Historical Account of

PUBLIC WATER SUPPLIES

in North Carolina

by David H. Howells

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of The University of North Carolina

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The ultimate decisions as to content and presentation are those of the author and he accepts full responsibility for any errors of fact or interpretation that may still exist.

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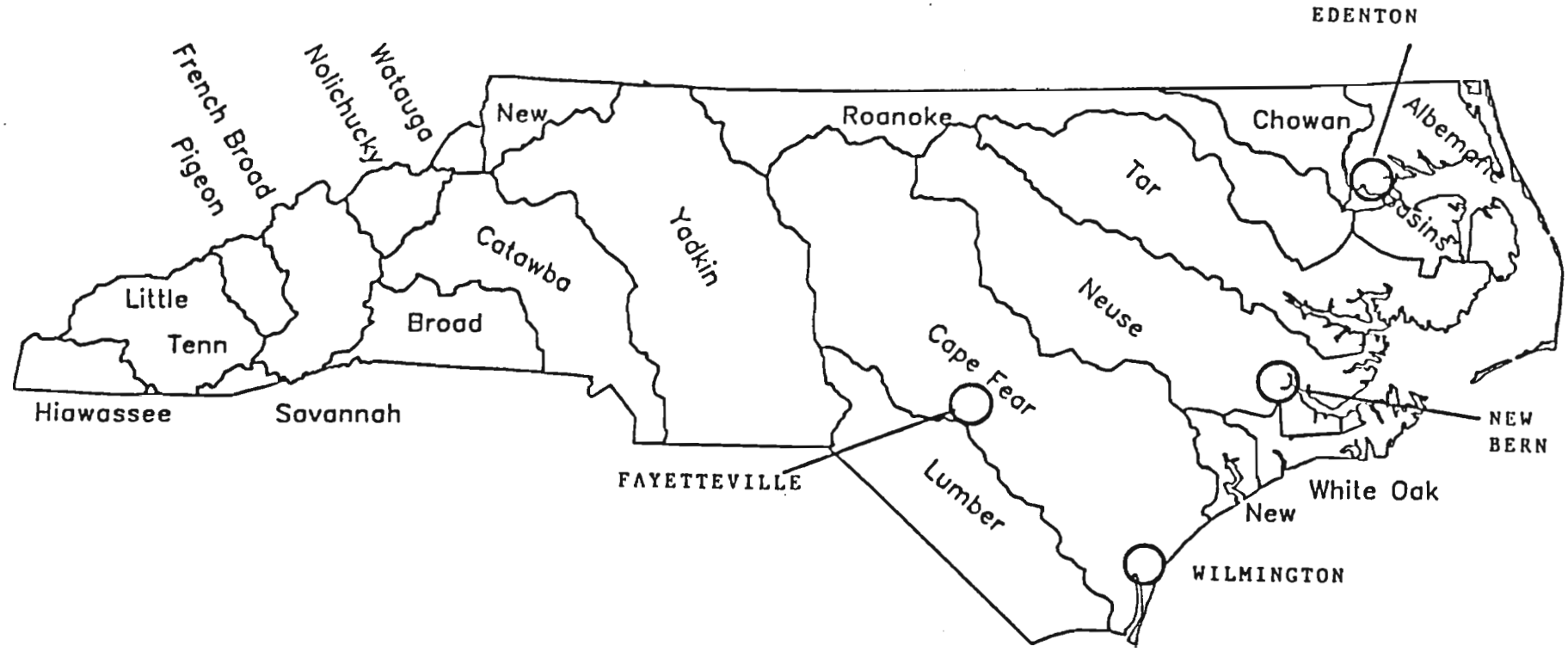
INTRODUCTION

The purpose of this report is to explore and document the North Carolina experience with respect to public water supplies in the hope that this will be useful for the guidance of future decision-making in this vitally important area. There are lessons to be learned from this experience.

History reveals that we have too often chosen to ignore the prophetic voices which urged state and local officials to change course and take the steps necessary to preserve high quality sources of public water supply. Time is now running out. The tide of development threatens to engulf the very lands that should be preserved for this vital purpose.

This historical account ultimately speaks to the urgency of major changes in public policy. While the hour is late and many opportunities have been lost, it is still possible to correct the course and move ahead on a more rational basis in the future.

Figure 1: River Basins of North Carolina with Principal Towns at Close of Eighteenth Century



I ANTEBELLUM NORTH CAROLINA

Seventeenth century North Carolina was entirely rural. The first town, Edenton, was not founded until 1700. While more than eighty towns were mentioned in acts of the General Assembly during the next century, few materialized.[1] By 1775, there were only about a dozen towns, all small and none very impressive in appearance. As the eighteenth century came to a close, only four towns had more than 1000 inhabitants. They were New Bern, Wilmington, Fayetteville, and Edenton.[2]

The center of these early towns was usually the courthouse with the stocks and whipping posts occupying a prominent place in the courthouse yard. At one end of the single street, just opposite the courthouse, were the stores and shops. Strung out along the street were the homes of the more prosperous citizens. Every "self-respecting" town of at least 500 inhabitants was said to contain a tavern, five or six retail stores, a blacksmith's shop, perhaps a shoe shop, a church or two, and a male or female academy. Some towns, such a Raleigh, Fayetteville, and Wilmington boasted a city hall, the first floor of which sometimes housed the town market. Of course, the center of activity of every town and village was the grog shop or tippling house, as the local saloon was called. Each town also had its public water pump located conspicuously at a central point to serve as a water supply for those who did not have private wells, as a watering trough for horses, and as a precaution against fire.[3]

The Threat of Fire and Municipal Water Works Development

The danger of fire was always present. Buildings were predominantly of wood construction and the water supply was inadequate to meet emergencies. Every town in the State, at one time or another, suffered great loss by fire and some of the larger towns like Wilmington, Fayetteville, and Raleigh were burned almost to the ground.[4]

Before fire companies came into general use in the 1730s, fire fighting engaged all residents. Edenton required each householder to have his own ladder and New Bern required not only a ladder, but two leather buckets as well. While Wilmington adopted a law in 1745 authorizing a tax levy for the purchase of a fire engine, it was not until 1755 that the town bought its first "water engine." The nineteenth century had arrived before adequate fire protection came to most towns in the State.[5]

By the 1840s, most of the large towns in North Carolina boasted a "city fire department." Fire engines were usually provided water from public wells, but in the case of large fires this type of source was inadequate. At one time, twelve barrels of vinegar were used in Raleigh when all water in the nearby wells had been exhausted.[6] Municipal waterworks systems developed more as a means of fire fighting than as a convenient water supply for residents.

North Carolina's First Public Water Supplies

The earliest public water supply in North Carolina came to Salem in 1778 when the Congregation Council employed a certain J. Krause to erect a municipal waterworks system.[7] Water was piped into the homes through oak pipes from a source about a mile out of town.[8] The town itself had been prudently located so as to be above flood stages of surrounding streams and below springs on higher ground from which the town could be served with water by gravity. The two most sought-after site characteristics for early North Carolina towns seems to have been an elevated ridge or hill and a plentiful water supply.[9]

Raleigh's first effort to provide an adequate supply of water for fire-fighting and other purposes reportedly came in 1818 when the Raleigh commissioners announced that after three years of work a city water system had at last been completed. The supply was said to be "sufficient to fill three underground reservoirs with a total capacity of 8000 gallons." Located in different parts of the city, the reservoirs were intended to provide sufficient water "for culinary and other purposes, and a supply always in readiness in cases of fire." The water was conveyed in wooden pipes from springs nearly a mile and a half distant before entering a "propelling engine" driven by a water wheel on Rocky Branch. The water was raised to a tower from which it descended by gravity into a reservoir in the Statehouse yard. But, the early Raleigh system was not successful. The springs ran low during droughts, the wooden conduits fell to decay, and the system was apparently abandoned.[10]

Fayetteville is said to have introduced a "town-owned" water system in 1824. Water from springs at the edge of town was collected in a brick reservoir and conveyed through "bored logs connected by iron couplings."[11]

Prior to 1881, Charlotte depended upon four cisterns for fire protection and numerous private wells for domestic use.[12]

Unsafe water supplies and other deficiencies in environmental sanitation were undoubtedly major causes of death during this period. Mortality figures for Union Forces during the Civil War disclose more than

twice as many deaths from disease as from injuries in battle. ". . .diarrhea and dysentery occurred with great frequency and occasioned a large mortality," reported Surgeon C. S. Smart, U.S. Army.[13]

II THE GREAT SANITARY AWAKENING

The indifference to hygiene and sanitation was universal and could be found among physicians and the public, alike.[14] Nevertheless, the "Great Sanitary Awakening," which arose in England through the work of Sir Edward Chadwick during the first half of the nineteenth century and subsequent publication of the "Report of the Massachusetts Sanitary Commission" by Lemuel Shattuck, had begun to influence thinking in North Carolina.[15] This resulted in the creation of the North Carolina Board of Health by the General Assembly in 1877. While the initial appropriation of $100 may have been disappointing to some, it did represent a first tentative step forward.[16] During the next two years the board published two significant reports concerning water sanitation. These were "Disinfection, Drainage, Drinking Water, and Disinfectants" and "Sanitary Engineering," by Professor William Cain of the University of North Carolina, a member of the board. As a result, the State Experiment Station chemist undertook rudimentary drinking water analyses soon thereafter.[17]

Professor Cain asserted in the early 1880s that typhoid, diphtheria, and certain enteric diseases "are common in North Carolina due to bad wells, foul yards, privies and cess pools tainting the air with their gases." "Whether we accept the germ theory or not," Cain said, "it is admitted that drinking foul water and breathing impure air debilitate the system and thus render it less able to withstand epidemics." He went on to say, "Let us then follow the natural instincts and avoid polluted air and water, especially as North Carolina can afford the pure articles in such abundance."[18]

Early analyses of drinking water were limited by the incomplete understanding of the relationship between water quality and disease and the crude analytical technology. The latter included "total solids, chlorine (chloride), free and albuminoid ammonia, and the poisonous metals." The Board of Health reported that "waters containing undue amounts of organic filth are very injurious to health" and "are the cause of cholera, typhoid fever, and diarrhoea." The analyses were thought sufficient to "judge whether the water contains such contamination."[19] State Chemist Charles W. Dabney reported in 1880 that samples of well, tank, and spring water from Durham showed "evidence of organic contamination," those from

Goldsboro "are rather better," and waters from Wilmington "are almost uniformly bad."[20] In the same year, Professor Cain prophesied that "It will probably not be long before our cities will demand purer water than can be supplied by wells and springs now used, and "adopt a public system of water supply."[21]

In 1886, The Board of Health, noting that only 12 water analyses had been made over the previous two years, expressed regret that "the State is so backward in this matter of such vital importance to her citizens." It viewed contaminated drinking water "as one of the commonest and most persistent sources of disease and death with which we have to combat."[22]

The Dangers of Shallow Wells

Civil engineer Arthur Winslow reported in 1887 that with two or three exceptions Raleigh drinking water came from private wells located within house lots or public wells on street corners. Wells were described as walled with loose rock with an average depth of 30-40 feet. The top 10-12 feet of public wells was said to be "cement-lined" in many cases and the ground surface prepared to prevent entry of surface water.[23] He went on to say that "in country places and small towns rainwater ranks among the purest and best for all household uses." His comment "There is considerable evidence going to show that in many cases malaria is due to the character of well waters," illustrates the shaky underpinnings of public health in that period.[24]

