substantiate this conclusion. Furthermore, some gravel mining operations have recently been discontinued thus the sediment problem may have been reduced.

The temperature in the South Platte River is primarily a function of releases from the bottom of Chatfield Lake, the degree of warming that takes place in the shallow mainstream and isolated pools, and the warming that occurs through the mixing of power plant cooling water with the South Platte River.

B. Chemical Factors

Water quality conditions in the South Platte River are substantially affected by municipal and industrial wastewater discharges, irrigation return flows and other agricultural activities, and non-point sources of pollution (primarily during rainfall-runoff events). Irrigation and water supply diversions also exert a major influence on water quality by reducing the stream flow, and thereby reducing the dilution assimilative capacity of the river.

- Dissolved oxygen levels were above the 5.0 mg/l criteria acceptable for the maintenance of aquatic life.
- Average concentrations of un-ionized ammonia exceeded the State water quality criteria of 0.06 mg/l NH_3-N only in the lower portion of Segment 14 (north of Speer Blvd.)
- Average total lead concentrations exceeded the water quality criteria of 25 ug/l in Big Dry Creek, Cherry Creek, and the South Platte River north of Cherry Creek, ranging from 30-72 ug/l.
- Average total zinc concentrations exceeded the criteria of 11 ug/l at all the DRURP sampling stations, ranging from 19-179 ug/l.
- Average total cadmium concentrations exceeded the criteria of 1 ug/l in Beer Creek, Cherry Creek and several sites in the South Platte, ranging from 2.2-3.6 ug/l.
- Average total iron concentrations exceeded the criteria of 1,000 ug/l in Cherry Creek and several locations on the South Platte River, ranging from 1129-9820 ug/l.
- Average soluble manganese concentrations exceeded the criteria of 50 ug/l in the South Platte River north of (and including) 19th Street and in Cherry Creek, ranging from 51-166 ug/l.
- Average total copper concentrations equalled or exceeded the criteria of 25 ug/l at all but two of the DRURP sampling sites, ranging from 25-83 ug/l.

C. Biological Factors

Several electrofishing studies have been conducted on the South Platte River in recent years. Most of the sampling took place in the fall with the exception of the study in the spring (1979). The data was reviewed by Colorado Department of Health personnel and it was generally agreed that the overall health of the existing warm water fishery is restricted by temperature extremes (very cold and shallow during the winter and low flow and high temperatures during the summer), the lack of sufficient physical habitat (i.e. structures for cover including rocks and dams, and deep pools) and the potentially stressful conditions created by the wastewater discharges (i.e. silt and organic and inorganic enrichment).

Following a review of the physical, chemical, and biological data available on the South Platte River, it was concluded that a fair warm water fishery could exist with only modest habitat improvements and maintenance of the existing ambient water quality and strict regulation prevent overfishing. With large habitat and water quality improvements, brown trout could potentially become a part of the fishery in Segment 14 of the South Platte River.

III. FINDINGS

A. Existing Uses

Segment 14 of the South Platte River is currently being used in the following ways:

- Irrigation Diversions and Return Flows
- Municipal and Industrial Water Supply
- Ground Water Recharge
- Once-through Cooling
- Municipal, Industrial, and Stormwater Discharges
- Recreation
- Warm Water Fishery

The irrigation diversions, water supply, ground water recharge, and cooling uses have primarily affected the flow in the South Platte River, resulting in significant dewatering at times. Irrigation return flows and wastewater dishcharges, on the other hand, exert their effects on the ambient and storm water quality in the River. These previous uses ultimately affect the existing warm water fishery and how the public perceives the river for recreation purposes.

B. Potential Uses

With the exception of a potential for increased recreation and the improvement of a limited warm water fishery, it is anticipated that the existing uses are likely to exist in the future. The increased recreational use will result from future Platte River Greenway Foundation projects. The improvement of a limited warm water fishery may come about in the future as the result of habitat improvements (pools, cover) control of toxic materials (un-ionized ammonia, heavy metals, cynanide), and the prevention of extensive sedimentation. However, the success of the fishery would rely on strict fishery regulations to prevent overfishing.

IV. SUMMARY AND CONCLUSIONS

A summary of the findings from the use attainability analysis are listed below:

- ° There is evidence to indicate that a warm water aquatic life community does exist and the potential for an improved fishery could be attained with slight habitat modifications (i.e. cover, pool).

- ° Elevated un-ionized ammonia levels were exhibited in the lower portion of Segment 14, although this cannot be attributed to the Littleton-Englewood WWTP discharge upstream. However, at the present time there is no basis for a change in the existing un-ionized ammonia criterion, particularly if EPA's methodology for determining site specific criteria becomes widely accepted.

- ° Increased turbidity exists in the South Platte River during a good portion of the fish spawning season, which represents a potential for problems associated with fish spawning.

- ° Increased sedimentation and siltation in the South Platte River could pose a potential threat to the aquatic life present; however, this condition might be reduced if Chatfield Lake could be operated to provide periodic flushing of the river.

- ° Elevated levels of heavy metals were observed in water and sediment samples, which could potentially affect the existing aquatic life.

- ° Insufficient data existed to determine the possible effects of chlorine and cyanide on the aquatic life present.

- ° Fecal coliform levels were extremely high in the lower portion of the South Platte River and Cherry Creek during periods of both low and high flow. The source in the South Platte River is apparently Cherry Creek, but the origin in Cherry Creek is unknown at this time.

On the basis of the preceding conclusions and recommendations, the warmwater fishery use classification and the un-ionized ammonia criterion (0.06 mg/l) recommended for Segment 14 of the South Platte should remain unchanged until there is further evidence to support making those changes.