On the coast, Wilmington was faring about the same as its upland neighbors. By 1880, "the Public mind in Wilmington," was reported to be "agitated on the question of water supply" and the matter was to be remedied by "the erection of water works at no distant day."[25] Sanitation was reportedly poor with private wells and privies indiscriminantly intermingled.[26] "Bad water," it was said, "is one of the most efficient agents in spreading disease."[27]

Issues in the Development of Early Water Supply Systems

In 1881, concerned citizens of Wilmington took action to replace private wells and cisterns with a system to serve the main part of the City. They organized the Clarendon Water Works Company and started the erection of a plant on the Northeast Cape Fear River just upstream from the city. Water was drawn directly from the river with no treatment. The purpose at that time was to use the water for fire fighting and flushing of sewers. Water for domestic use was reportedly obtained from "deep wells"

along city streets or on private property. Contaminated shallow wells continued to contribute to a high incidence of typhoid and other enteric diseases and the death rate from these causes was high.[28] One health official commented at the time that the Cape Fear River water source was not studied systematically "because the business interests involved were by no means identical with the sanitary interests."[29] "The chief obstacle to a wise selection of a water supply," he said, "is the money element. . .a question of profit to investors."[30]

When John Burton surveyed the 21 acres of mountain land which later became Asheville, he picked an area with an abundance of spring water. Incorporated in 1797, the town was named in honor of Samuel Ashe, who was governor of North Carolina at the time. Water became a major problem for the community once it became popular as a health and summer resort. The first water system consisted of a small reservoir on Beaucatcher Mountain fed from springs through wooden flumes. Wood stave pipe conveyed the water to several watering centers in town. Wells were also dug to provide water to areas not served by this system. Following incorporation in 1883, the city constructed a pump and filter plant on the Swannanoa River four miles east of Asheville and a reservoir on Beaucatcher Mountain. This took place in 1884.[31]

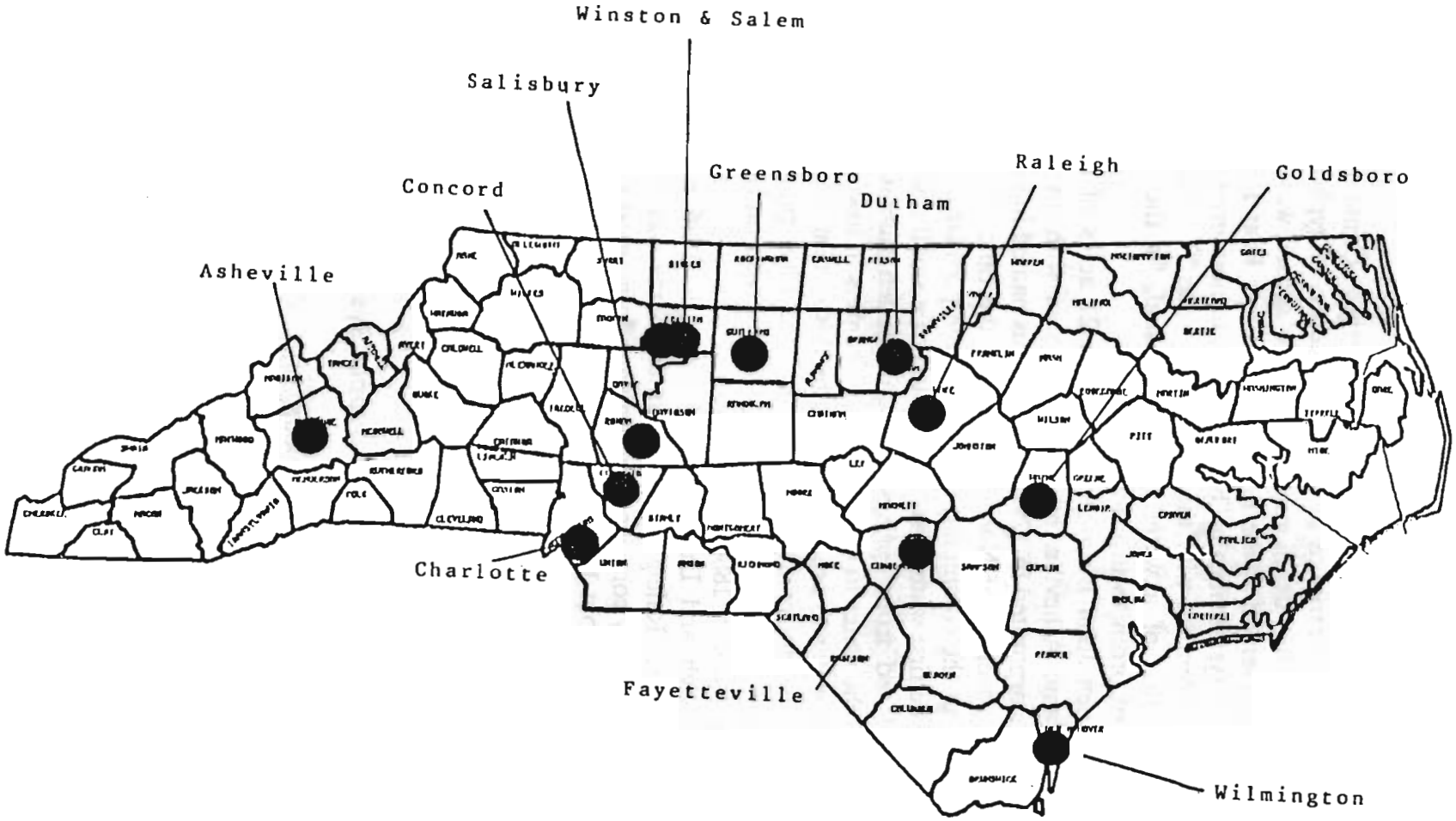
Raleigh and Durham both moved in 1886 to provide community water systems. Raleigh's most obvious source was Walnut Creek, but the watershed already contained the drainage from one-fourth the Town of Cary, "excrement of about 100 people being cast daily upon the watershed in close proximity to the stream." Several cases of typhoid were also reported in the drainage area by the Wake County Board of Health. Strangely, the board ruled that a condition for approval of the stream as a source of supply was that there be no impounding reservoirs "so that the water supply may be taken from the daily flow of the stream."[32]

Public Water Supply Systems in 1888

By 1888, the N.C. State Board of Health reported twelve communities with water supply systems.[33] The majority were owned by private water companies. These communities included:

> **Asheville** - Its Swannanoa River water supply was "filtered by the Hyatt method"–a combination of filtration with forced aeration and chemical sedimentation. Introduction of the new supply the previous year was "followed by a marked decrease in typhoid and other enteric diseases." The cost to consumers

Figure 2: N.C. Public Water Supplies in 1888



was $.25/1000 gallons. The supply was "not in general use among the poorer classes."

Charlotte - The source of water supply included several small streams and ponds on the outskirts of town. The water was often reported to be muddy and liable to pollution since the water company controlled only a small area of the watershed. As with Asheville, the water was not in general use among the poorer classes. The cost to those who used the supply was $.50/1000 gallons.

Concord - A private supplier utilized a spring near the center of town. The water was "not in general use."

Durham - A company-owned water supply had been introduced two years previously. The supply came from several springs six miles north of town. The water, slightly turbid after heavy rains, was "pretty generally used, at least by the better classes." It cost $.40/1000 gallons.

Fayetteville - The town-owned system, first introduced in 1824, was fed by springs "just outside the corporate limits." Collected in a brick reservoir, the water was conveyed to customers through bored logs connected by iron couplings.

Goldsboro - A contract had been entered into with "a northern (water) company" to supply two million gallons per day at a cost of $5.50 per faucet. The supply was to be taken from driven wells, if possible. Otherwise, the Little River–characterized as a source of "questionable wholesomeness"–would be used.

Greensboro - The report noted that a privately owned waterworks was established during the past year and that the supply came from springs about 1 - 1 1/2 miles from town center. "Supply limited and not yet much used. . .often muddy," the report said. The meter rate was $0.25/1000 gallons.

Raleigh - The water company took its supply from Walnut Creek, whose watershed included cultivated fields, woodlands,

and part of the Town of Cary. The N.C. Board of Health reported that "special legislation has been obtained for protection of the stream and watershed, but its great extent renders proper supervision difficult, if not impossible." There was direct service from pumps with stand-pipe storage for fire protection. Water was filtered by the "Hyatt method." The cost was $.40/1000 gallons.

Salem - The original supply taken from springs of limited capacity had been superceded in 1878 by shallow wells along the stream which drained a section of Winston and Salem. Water was said to be clear with no "detectable" connection to the stream or surface drainage. An absence of "zymotic diseases" among consumers was noted. Water sold for $.50/1000 gallons.

Salisbury - The company-owned supply came from Cane Creek, two miles southeast of town. Its watershed was "largely cultivated." The water was "muddy and not used for drinking purposes."

Wilmington - The company-owned supply came from the Northeast Cape Fear River at its junction with the Cape Fear. Subject to tidal influences, the intake was located one mile above docks and shipping. The stream at that time also received "drainage from several cemeteries, slaughter houses, and a large part of the City." Rice fields were located across from the intake and a large guano works was sited one mile above on the Cape Fear. The water, colored by swamp discharges, was "in only limited use for drinking purposes, though doubtless far more wholesome than water in private wells." The rate was $.20/1000 gallons.

Winston - The company-owned supply was said to be taken from shallow wells along a stream draining mostly cultivated lands, old fields, and the suburbs of Winston. The water was "not in general use by the poorer classes." It sold for $.50/1000 gallons.

The Quality of Early Water Supplies

Most early public water supplies in North Carolina were delivered to consumers without treatment beyond some degree of sedimentation afforded by whatever storage was provided. The mechanical or Hyatt filters referred to in the above descriptions of the Asheville and Raleigh supplies were probably similar to the pressure sand filters introduced by the Newark Filtering Company in 1885. They were called "mechanical" because the filters were cleaned by mechanical means in contrast to manual cleaning of slow sand filters. The reference to "chemical sedimentation" at Asheville is presumed to mean that alum or other coagulant was used in conjunction with sedimentation and filtration at that location.

Of the community supplies, Asheville's was viewed by the Board of Health as the most free from risk of pollution "until the valley of the Swannanoa is well settled." The Durham and Greensboro supplies came next with "watersheds only requiring watchful supervision." The Raleigh supply, the board said, "depends for its safety upon the permanency and the lively appreciation of danger at the present evinced by its health authorities." The Winston, Salem, Salisbury, Charlotte, and Wilmington supplies were placed on a "doubtful list because of risk of pollution." Concord and Fayetteville were not rated because of their limited supplies.

The board concluded that "the public (water supplies) should be guarded with special care by the local authorities, but in many instances these would be powerless without the cooperation of the authorities of the State." "This," it said, "is shown by the action of Raleigh in securing special legislation to prevent the pollution of its source of water supply. Without such legislation, every public water supply in the state, located outside the corporate limits of a town, is completely at the mercy of every ignorant or wanton trespasser."[34]

III THE SPECTER OF WATER-BORNE DISEASE

Typhoid fever was a common experience for North Carolinians in the late 1880s with thirty-five counties reporting cases in mid-1888. It was to remain so well into the twentieth century. The relationship between typhoid and other enteric diseases and sanitation was gradually becoming apparent as evidenced by several observations of public health authorities in issues of the *Bulletin of the N.C. Board of Health* in 1889. The April issue of that year reported that "cholera and typhoid fever. . .are contracted in the majority of cases through the ingestion of infected food and drink, especially the latter. Hence, when diseases are present, it is a safe plan to boil the water used for drinking purposes."[35]

This was followed in May with the statements that it is an "established fact that polluted drinking water is the primary cause of typhoid fever. . . . We should impress upon our readers that the pollution usually comes from the drainage of privies, sink drains, barnyards, and other nuisances into the family well. . . . Be sure that the water supply is protected from such dangers of contamination."[36]

Excerpts from *Transactions of the N.C. Sanitary Association* in 1889 carried the message that "the importance, nay, the vital necessity, for a pure water supply for our people. . .must be conceded. As towns increase in population, the difficulty of procuring a wholesome water supply, and the dangers of its pollution, are correspondingly augmented."[37]

Early Calls for Municipal Ownership and Protection of Water Supplies

The importance of protecting high quality watersheds in the face of rapid settlement was emphasized by Dr. H. T. Bahnson in his 1889 treatise, "The Public Water Supply of Cities and Towns in North Carolina." He concluded that "North Carolina is a well-watered state, and our surface is not yet settled so thickly that a suitable area for a wholesome water supply cannot be found, in most cases, near a town." "Such localities should be secured without delay and zealously guarded against contamination."[38] The urgency was underscored in 1890 by a report that "only ten of our cities and towns have systems of waterworks in popular use. This leaves a great majority of our population dependent either upon springs or wells. Even in

some of the towns boasting of water works the supply is drawn from shallow wells."[39] Such prophetic warnings were to be repeated again and again over the years with all too little impact on the minds of local officials responsible for the acquisition and protection of high quality sources of water supply.

The expectations for a public water supply were voiced at that time by the N.C. Sanitary Association as purity and adequate quantity. By purity, they meant "absolute freedom from apparent and possible. . .contamination and pollution." "This," they said, "necessitates undisputed control and watchful supervision of the watershed and the surface area supplying it." They asked for water in "sufficient abundance and cheap enough to be used freely for domestic purposes by all classes." These needs, they concluded, "can be met only when the waterworks are owned by the town." Such ownership was expected to "result in the closing of private wells and springs, which are always liable to pollution."[40]

Calls for Waste Treatment

Typhoid fever continued to be viewed as the most prevalent and fatal of all the preventable diseases appearing in the State. North Carolina health officials cited contamination of drinking water by infected persons as a major cause of the disease. The "only way to prevent spread," they concluded, "is to destroy the germs while within reach through disinfection" of the wastes before release to the environment. Thus, a major emphasis to prevent contamination of water was waste disinfection–waste treatment, if you will–at the source.[41] This emphasis was undoubtedly influenced by an earlier paper "Sewage in Water Supplies," read by Dr. C. S. Smart of the U.S. Army at the Sanitary Convention held in Philadelphia in May 1886. Smart is reported by state officials as having given a "clear exposition of the specific dangers to the public health attending the use of unwholesome water supplies. The point of greatest interest brought up for discussion was the connection between sewage in water supplies and the prevalence of typhoid fever." He said that "sewage entering a river or lake must be regarded as an infected sewage and capable at some times, if not at all times, of spreading the disease by the use of water from these infected sources." Dr. Smart presented evidence from experience in the U.S. and abroad to support his thesis "that the typhoid death-rate is proportioned to the carelessness of a community in regard to its water supply."[42]

Despite the seeming advance in relating disease transmission to contaminated drinking water, there was still a great deal of ignorance in this area as evidenced by a pronouncement by Dr. R. H. Lewis, secretary of the N.C. Board of Health, in 1894 that "the evidence that malarial diseases are

introduced into the system. . .through the medium of the drinking water is, to my mind, conclusive."[43] The role of mosquitoes in transmission of this debilitating disease was yet to be revealed.

These first tentative steps toward the control of water-borne disease through treatment of infected human wastes and treatment of drinking water reveal the two foundations of water supply protection today. That is, control of pollution at its source and treatment and protection of the finished water supply at its point of use.

Early Drinking Water Treatment and Analysis

The use of alum in water treatment was being cited as an "apparent discovery that minute quantities of alum will sterilize the water by the precipitation of the bacteria. . .the whole precipitate being removed by filtration."[44] Actually, coagulation as an aid to sedimentation for the clarification of water had been practiced since ancient times. But, its use for public water supplies is little in evidence before the last quarter of the nineteenth century. Hardly, if ever, used as a separate process, it was generally used in conjunction with rapid sand filtration after 1885. In his historical account of man's *Quest for Pure Water*, M. N. Baker concluded that coagulation might have been used "earlier for the improvement of public water supplies had public demand for clear water been more insistent and had it not been for the influence of ill-informed or prejudiced persons whose word was respected."[45]

State Board of Health Oversight and Care of Inland Waters

In 1893, the North Carolina Legislature gave the State Board of Health "general oversight and care of all inland waters" and authorized "examination of said waters" for the purpose of ascertaining their fitness for use as sources of domestic water supplies. The act extended the board's protection to watersheds, fixed penalties for violation, required physicians to give instructions to householders regarding the disinfection of typhoid discharges, and imposed a penalty for failure to comply. This was one of the earliest state laws requiring analysis of public water supplies.[46] Analytical techniques for assessing water quality were still primitive. The absence of albuminoid ammonia, for example, was taken by the "highest authorities on water analysis" that "water was organically pure despite much free ammonia and chlorides."[47]

IV SANITATION AND WATER SUPPLY IN THE LATE NINETEENTH CENTURY

The status of sanitation in the late 1800s is well illustrated by facilities at several of the State's leading universities. A & M College at Raleigh (NCSU) reportedly obtained its water supply from a large well on the premises. There were no sanitary fixtures because of difficulties in disposing of sewage to a local branch. Some insight into the origins of future practices was disclosed when land irrigation was suggested as a possible means of sewage treatment. The only water supply available to A & M College at Greensboro (A & T) was "a comparatively shallow well near the kitchen." There were no sanitary fixtures. The same situation prevailed at the University of North Carolina at Chapel Hill until 1892 when the basement of the library "was fitted with urinals, water closets, bath tubs and showers." The water supply came from a "deep well on campus" and was pumped by steam to tanks in the attic of one of the buildings.[48]

Public Indifference to Sanitation

Public indifference to hygiene and sanitation was a major obstacle to improved public water supplies. A physician of the period reported that even in the face of a scourge of typhoid fever associated with a contaminated water supply, the people "would rather die than to boil their water."[49] In reporting on a health conference at Salisbury in 1894, however, one observer noted signs of progress when he reported that "the discouragements in sanitary work have been so great and so depressing that we can but rejoice at this evidence of a brighter day." He said the conference "was like a cool breeze on a hot, sultry summer's afternoon."[50]

It was at this time, in 1894, that a Dr. Faison of the State Board of Health alleged that the Little River water supply of Goldsboro "showed an alarming amount of albuminoid ammonia" and that "inspection of the source. . .disclosed several sources of contamination," including streams draining unsanitary sections of town. The town was advised to abandon the river and obtain its water from deep wells. Dr. Faison also alleged that the water of Charlotte was "decidedly foul and full of germs." In contrast, the Morganton

water supply was said to come by gravity from a mountain stream and to be "first class."[51]

Report on Sanitary Conditions in 1894

An 1894 report by the N.C. Board of Health showed Elizabeth City with no water or sewer systems. Private rainwater cisterns and driven wells were in general use. Experiments to use artesian wells had proven unsatisfactory, and the town was looking to the Pasquotank River as a source of "juniper water of presumably good quality." Greensboro was being encouraged to adopt filtration, and plans had been prepared for a sewer system and outfall. Henderson now reported a privately owned water supply from an old millpond and small creek out of town. There was no sewer system.[52]

A privately owned artesian well supply had recently been placed in operation in New Bern. Cisterns and driven wells were still in general use. A sewer system on the "franchise plan" had recently been constructed with sewage discharged to the Neuse River. Further up the river at Raleigh, the water company was still drawing water from Walnut Creek "above all supposed sources of contamination." Alum coagulation was used "to some extent" and mechanical filtration continued. A "complete system of sewers built some years ago discharged. . .into running water a satisfactory distance from the City."[53]

Salem's supply was still reported to be of "excellent quality." There was now a sewer system, but the town was expressing an interest in connecting to the Winston outfall sewer. The unsightly appearance of a small branch from textile wastes was noted. The Salisbury water supply was now being filtered "by one of the mechanical devices" and alum was reportedly used as a coagulant. In Statesville, there was discussion of development of a community supply from a small creek. Tarboro's waterworks was only for fire protection. Wilmington was considering the erection of a filter plant to improve its supply. No sewer system had yet been built, though plans had been "prepared some years ago." Wilson had just completed its water supply from Toisnot Creek which was reported to be of variable quality requiring filtration. Plans for a sewer system had been prepared and some portions were expected to be built in the coming year. Winston had purchased the local water company and was making plans to filter a new supply from a spring-fed branch nearby.[54]

Quality Versus Quantity of Water Supplies

In summary, the Board of Health reported visits to twenty cities in 1894. Sixteen of these had water works with fifteen supplying water for domestic purposes. The fifteen cities were:

Asheville	Goldsboro	Salem
Charlotte	Greensboro	Salisbury
Concord	Henderson	Wilmington
Durham	New Bern	Wilson
Fayetteville	Raleigh	Winston

Six of the communities now provided filtration. An additional five were said to require filtration. Only five of the fifteen cities with domestic supplies were said to have sewer systems of one sort or another.[55] The sanitary engineer member of the State Board of Health, J. C. Chase, said at the time that "less than a generation ago the largest city of our State had hardly dreamed of water works, while today no less than fourteen municipalities have public water supplies, satisfactory, perhaps, in point of capacity, but some of them more or less doubtful quality when question of purity is considered."[56]

The results of bacteriological examinations of community water supplies were not encouraging. In 1896, the cities of Charlotte and Fayetteville did not respond to the Board of Health's request for samples. Analyses for Asheville, Concord, Greensboro, Henderson, and Raleigh showed the samples to be "infected" with intestinal bacteria. Results for Goldsboro, New Bern, and Winston were said to be "suspicious." UNC chemistry professor F. P. Venable said that "in many towns. . .the most available source of supply is some country stream" and that "they are subject to a great many sources of pollution and [will] be considered safe only when the community owns and carefully guards the entire watershed."[57]

V WATER SUPPLY PRACTICES AT THE TURN OF THE CENTURY

A discussion of public water supplies and their purification by John C. Chase, engineer member of the State Board of Health, in 1897 casts more light on the state of the art at that time. "The source of supply," Chase said, "should be above reproach. Yet, such is the general public indifference that were it not for the never-ending missionary work of the physician and sanitarian, our land would stand a fair chance of devastation by filth diseases that would rival the death-dealing plagues of former times."[58] In his opinion, "any public officer who passively allows. . .the continued use of a polluted source of water supply is morally responsible for the . . .consequences."[59]

Chase noted the rapid growth of public water systems in the United States from 243 in 1870 to about 2800 in 1897. At the earlier date, he wrote, "A city of less than 25,000 inhabitants hardly dreamed of a public water supply; now, scarce a hamlet but what aspires to have this great convenience". He viewed natural lakes or ponds–situated at a distance from habitations and free from actual or prospective pollution–as the most desirable source of supply. Yet, he counselled his readers that "it is the unexpected that always happens and that it is not safe to assume that once pure always pure." Water drawn from a running stream that receives household or "mechanical" wastes of another center of population called for "vigorous condemnation."[60]

Treatment of Water Supplies

"In the early days of water works construction," wrote Chase, "comparatively little attention was given to the purity of the supply. A single analysis was usually made, and if the result showed that the supply was of satisfactory quality the question was considered settled for all time. . .and the only purification. . .considered necessary was the removal of matter held in suspension, as in the case of turbid rivers."

"We confidently expect," he prophetically observed, "that the discovery of a successful way to eliminate all known pathogenic bacteria will only be the signal for the advent of others equally detrimental to health."[61]

With respect to water treatment, Chase reported that "within a few years a growing sentiment in favor of purification by filtration has taken root." "The mechanical filter has, as a class," he said, "done efficient work." Its efficiency was increased through the use of alum, iron salts, or lime, as a coagulant prior to filtration. As observed in those days, the function of the coagulant was "to form. . .a gelatinous precipitate which draws together and surrounds the suspended matter present in the water." "This type of filter, using the coagulants," he said, "has been very successful in removing bacteria and the opinion is ventured that it will be the only type of filter that is commercially available for water works systems of small sizes."[62]

Chase reported that ground water sources were to be usually of "good quality, and are practically nothing but filtered surface water." "Geological conditions," he said, "play an important part in settling the question of securing supplies of this nature, and comparatively few are thus derived. The water very often possesses a degree of hardness that is tolerated because nothing better can be had."[63]

Speaking further of ground water sources, Chase stated that "supplies drawn from wells are not always free from danger of pollution. If the wells are shallow and located no great distance from contaminating influences, an excessive draft. . .is very likely to. . .cause practically the same pollution that would be found in a surface supply in the same locality." He found artesian well supplies to be "generally free from organic contamination."[64]

Of the sixteen water supply systems in North Carolina at that time, Chase noted that "three draw their water from an artesian well, a deep well, and springs; two use the ponded water of small streams one of which has built a filter well. . . The other supplies are surface waters from streams of varying size and character. . .most. . .not being above suspicion..." Eight of the latter were said to utilize filters of the mechanical type "which certainly improves the looks of the supply." In summary, he concluded that, "the large majority of our public water supplies are of uncertain or suspicious character." Chase made no reference to chemical disinfection as a treatment process at that time.[65] Though the first American patent on chlorination of water was issued in 1888, its routine use for water treatment in the United States was not to materialize until another two decades had passed.[66]

Watershed Protection Initiatives

Watershed protection legislation was introduced in the General Assembly in 1897 by Representative Thomas H. Sutton of Cumberland at the request of the State Board of Health. The principal thrust of the bill

was to extend the police powers of the cities and towns to their watersheds and to require periodic watershed inspections. Despite endorsement by the cities of Raleigh, Henderson, and Durham and unanimous support of the House Committee on Public Health, the legislation never reached the floor. However, the Secretary of the Board reported that the Raleigh Water Company intended to voluntarily carry out provisions of the bill and expressed the hope that "some of our other water companies may be induced to do the same."[67]

At the annual meeting of the Board of Health in 1897, "it was ordered that the municipal water supplies of the State be examined chemically and bacteriologically during the current year." This was to be carried out by the engineer of the board, Col. A. W. Shaffer. While investigations of public water supplies in North Carolina were first undertaken in 1896, this was initially limited to analyses of water samples because of the "extremely small appropriations."[68]

Frequent inspections of watersheds and "thorough filtration" were viewed as the mainstays of a safe water supply on the basis that "it is far safer and easier to prevent disease germs from getting into the water than to get them out after they have taken possession." The board concluded that "the best thing water companies obtaining their water from inhabited watersheds can do to insure the purity of their water is to employ some reliable man whose sole duty it shall be to thoroughly patrol the watershed, going over it and visiting every residence thereon at least twice a week, and promptly reporting every case of fever or diarrheal disease, that it may be immediately investigated and such precautions taken as may be necessary." The Charlotte Water Company was cited as an example of such a practice.[69]

J. A. Holmes, the State Geologist, reported at about this time, that "a large number of wells have been put down in nearly all of the eastern counties to depths of from 50 to 300 feet and, while there have been some cases of failure to reach adequate water supplies, . . .in a larger number of cases the experiments have been fairly successful, and the health of many communities has been greatly improved by the use of the water from these deeper wells."[70] Near the end of the nineteenth century, Holmes reported that investment in artesian well supplies continued in the eastern counties. A special study of geological formations along the Cape Fear River was conducted "with a view of possible water supplies. . ." and a report on deep wells was being prepared.[71]

Public Water Supplies in 1897

The report of Col. Shaffer's investigation of public water supplies in 1897 contributes additional insight into their status at that time.[72]

Asheville - The power house and intake were five miles out of town on the "left bank of the Swannanoa River." The standpipe and reservoir were on Beaucatcher Mt. and the filter, in town. It was cited as "the best plant in the State." The city-owned waterworks had four large filters enclosed in brick walls. The reservoir was an abandoned rock quarry, cleaned out and cemented, safe against the intense cold that destroyed the standpipe a few years ago, and the power house, dam and forebay were of solid rock masonry. The only settlement on the watershed was "at Black Mountain," sixteen miles away, and very small. Chemical analysis revealed "a very pure water" and "no harmful bacteria were found."

Charlotte - The privately owned system took water from a watershed consisting "largely of cultivated land." Shaffer reported it "was not a favorable watershed for first-class water without thorough filtration," though he acknowledged there were four filters in use. The supply came from two streams about one and one-half miles from the city center to a settling basin near the power house. The water was said "to indicate vegetable organic contamination." Bacteriological analysis of an un-iced sample reportedly indicated "a safe drinking water."

Concord - The privately owned supply was taken from the Reed Gold Mine shaft in one watershed and surface springs from another. There was a single stand-pipe, but no reservoir or filter. While chemical analysis reportedly did not show any indication of organic contamination, bacteriological analysis gave suspicious results. A second visit in 1898 showed little change. There were "numerous stables and closets discharging to the surface" and "unwalled pits" and "old wells." Shaffer regretted to say that "the situation. . .is not greatly improved" from the earlier report and he expressed doubt that it ever would be "until the water supply is taken from a source above and beyond the town limits." Chemical analysis was said to

indicate "a very pure water," though bacteriological tests indicated only a "fair drinking water."

Durham - Private owners of the water system took their supply "from a stream nine miles out, at its junction with the Eno River. Filter and sewerage here." Shaffer "did not visit watershed, as it would consume another day." Chemical analysis "will not condemn this water, but places it under suspicion of being contaminated with organic matter." Results of bacteriological examination indicated "the water is fairly good."

Fayetteville - The privately owned supply was "derived from the great spring on Haymount Hill" and used primarily for drinking purposes. Other water was taken from the run of Cross Creek and was used for general purposes and for drinking when the Haymount water was not available. Chemical and bacteriological analyses "showed no organic contamination or suspicious organisms."

Goldsboro - Small privately owned waterworks on Little River. The filter was noted as working well. The supply was characterized as "tinted with juniper and cypress through which it passes, but clear and free from green scum, bad odor or taste, which had been previously reported there." The report noted: "No sewer system. Water-bearing strata lies about 10 feet below the surface. In wet seasons, water in the wells rises to within 4-6 feet of the surface. Wastewater of the town empties into shallow ditches and liable to percolation to the wells, [from] which a large majority of the citizens obtain their water for all purposes." Shaffer saw greater danger to health than with no waterworks because of the lack of sewers to carry off the wastes. "If typhoid germs breed and multiply under these conditions," said Shaffer, "then Goldsboro is an ideal propagating ground, though the waters at the intake be as pure and limpid as those of Pison, Gihon, or Hidekel, that sprang from the garden of God." He indicated that since his visit Goldsboro citizens voted bonds for sewering the city. He concluded, that "chemical analysis indicates. . .this is not a good water for drinking purposes."

Greensboro - The day of Shaffer's visit was Thanksgiving Day and he reported "everybody gone a birding." He "couldn't find anybody who knew anything about it [the watershed]." Chemical analysis reportedly did not give any indication of organic contamination and bacteriological analysis led him to conclude, "This water is good."

Henderson - Water for this privately owned system was taken from **wells**. There was "no watershed, no filter, and no sewerage." No interpretation of chemical analysis. Qualitative bacteriological examination indicated a "safe drinking water."

New Bern - Water was reportedly taken from six bored or artesian wells. There was no surface water supply. Chemical analysis showed no "organic contamination." Bacteriological tests showed this water "to be very good."

Raleigh - Raleigh's water supply continued to be taken from Walnut Creek one mile south of the city. The intake was "a mile above (city), and a fourth of a mile above Rhamkatte road." The report noted that the stream rose at Cary, eight miles west of the city and that the condemned Yates dam still dominated the waters. The report also said that the private owner filtered the water and that the city was sewered. A report of a watershed inspection by city superintendent of health, mayor, and a representative of the owner disclosed conditions typical of the period:

> Commencing at Cary, we found two open, unboxed privies on the bank of the main ditch, and a pig-pen on another, the contents of the latter flowing directly into the main ditch at a distance of about 200 feet.
>
> The main ditch contained a very slight run of water, the product of a heavy shower the previous night. There is no living tributary at Cary, the ditch carrying no water except surface water during, and a few hours after, a storm–twenty-four hours after which it is as "dry" as the town ordinance. The first evidence of a

living stream appears about a mile below the town.

We found all the streams running muddy water from the rains of the previous night, until we reached the Hugh Campbell spring branch, a bold, crystal stream flowing from two fine springs on the place.

The water-shed from Cary to Raleigh is largely covered and protected by a natural growth of forest and hedge, briars, cane and shrub, and we found little to criticize until we reached the Little Yates Mill, of L. D. Castlebury, on the Avent Ferry road in Swift Creek township. The dam of this mill backs water over five to six acres, filled with mud and decomposed vegetation, with a rank growth of grass, reeds, shrubs and weeds. As the water is very shallow and the mud very deep the site can be of no considerable value for mill purposes and afforded no evidence of late use. Such a deposit in the main run of the water supply must of necessity contaminate the water that flows from that point, creating a nuisance that ought to be abated if possible.

. . .this dam was reported detrimental to the health of the people of Raleigh and declared to be a nuisance in December, 1895.

The intake of the company is situated upon the Grimes farm above the bridge on the Rhamkatte road about a mile southwest of the corporate limits of the city. The surplus water flows over a natural ledge of gneissoid granite brought to a dead level so as to carry off all floating foreign matter at every point, always provided it first escape the wide mouth of the intake, set in the current and facing up stream, like a saurian bobbing for flies. A proper adjustment of this intake would greatly relieve the filter at the pump-house, and remove an ever present source of adverse criticism.

While the chemical analysis showed "no indication of contamination from organic matter," the bacteriological examination disclosed bacteria "of a suspicious nature."

Salem - Water for the privately owned supply was taken from "springs in the southwest part of town." The report noted, "No watershed, no filters, and no sewerage." Chemical analysis was said to indicate that the water was "very dangerous" and seemed to be "contaminated from sewage." Reexamination showed "chemically excellent water." Bacteriological analysis "gave no indication of the presence of suspicious organisms."

Salisbury - Water for the privately owned supply came "from Cane Creek, rising about six miles above town and flowing along the base of Dunn's Mountain." The watershed consisted of "cleared land on one side of the Creek and mountain growth on the other." There were "no residential obstructions." The system consisted of a power house, intake, and stand-pipe. There was no filtration. The town was unsewered. While chemical analysis gave no indications of organic contamination, bacteriological examination "revealed some bacteria of a suspicious nature."

Wilmington - Work was underway on an artesian well. "Owing to the liability of infection by the city sewage in the ebb and flow of the tide on the Northeast Cape Fear River source," Shaffer recommended that the intake be removed above tide water in the event of failure of the artesian well. The works were said to be privately owned.

Wilson - The power house, intake and watershed were reported to be "about a mile from town." Shaffer said the publicly owned works had no filter and the town was unsewered. The intake was located on the run of Toisnot Swamp. Water was said to be "full of floating leaves and tinted slightly by decaying vegetation." This was borne out by the high concentration of albuminoid ammonia disclosed by the chemical analysis. Bacteriological examination, however, showed the "water to be very good."

Winston - The privately owned system was taking water from two springs. The report said, "No watershed, no filter, and no sewerage." Chemical analysis gave "no indication of contamination" and un-iced sample revealed "no suspicious bacteria."

In his inspection of public water supplies during the 1899-1900 biennium, Col. Shaffer reported on the following additional water supplies:[73]

Gastonia - A new water and sewer system were under construction. The water source was Long Creek, which was very muddy at time of the visit.

Lumberton - The supply came from eight deep, flowing wells about the City. "Water practically sterile."

Monroe - Water came from a 750-foot well and had the odor and taste of sulphur. No sewer system was reported.

Reidsville - Water came from a 29-foot well with small "feeders." No sewer system was reported.

Rocky Mt. - The water source was Rocky River. The sewer system was said to be limited.

Sanford - Water came from deep wells and there was no sewer system. The report noted, "An old pump and engine, chronically indisposed, not more than half the requisite power. An ill-constructed and ill-kept reservoir. All built for a railroad supply. Proteus vulgaris in water."

Statesville - The water came from deep wells and the sewer system had not been completed.

Tarboro - Water came from driven wells near the river above town and there was no sewer system.

This later series of inspections now showed Raleigh with a new filter plant possessing the "very latest improvements in mechanical filtration." Charlotte had purchased its privately-owned water works and had "greatly improved its watershed, mechanical [equipment] and service." However, the

Charlotte supply was characterized as "inadequate and not creditable to that enterprising city." Shaffer found the Durham supply to be "very low and very turbid. . .[and] inadequate in case of fire." Greensboro was reportedly experiencing similar complaints with its water supply: "very low and muddy with universal complaint everywhere." The Greensboro supply was "so low and so bad that a pending contract for its purchase by the city [had been] cancelled."

In 1899, the General Assembly adopted legislation requiring public water companies to make quarterly biological and chemical analyses of water at the expense of the company or city involved.[74]

VI THE OPEN WELL

At the turn of the century, a physician, Dr. W. T. Pate of Gibson, N.C., pleaded with his fellow physicians at the Wilson Health Conference to take a greater leadership role in stressing the importance of pure drinking water in the prevention of gastrointestinal diseases. The focus of his attention was the contaminated, open well still very prevalent in urban as well as rural areas. "Open wells from which the water is brought to the surface in buckets are filthy and dangerous," he said. In 1900, only about 7 per cent of the population of North Carolina obtained their drinking water from public supplies–the source of which was said to be surface waters exposed to both direct and indirect contamination. "But," Pate said,"such supplies are better than private wells in city soil." With respect to wells, he concluded that "supplies should use only underground [driven] wells, the water should be raised by suction. . .not buckets, the soil should be free from pollution within 100 feet radius of the well, and surface drainage should be away from the well."[75]

Despite the romantic images evoked by the old oaken bucket and open wells, they were increasingly viewed as unhygienic sources of disease as the following poem by Dr. J. C. Bayles, formerly President of the New York City Board of Health, testified:[76]

The Old Oaken Bucket
A Hygienic View

With what anguish of mind I remember my
childhood,
Recalled in the light of a knowledge
since gained.
The malarious farm, the wet fungus-grown
wildwood,
The chills then contracted that since
have remained;

The scum-covered duck-pond, the pig-sty
close by it,
The ditch where the sour-smelling house
drainage fell,
The damp, shaded dwelling, the foul barn-yard
nigh it–
But worse than all else was that terrible
well,
And the old oaken bucket, the mold-crusted
bucket,
The moss-covered bucket that hung in
the well.

Just think of it! Moss on the vessel
that lifted
The water I drank in the days called to
mind;
Ere I knew what professors and scientists
gifted
In the waters of wells by analysis find;
The rotting wood fibre, the oxide of iron,
The algae, the frog of unusual size,
The water, impure as the verses of Byron,
Are things I remember with tears in
my eyes.

And to tell the sad truth–tho' I shudder
to think of it–
I considered that water uncommonly
dear,
And often at noon, when I went there to
drink of it,
I enjoyed it as much as I now enjoy
beer.
How ardent I seized it with hands that
were grimy,
And quick to the mud-covered bottom
it fell,
Then reeking with nitrates and nitrites,
and slimy

With matter organic it rose from the well.

Oh, had I but realized in time to avoid them–
The dangers that lurked in that pestilent draft–
I'd have tested for organic germs and destroyed them–
With potassic permanganate ere I had quaffed.
Or perchance I'd have boiled it, and afterward strained it
Through filters of charcoal and gravel combined;
Or, after distilling, condensed, and re-gained it
In potable form, with its filth left behind.

How little I knew of the enteric fever
Which lurked in the water I ventured to drink,
But since I've become a devoted believer
In teachings of science, I shudder to think.
And now, far removed from the scenes I'm describing,
The story of warning to others I tell,
As memory reverts to my youthful imbibing
And I gag at the thought of that horrible well,
And the old oaken bucket, the fungus-grown bucket–
In fact, the slop bucket–that hung in the well.

- Literary Digest.

This whimsical parody of open wells may have influenced the University of North Carolina to act in 1902 to substitute a pump and well cover for the previous bucket and open well as a source of drinking water at its campus in Chapel Hill. The same year, the university reported completion of a waterworks utilizing Bolin Creek as a source of supply. The A & M College in Raleigh (NCSU) was being encouraged to get rid of its privies and construct a sewer system.[77]

VII WATER SUPPLY PROTECTION IN THE EARLY TWENTIETH CENTURY

Water supply protection advanced slowly in North Carolina. A hoped-for authorization of $500 annually for a bacteriological laboratory was stricken from 1899 legislation to protect water supplies, leaving the Board of Health with insufficient resources to provide for "more than a very few such examinations of public water supplies" during each biennium. The Board of Agriculture fared better, however, and agreed to examine waters "where there is a reasonable ground to suspect the water of causing disease." In reaching out for this assistance from a sister state agency, the Board of Health noted that typhoid fever was nearly always conveyed by drinking water and that the sources of infection could be ascertained only by bacteriological examination. The number of deaths annually from this disease at that time was reported to be in excess of 1000. "Modern sanitarians" were said to be in agreement "in declaring that the first requisite for the healthfulness of any neighborhood is a water supply uncontaminated by human and animal excrements."[78]

Then, as now, public concern over drinking water quality gave rise to entrepreneurial innovation and the marketing of "numerous patent forms" of domestic filters. All of these, except for one, a N.C. Department of Agriculture biologist, Dr. Gerald McCarthy, said "the biologist must pronounce anathema!" He alleged that "after being used a short time these filters pollute instead of purifying water."[79]

Quality of Public Supplies

The Board of Health reported in 1902 that four additional towns (High Point, Waynesville, Wadesboro, and Southern Pines) had installed public water supplies bringing the State total to twenty-seven. However, the increasing number didn't necessarily mean higher quality supplies. In his inspection report of 1902,[80] engineer board Member J. L. Ludlow reported, "too many instances where the purpose is to simply furnish water without regard to its character or purity." He noted that State law requiring quarterly watershed inspections and water analysis "has not been generally observed." He recommended that the requirements should be mandatory rather than "suggestive." Analyses, he said, should be at least monthly. He

also recommended filtration for all surface supplies. Water quality standards were considered, but Ludlow concluded, "[It] is too early. . .owing to lack of data."

Water quality criteria in use at the time included chlorine (chloride), free ammonia, albuminoid ammonia, nitrate and nitrite.

Engineer Ludlow's inspection of 1902 found some changes from conditions noted by Shaffer in 1897 and 1900. There were now three communities located upstream from the Asheville intake on the Swannanoa River instead of the relatively unoccupied watershed reported previously. Steps were being taken to move the intake upstream from the villages of Swannanoa, Black Mt., and Montreat. Concord had substituted deep wells for its contaminated surface supply, but analyses showed "some impurities due to organic matter–thought to be due to surface seepage into the wells."

Mechanical filtration of the Goldsboro supply "could be improved," said Ludlow. He noted excessive organic matter, probably of vegetable origin. Greensboro was still experiencing problems. Analyses of the N. Buffalo Creek source did not show the "proper degree of purity." A filtration plant was being installed. The watershed of the privately owned Henderson supply was seen as "badly exposed to contamination from City, cotton mill, and factory settlement" with "very serious contamination."

Inspection of the city-owned and -operated High Point supply, taken from the Deep River, disclosed "some contamination which may be overcome by proper filtration." The situation in Lumberton appears to have deteriorated from that reported in 1900. Ludlow reported the city-owned system now took its supply from the Lumber River at a point opposite the town "where it is exposed to the drainage and sewage of a portion of the town." The source should be changed, he said, to either the river above the town drainage with filtration or to "a driven well the town owns." One can only speculate as to discrepancies between this report and that of 1900 which had the town supplied by eight deep, flowing wells. In contrast to earlier reports, the New Bern supply was now reported to be "very dirty but not polluted by sewage." It could, said Ludlow, "be greatly improved by filtration."

In Raleigh, the Wake Water Company source, Walnut Creek Watershed, was said to have "some unfavorable exposure." Sanitary inspections of the entire watershed were being made "very frequently and every cause of possible pollution removed." In Salisbury, the city-owned and -operated water system took its water from an unnamed creek. The watershed was reportedly "quite large" and had a "considerable population." As might be expected, it was not considered to be "a highly desirable source of water supply." According to Ludlow, the filtration plant was "quite

defective and should be removed." Statesville was reported at this time to utilize a "small branch fed by springs." The watershed was "mostly wooded without buildings." There was no treatment. "Analysis indicated that the water should be filtered." This was in contrast to the previous report of a groundwater source.

In Wilmington, the Clarendon Water Company continued to use the Northeast Cape Fear River where its intake was "exposed to the ebb and flow of the tide and constant danger of serious contamination by organic matter." A "proper filtration plant is needed," reported Ludlow.

Legislation to Protect Public Water Supplies

In 1903, the North Carolina General Assembly adopted An Act to Protect Water Supplies. This empowered the State Board of Health to have biological analyses of water made in its own laboratory and to impose a charge for this service. The act also required watershed inspections every three months "where streams were not more than 15 miles in length" and "more frequent inspections of trouble spots." Pollution of water supply sources was said to be a misdemeanor with fines and imprisonment authorized.[81] The board soon thereafter required monthly analyses of all public water supplies. These included physical, chemical, and bacteriological examinations.[82]

There were thirty public water supplies in North Carolina in 1904. The water from all was said to be "very soft, and, with a few exceptions, free from organic matter." "The quality and safety of the public or municipal water supplies of the State was enormously superior to the average quality of the well waters sent to the laboratory," said biologist McCarthy. "No incorporated town having 1,000 inhabitants can afford to permit its citizens to be supplied by private wells of the ordinary shallow type," he admonished. In his view, "the danger of typhoid hangs like the sword of Damocles over every community getting water from shallow wells."[83]

Advances in Understanding and Attitudes

The biologist's report on the intensified analyses of public water supplies casts some interesting light on water-works practices of the day. Chemical analyses disclosed that "the larger part of the water companies were using too much alum in their filters and passing a part of this into the filtered water." The companies were notified and "though there was at first some indignation expressed upon the imputation cast upon their waters," they "soon improved their services and apparatus." He reported that "we

are now fully justified in stating that no state or country anywhere has municipal water supplies superior to that of North Carolina–so far as regards freedom from pollution and injurious chemical compounds."[84]

Old theories about disease long associated with water were not easily discarded in the face of increased knowledge and understanding. Distinguishing between water as a breeding site for the anopheline mosquito and water as a vector in itself came with difficulty. In 1906, the Board of Health acknowledged that malaria "is undoubtedly transmitted by mosquitoes, and probably by mosquitoes only, although we find it hard. . .to abandon altogether the drinking water theory."[85]

A landmark case under the 1903 Act to Protect Water Supplies arose in 1905 when the City of Durham sued the Eno Cotton Mills alleging pollution of their Eno River water supply and noncompliance with the 1903 Act to Protect Water Supplies. The Act prohibited wastewater discharges to surface waters utilized as sources of public water supplies without purification approved by the State Board of Health. The lower court ruling in favor of Durham was sustained on appeal to the State Supreme Court.[86]

VIII INTRODUCTION OF DRINKING WATER DISINFECTION

Interest in disinfection of drinking water supplies was also beginning to emerge in the first decade of the twentieth century. *A Bulletin of the State Board of Health* reported in 1905 that experiments by the Bureau of Plant Industry, USDA, on purification of public water supplies by copper sulphate had "excited widespread public interest." The method was viewed as "quite effective for algae control," but its "effect on pathogens is by no means so certain."[87] Water chlorination had been earlier demonstrated on a plant-wide scale in Belgium but had yet to be brought to the attention of water works officials in the United States.[88]

The sanitary quality of water supplies was receiving increased attention. In a paper for the Board of Health in 1905, Dr. E. C. Levy wrote that "it is only within comparatively recent years that the importance of pure water has come to be fully recognized." "Up to that time," he noted, "little more was asked of any source of supply than it could be relied upon to furnish an abundant quantity of water pleasing in appearance and agreeable to taste." He deemed chemical analysis, alone, as insufficient to determine water quality. Prophetically, he emphasized that, "bacteriological methods are able to determine. . .the organisms characteristic of sewage, and since a water supply which is shown to contain sewage must be liable at any time to contain dangerous micro-organisms. . .such water is very properly held to be dangerous."

"In determining the sanitary quality of a water supply," Levy continued, "we have. . .two other methods of the utmost value: (1) a study of the vital state of the community supplied by the water in question, and (2) a sanitary study of the watershed in the use of streams and the more immediate environment in the case of wells and springs." Other factors Levy considered to be important were: relation of volume of stream to amount of pollutants, distance from source of pollution to water supply intake, and time of flow. Levy concluded that "In the present built-up condition of our country, very few streams indeed furnish a water satisfactory from a sanitary standpoint without the adoption of some means of artificial purification."[89]

By 1905, a total of forty-seven public water supplies were registered by the State Board of Health. Thirty of these were said to utilize surface

waters for which nineteen provided mechanical filtration and one slow sand filtration.[90] In 1907, engineer Ludlow of the board reported twenty-five communities with both public water supplies and sewer systems and another twenty-three with public water supplies alone.[91]

Water Purification Technology

State of the art of water purification through chemical coagulation and filtration is described by McCarthy in a 1907 *Bulletin of the N.C. Board of Health*.[92] He cited the standard of quality of "good drinking water from shallow wells and streams" as not exceeding the following in parts per million:

Total solids	250
Phosphates	Light Trace
Turbidity	4
Free Ammonia	0.15
Color	15
Albuminoid ammonia	0.20
Chlorine (chlorides)	5
Iron	0.5
Nitrites	Trace
Other heavy metals	None
Nitrates	0.45
"Infusoria" or fecal bacteria	None
Alum	None
Odor	None

He viewed bacteriological analysis as "the surest and most trustworthy test of the wholesomeness of any drinking water." The logic of resorting to coliform indicator bacteria rather than to search for individual pathogens emerges in McCarthy's statement that "bacteriologists condemn as unfit to drink any water which contains *Bacillus coli-communis,* since such waters are considered as having been polluted by fecal matter and may contain typhoid germs." Bacteriological analyses of water "should be made systematically" at least monthly according to McCarthy.

McCarthy also attempted to develop data on the association of exposure of water supply sources to contamination and mortality rate from typhoid. In addressing water purification, he discussed filtration, alum coagulation, and distillation. "Water may also be sterilized by chemical treatment," he said, "but such treatment is undesirable from a hygienic point

of view." He didn't elaborate on this point. Chlorination had not yet arrived in North Carolina.

McCarthy even ventured into the area of water use, noting that "a fair average for medium-sized American cities, excluding those notorious for reckless waste, is 100 gallons per head per day"–a figure still widely used. Touching on the potential for conservation and more efficient use he noted that "where water meters are generally used and the consumption above a stated minimum is charged for by the gallon, the consumption tends to sink to less than 50 gallons per head without endangering either health or comfort of water consumers." He further stated, "The minimum of 50 gallons includes the average requirement of towns for manufacturing uses, street sprinkling, sewer flushing and fires."

Water Supplies and Governmental Responsibility

In writing on the topic of public water supplies in 1910, Ludlow addressed the relation between public health and the purity of water supplies.[93] Addressing governmental responsibility for such supplies, he said, "Of necessity, the people must take and use such water as the duly constituted authorities see fit to furnish in blind faith and reliance that the authorities are performing this duty with intelligence and fidelity. The responsibility attached to such authority is enormous and far reaching." "By statutory law," he continued, "the State Board of Health is constituted the centralized authority and final custodian in matters pertaining to the public health interests of the State, and is charged with the duty of. . .enforcement of the laws pertaining to. . .public water supplies." He went on to emphasize the importance of local-state cooperation in this endeavor and the hope that water supply authorities "would so appreciate the importance of the work" that the State would not have to resort to litigation to gain enforcement. "Plans and surveys" for public water supplies were now required to include descriptive data and information on watersheds upstream from water supply intakes, sources of pollution and relationship to drainage ways, development, waste treatment and disposal, water use, filtration, or other purification. Where supplies were taken from streams more than 15 miles from their source, requirements pertained only to the 15 miles of stream immediately above the intake. How this figure was derived by the General Assembly was not explained.[94]

Advances in epidemiology of water-borne disease were evidenced by a description of the "Characteristics of Outbreaks Due to Water," by Dr. John F. Anderson of the United States Public Health and Marine Hospital Service published in the 1909 issue of the *Bulletin of the N.C. Board of*

Health. Careful observations and analysis were beginning to lead to a systematic approach to establishing the association between contaminated water supplies and water-borne disease outbreaks.[95]

Despite the continuing pleas of public health officials, strengthened laws, and other uplifting influences, poor hygiene and sanitation continued their untoward influences on the safety of drinking water supplies. Political leadership had a role to play in changing resistant habits and attitudes. Governor W. W. Kitchen joined the crusade in 1910 by declaring April 24 as "Sanitary Sunday."[96]

The oft-held assumption that bottled water offered a safe alternative to suspect public water supplies was damaged by a 1910 report of bacteriological test results for various categories of drinking water sources. The data for nearly 3000 analyses showed 5 percent "bad water" for municipal supplies, 19 percent for bottled water, and 40 percent for private family supplies.[97] This early reference to bottled water and its quality compared to municipal supplies is interesting because of the contemporary debate over the merits of bottled water and home treatment devices as alternatives to public water supplies for drinking water.

Chlorine Disinfection

Water disinfection with compounds of chlorine was first mentioned in publications of the State Board of Health in 1911 when its monthly bulletin published a paper on treatment with chloride of lime in its "Recent Advances in Sanitary Engineering" column. Written by N. D. Baker of the California State Board of Health, the paper called attention to the use of bleaching powder, or the commercial "chloride of lime," within the "last year or two" for water treatment. "Although of such recent origin," he said, "the process has already been adopted by many cities throughout the United States and Canada." He called it "one of the surest and cheapest ways of rendering safe for drinking purposes waters from slightly polluted sources." Baker also recommended its use in conjunction with filtration for the treatment of more seriously polluted waters. But, he emphasized, "The aim of the bleaching powder process is 'to kill the germs' and render safe water which is already acceptable from the standpoint of color, taste, and other considerations."[98]

According to M.N. Baker, the author of *The Quest for Pure Water*, impetus to chlorination in the United States came in 1908 from its introduction on a large scale at the Boonton Reservoir of Jersey City, N.J., and on a small scale at the Bubbly Creek filters of the Union Stockyards in Chicago.[99]

The attack on open wells by public health authorities continued. A report of the director of the State laboratory of hygiene in mid-1911 concluded:

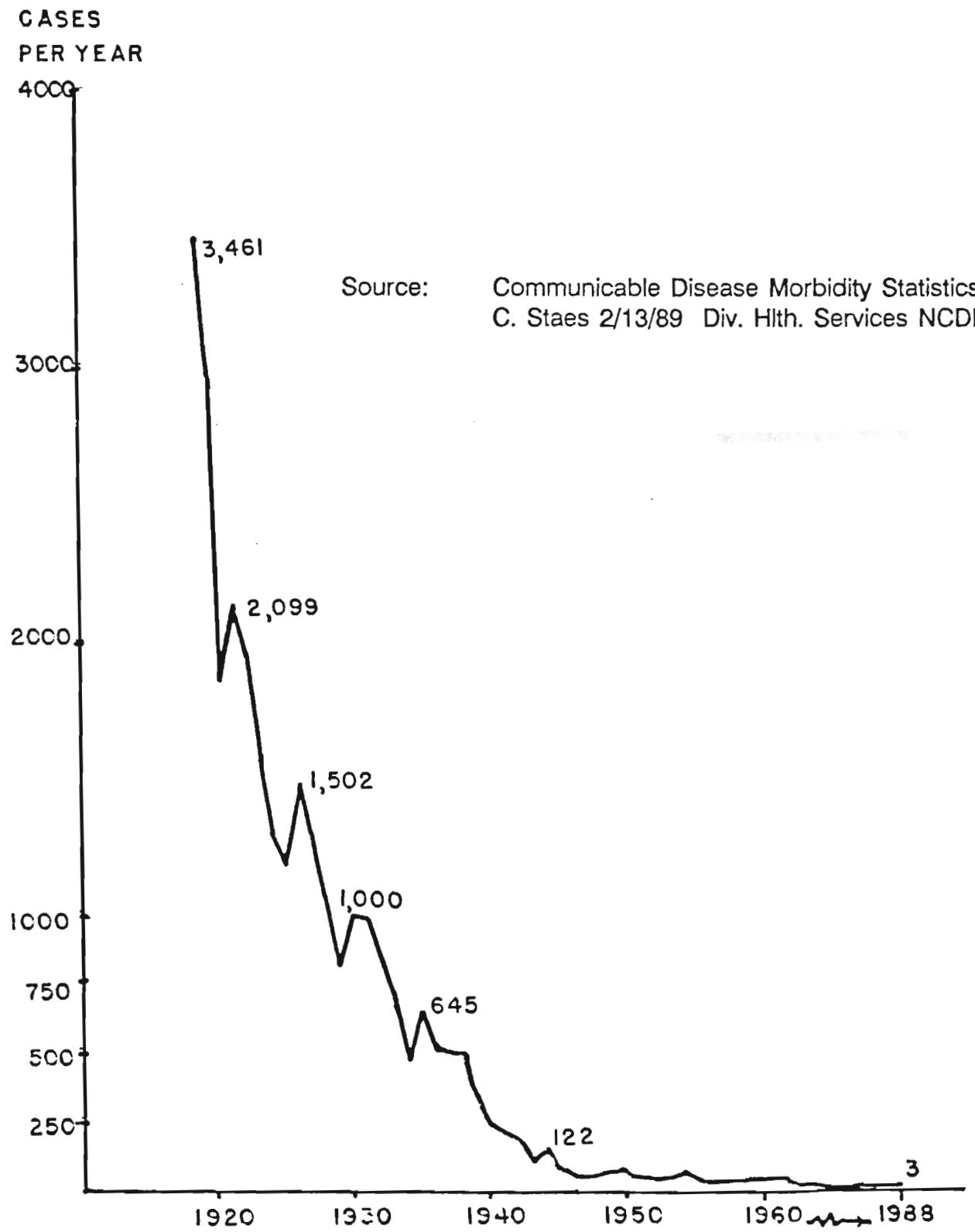
> The last year's work again emphasizes the filth of the open top bucket well–the old oaken bucket of song and sentiment. It may supply the family with cool water direct from the bottom of the well, but it may also serve (as) a wash basin for the hands and mouths of every servant and ragamuffin in the neighborhood. It should be placed along with the surface privy as one of the most important dangers to the public health.[100]

A survey of water and sewer facilities in Asheville, Charlotte, Greensboro, Raleigh, and Winston in 1911 showed Asheville well out in front with 90 percent of its population using public water and sewer facilities. The findings are as follows:[101]

	Percent of Population Served By	
	Public Water Supplies	Sewer System
Asheville	95	90
Charlotte	50	33
Greensboro	50	37
Raleigh	75	35
Winston	75	33

The movement away from private water companies to municipally owned water systems was well under way in 1913 when an earlier suit by the City of Raleigh against the Wake Water Company for non-compliance brought the company into receivership and subsequent purchase by the city. There was a good deal of debate at the time as to whether Raleigh should continue with the Walnut Creek supply or seek alternative sources. Professor W. C. Riddick of the N. C. College of Agriculture and Mechanical Arts (NCSU) was serving as a "special engineer for the City of Raleigh" at the time. His position was that "if the city was to go to some other place than Walnut Creek for water, he wanted the State Board of Health to expressly command such action." Permission was granted by the board "for the continuation of Walnut Creek as the source of supply and execution of the proposed improvements."[102]

Figure 3: Reported Cases of Typhoid Fever 1918-1988



Source: Communicable Disease Morbidity Statistics 1985 and C. Staes 2/13/89 Div. Hlth. Services NCDHR

The battle against typhoid fever was being fought on several fronts. While improved water supplies and sewage disposal were beneficial, a vigorous vaccination campaign was bringing dramatic results in some quarters. Typhoid vaccination in the U.S. Army, commenced in 1909, reportedly "banished" typhoid among army personnel by 1914. The same year, however, the Board of Health reported 12,000 cases and "about 1200 deaths" annually in North Carolina.[103] The routine reporting of typhoid fever and other infectious diseases did not commence until 1918. Figure III illustrates the dramatic decline in reported cases from that date forward.

Interstate Drinking Water Standards

It was in 1914 that the U.S. Public Health Service first issued its Drinking Water Standards to protect the health of the traveling public. While applicable only to water supplies serving interstate carriers, the Public Health Service Drinking Water Standards soon became an important reference for drinking water quality in North Carolina and throughout the United States.[104] The principal encouragement for upgrading substandard supplies came from adverse publicity experienced by a city when notified that its supply had been placed on probation or prohibited for use on interstate carriers.

Governor Locke Craig joined the battle for improved water supplies in 1915 in an address at the opening of the State Fair. He said, "If I were asked to name what. . .is the most desired utility of modern life, I would not name the railroad, nor the telephone, nor the electric light, nor the automobile, essential as they are, but I would name running water in the house. This conduces more to cleanliness and health and comfort than any other improvement that modern civilization has brought us."[105]

IX CHANGING PACE OF THE TWENTIES

Periodic reporting on individual public water supplies by the State Board of Health decreased substantially by the early 1920s and documentation of change becomes increasingly difficult. The earlier reports focused on assessment of problems and needs, while later reports emphasized health personnel work load in terms of such things as inspections made or plans reviewed. However, a major treatise on "Water Supplies and Public Health" by H. E. and K. E. Miller, engineers of the N.C. Board of Health, appeared in the August 1920 *Bulletin of the N.C. Board of Health*. This was a public education effort to inform the average citizen about the relation of water to health and about sources and purification of private and public supplies.

By that time, purification of surface water supplies often included chlorination as well as coagulation, sedimentation, and filtration. Of the 106 public water supplies reported by the board in 1920, sixty were surface and forty-six were well supplies. Forty of the surface supplies were said to be chlorinated. However, a relatively high proportion of water samples from both surface and ground sources and the eighteen "commercial spring waters" were reportedly contaminated. This was true for both chlorinated and unchlorinated supplies. There is no way to know the extent to which sampling and handling procedures of the day may have influenced these results, but they probably left their imprints.

Importance of Water Management Education

One of the essentials for the protection of surface water supplies was said to be "a plant operator thoroughly qualified by training and experience to perform the. . .tests and make use of the information thus obtained." In discussing "sterilization," the authors acknowledged that "unfortunately many of our filter plants are operated by men not qualified by training and experience [and that] the human element involved in water purification is very great, and every water customer should recognize that therein lies his hope of safety."[106]

While watershed protection was widely recognized as an important element of assuring a safe drinking water supply, sole reliance on watershed isolation and patrol, was "to invite inevitable disaster." So wrote George A. Johnson in 1921 when he stated that "the problem of protecting the public from water-borne disease should embrace the application of watershed pollution minimization, and purification by sedimentation, coagulation, filtration, and sterilization."[107]

In a qualified, but euphoric, commentary in 1922, the Board of Health characterized North Carolina as "perhaps the best sanitated state in the union, considering its rural population." "It is the only state," said the Board, "having state laws requiring the sanitary disposal of human excreta. Practically the entire urban population is now served with public water supplies and sewerage." The semi-urban areas, villages, and a "large portion" of the rural population were said to be "protected by a system of sanitary privies." The Board reportedly had 137 water systems serving 600,000 people under its supervision in 1922.[108]

Concerns About Urbanization

"Public Water Supply–The Mutual Responsibility of Municipality and State" was the theme of a post-election appeal to newly elected municipal officials by civil engineer H. E. Miller of the State Board of Health in the early 1920s. Miller reminded the successful candidates of the importance of safe public water supplies to local communities and the respective responsibilities of state and local governments. He noted the rapid changes of the past decade resulting in increased pollution of state waterways, increased urbanization, and demand for water. "The problem confronting public officials today," he said, "is an entirely different problem than that of ten to twenty years ago, and it ranks in magnitude second to no other public problem facing the city official." Miller was calling attention to fundamental changes on the American scene which signaled an evolution from a predominantly rural to an increasingly urban society. Public water supplies were going to have to be viewed in this emerging context which represented a sharp departure from the past.[109] This also heralded major accomplishments in the control of typhoid fever through increasingly protected water supplies, enforcement of the sanitary privy law, and use of typhoid vaccine.[110]

There were now fifty-four filtration plants under state supervision. However, only twenty-four were reported to be "operated on the best scientific basis in a manner capable of maintaining the full effectiveness in purification for which the plants were designed." All of the filtration plants

were reportedly providing "sterilization." There were still twenty-two unfiltered surface water supplies of which eighteen provided "sterilization." With respect to ground water supplies, fifteen were described as shallow ground water supplies and sixty as "deep seated" ground water. Five of the shallow ground water supplies and four of the deep seated utilized "sterilization." Liquid chlorine was the principal "sterilizing" agent utilized.[111]

The Coming of Professional Water-Management Organizations

Initiatives for safe public water supplies came from the dedicated cadre of water works operators and utilities officials as well as from the health and engineering professions. On the national scene this was evidenced by the founding of the American Water Works Association in 1881 by Jacob Foster, Superintendent of Public Works and Engineer for the Town of Lake, Illinois. The objectives were the "exchange of information pertaining to the management of water works for the mutual advancement of consumers and water companies and for the purpose of securing economy and uniformity in the operation of water works." A North Carolina Section of the American Water Works Association (AWWA) was founded in 1921. Lee S. Dukes, former engineer with the State Board of Health and City of Charlotte, reported that "over fifty water works superintendents from various parts of the State attended the sessions which dealt with such issues as filter plant operation, operator training, water supply and fire protection, public utility accounting, and maintenance problems.[112]

The relationships between water supply and water pollution control were recognized by the inclusion of sewage disposal and stream pollution topics in the annual *Journal of the N.C. Section of AWWA* and change in name of annual meetings to "Conference on Water Purification and Sewage Treatment." The North Carolina Water Pollution Control Association was established in 1928 as an affiliate of the national Water Pollution Control Federation–then known as the Sewage Works Association. The two groups later combined into the N.C. Section of the American Water Works Association and Water Pollution Control Federation which was to play an increasingly influential role in development of operator training and certification programs in North Carolina.[113]

X PUBLIC WORKS PROGRAMS OF THE GREAT DEPRESSION AND WORLD WAR II

The "Great Depression" led to a 50 percent reduction in the sanitary engineering staff of the State Board of Health responsible for water works and other sanitation services provided by the state. "With the coming of the Local Government Commission and the unsatisfactory condition of the financial world. . .comparatively little water works or sewer construction" had been proposed in the state. Notable exceptions were new water works at Valdese and Canton. Public health officials alleged that "as a result of present economic conditions the lives and health of thousands of North Carolinians are not only being threatened, but actually sacrificed for lack of adequate sanitation."[114]

Passage of the Emergency Relief and Construction Act of 1932 by the Congress authorized Reconstruction Finance Corporation loans for improvements to local water works and sewerage systems. This led to the promotion of related public works projects by State Board of Health staff in cooperation with the National Recovery Committee of the American Water Works Association. That activity was said to be "in large measure responsible for fifty municipalities submitting applications to the Public Works Administration (PWA) for funds." Included were applications from nineteen towns without public water supply or sewerage conveniences. Drought conditions in 1932 and 1933 allegedly compounded water supply problems in many sections of the state.[115]

An increase in deaths from typhoid fever was reported in 1932 with a warning that "the water supply. . .should be closely scrutinized."[116] A few years later, in 1935, eighty deaths were reported. These occurred in counties from Cherokee in the west to Currituck in the east.[117]

N.C. Water Systems Expansion Under Federal Programs

Marked advances in the extension of water supply and sewerage services throughout North Carolina communities were reported over the next few years with the help of Emergency Relief Administration (ERA) and Public Works Administration (PWA) funds. Dr. H. G. Baity of the sanitary engineering faculty at the University of North Carolina served as State

Director of PWA, which financed the larger projects. The relationship was reported to be a "particularly happy one." During the 1934-1936 biennium, twenty new water distribution systems and nine new water purification plants were reported to be under construction or contract. The new plants were located at Canton, Hemp, Hickory, Hillsborough, Randleman, Ramseur, Rocky Mount, Siler City, and Tarboro. Major improvements in water works systems were also being made under the federal relief programs.[118]

The importance of water plant operator training was being increasingly recognized at this time and the first school conference for officials and plant operators of municipal water departments was held at "State College" in June 1933. The "meeting was received so favorably. . .that a motion that the school conference be held each year was unanimously adopted." The second annual meeting was held at the University of North Carolina at Chapel Hill in 1934.[119]

Reemphasizing the importance of water system operation, D.S. Abell, engineer of the State Board of Health, said in 1938 that "the most vital part of a municipal water department is the personnel that operate and deliver the water." If "given the choice between an unusually high-grade plant with a poor operator as compared with a poor plant and a high-grade operator, I would certainly take the latter every time," he said. He complimented the City of Raleigh for its high quality operating personnel and cited the Capital City as an example of "a poor plant with expert supervision." Abell expressed regret that a bill providing for licensing of water purification plant operators had not received favorable action by the legislature in 1937.[120]

The federal programs together with associated promotional efforts by the State Board of Health continued to expand public water supply services in North Carolina with eight new water purification plants and nineteen new water systems brought under construction during the 1936-1938 biennium. By the end of this period the state had 101 purification plants. Only thirty-five of these were under the control of technically trained operators. Annual water works operator short courses continued to be conducted at State College. A similar program for sewage works operator training was being conducted by the UNC School of Public Health. This pattern of operator training at the two schools continues to the present day.[121]

A promotional piece in the October 1939 *Bulletin of the N.C. Board of Health* encouraged local officials to take advantage of the federal public works programs before "war activities (preceding World War II) may greatly reduce the available labor supply ... or eliminate it entirely." Headlined, "Sanitation on the Bargain Counter" and "Many Towns Getting Water and Sewer Lines Cheap!," the piece extolled the sanitary virtues achievable at "25 cents on the dollar."[122]

Fifty-two water systems were constructed during the five-year period ending with 1940, bringing the state total to 267.[123] By 1941, the advent of national defense measures had made it almost imperative that major construction such as water and sewer systems "be carried out solely through means of private contracts." National defense projects had begun to absorb the labor formerly available for such work.[124] Some of these, however, continued to benefit communities in defense-impacted areas through such war-time legislation as the Lanham Act, under which Jacksonville, Fayetteville, and Wilmington received federal funds for the construction of major water supply facilities.[125]

Water Plant Operator Certification

Improved water system operation was reportedly enhanced through the formation of the Water Plant Operators' Association at the Annual Water Works School in 1941. The voluntary association of 106 members provided three grades of operator certifications. The Board of Health encouraged legislation to require that chief operators at filtration plants have state licenses issued after written examinations.[126]

Construction of new public water supplies continued during World War II with about half at military installations. Concern over the security of water systems in defense-impacted areas found expression in the Security Facility Program, a cooperative project between the State Board of Health, U.S. Public Health Service, and Office of Civil Defense. Inspections were made of water facilities having a direct bearing on the war effort.[127] A mutual aid plan initiated in 1942 provided inventories of water works materials available to participating communities. A Ten Point Program for Emergency Preparedness for Water Works was said to uncover many deficiencies in water works operation and to afford better protection of public water supplies against "sabotage and air raids."[128]

Deaths from typhoid fever, long the scourge of contaminated water supplies, continued a downward trend, dropping from 154 in 1930 to nineteen in 1943.[129] The number of cases reported annually fell from 1000 to 117 during the same period.[130] (See Figure III.)

The year 1943 was marked by the completion of Wilmington's new John H. Sweeney Filtration Plant, part of the city's new water supply system. Providing chemical coagulation, sedimentation, filtration, and chlorination, the plant represented a major advance in the sixty-two-year period from its first untreated supply from the Northeast River and mirrored general progress in upgrading public water supplies across the state.[131]

Following World War II, "a great number of towns" were planning water supply construction or reconstruction with financial aid from the Federal Works Agency. The State Board of Health reported that while the number of public water supplies had increased from 132 in 1921 to 336 in 1946, there was "still much to be accomplished toward providing a safe public water supply for the urban population of North Carolina."[132]

XI THE FLUORIDATION CONTROVERSY

When water passes over or through mineral deposits, a portion of the soluble elements or compounds is dissolved and enters the water. Many public water supplies, particularly ground water, contain fluorides derived in this manner. Wastewater discharged upstream from water supply intakes or to ground water recharge areas can also contribute to the fluoride content of water supplies. F. J. Maier reported in 1972 that over 2630 public water supplies in the U.S. contained 0.7 mg/l or more fluorides. Of those, about 1200 had such a high fluoride level that a noticeable mottling of tooth enamel occurred among all who drank those waters.[133] A report of the fluoride content in public water supplies in North Carolina by the U.S. Geological Survey (USGS) in 1949 disclosed twenty-six supplies with "natural" fluoride levels of 0.7 ppm or higher. All but one (a spring) were well supplies. Ten had natural levels of 1.3 ppm or higher.[134]

The first scientific evidence of the health effects of fluorides in drinking water appeared in 1901 when a U.S. Public Health Service physician stationed in Naples, Italy, reported mottled teeth among potential emigrants to the United States. Based on this and similar observations from other sources, studies were undertaken which gradually revealed a direct association between tooth mottling, reduction in dental caries, and fluoride concentrations, where fluoride-bearing waters were ingested during tooth development years. Extensive investigations led to the conclusion that trace quantities of fluorides ranging from 0.5 to 1.5 mg/l in drinking water would lessen dental caries among individuals who consumed the water during tooth development.[135]

The publication of classical epidemiological studies by Dean, Jay, Arnold, McClure, and Evolve in 1939 provided the data needed to demonstrate that domestic water containing 1 ppm fluoride did not result in any disfigurement of tooth enamel and that there was an inverse relationship between the fluoride content of the water and the dental cavities experience of children who consumed the water throughout tooth development. The effects of using fluoridated water to control tooth decay were further established through many subsequent studies undertaken to confirm these findings. These included controlled demonstrations involving a number of

cities in the United States and Canada.[136] There were early indications that the effects of fluoride ingestion on dental decay and mottling were influenced by climatological factors and associated water consumption and standards were adjusted to take this into account.[137]

Fluoridation in North Carolina

North Carolina approached supplemental fluoridation cautiously. The Board of Health was of the opinion in 1948 that "this treatment is still in the experimental stage. . ." and would "neither promote nor attempt to prevent" towns from starting the application of fluoride to their water supplies. Cities proposing to undertake the practice were asked to furnish qualified technical personnel to supervise the application, submit plans to the board for prior approval, make periodic analyses to assure fluoride concentrations did not exceed 1.5 ppm, and submit laboratory findings to the board monthly.

The Board also suggested "that municipalities contemplating this measure first seek the approval of their local dental and medical societies."[138] The latter recommendation was probably based as much on the need of local officials to offset the effects of the acrimonious debate associated with this first effort to utilize public water supplies for medical or dental prophylaxis. As M.N. Baker stated in his history of water purification, "What the future holds in store for the water works man in the field of mass medication remains to be seen."[139] The future he alluded to was to reveal an extended period of stormy controversy between those who viewed the adjustment of fluoride in drinking water to therapeutic levels as a sound public health measure and those who opposed the practice for a variety of reasons ranging from alleged harmful effects to religious beliefs.

A year later, on April 4, 1949, Charlotte was the first North Carolina city to adopt supplemental fluoridation.[140] A review of news coverage by the *Charlotte Observer* suggests little, if any, of the rancorous debate that surrounded similar actions by other North Carolina communities in the next few years. Perhaps, this was simply due to fortuitous timing of the event during the calm before the storm that was yet to come.

Winston-Salem adopted flouridation on October 11, 1951, and by 1958 a total of twenty-six additional cities and towns had followed suit.[141] Many of their experiences were far from tranquil. The capital city of Raleigh, for example, was to take two years, a city council vote and two general elections to overcome the tide of opposition that developed.

Fluoridation Controversy in Raleigh

The Raleigh action started with adoption of an ordinance on March 19, 1956, providing for fluoridation of the city's water supply.[142] There seemed to be little opposition at the time and the vote was six to one in favor of the ordinance. Late that year, there were reports of sharply increased interest on both sides of the question. The student government at N. C. State College adopted a resolution on December 1, 1956, stating: "Whereas fluoridation means better health for children, it is safe, and it is economical: be it resolved that the. . .Student Government endorses the program to fluoridate the water in the City of Raleigh."[143] This was followed by letters to the editor ranging from an allegation that fluoride "tastes and smells like carbide and cyanide" to letters expressing appreciation for the paper's position on the fluoridation issue.

Newspaper editorials encouraged voters to support the fluoridation proposal at the election scheduled for December 11, 1956. Voters were advised to decide whether their children were to get "protection of their health" that fluoride would provide.[144] The campaign against fluoridation was characterized by the paper as "being waged by ill-informed citizens who wish to deprive the city's living teeth of natural protection against decay." "The battle has been going on for months," reported the *Raleigh Times*, "ever since the City Council voted to supplement the fluoride in the city water." The fight was said to intensify after opponents had petitioned for a general election on the issue. "Much false and deceiving literature has been dumped on conscientious citizens," it was said. "If the voters examine the claims made by both sides," wrote the *Times*, "they will see that the medical and civic authorities who want flouridation base their stand on established facts and actual practice. Those who argue against fluoridation rely solely on fears and whims."[145]

Dr. J.W.R. Norton, State Health Officer at the time, said, "There is in our state. . .a great gap between dental health needs and available dental services. One means of closing this gap is to reduce the needs." "Fortunately," he continued, "we have an effective public health measure [fluoridation]." He cited the endorsements of fluoridation by state and national health and scientific societies and agencies.[146]

Opponents of fluoridation were alleged to have contended that fluoride is a deadly poison which will do just about everything from stiffening the joints. . .to producing premature senility." The voters approved fluoridation by a margin of 4012 to 3241.[147] The issue was not to be settled, however, until a second election on May 7, 1957, when voters rejected an ordinance which would have prohibited fluoridation.

Fluoridation of the Raleigh water supply was reportedly commenced on June 28, 1957.[148]

Fluoridation of drinking water supplies has enjoyed the strong support of the U.S. Public Health Service which pointed out that, "for about a dime a year per person, communities can add fluoride to their water supplies and bring their children the benefits of 40 to 65 percent less tooth decay. The practice had been endorsed by the American Dental Association, American Medical Association, American Public Health Association, and other professional societies.[149] By 1988, the number of communities providing fluoridated water in North Carolina had risen to 267 and the population served to more than 2,837,000.[150]

XII GROWING CONCERN OVER POLLUTION OF WATER SUPPLIES

While the pollution of surface and ground water sources of water supply by sewage and industrial wastewater discharges had long been viewed as a threat to the public health, there doesn't appear to have been any study explicitly directed toward the control of stream pollution until the late 1920s. Community sewerage systems had been increasingly recognized after the turn of the century as essential to the sanitary disposal of sewage and protection of water supplies against pollution. Studies of sewage treatment, industrial wastes, and streams were seen as necessary to determine the "safe capacity of the streams for assimilation and destruction by natural processes of sewage and other waste materials. A Stream Sanitation and Conservation Committee, representing the State Board of Health and the Conservation Commission, was formed in 1927 to coordinate and guide the early studies.[151] These included investigations of stream pollution on the Neuse, Haw, Tar, Catawba, and the Roanoke rivers.[152]

By the late 1930s, Board of Health engineers were reporting that "stream pollution in North Carolina is recognized as one of our greatest problems." "It is recognized by all who have given thought to the problem," they said, "that the first use of our streams should be for public water supplies," and that long-range planning, policies, and programs for water pollution control were needed.[153] However, in 1942 the board reported that, "the State had not deemed it necessary to make an appropriation for these activities, consequently [the Board] has been able to do only a negligible amount of stream pollution work. What little information we have been able to compile on our streams has been obtained largely from work previously done by agencies of the Federal government."[154]

Tangible evidence of broader support for water pollution control came in 1945 when the Legislature formally established the State Stream Sanitation and Conservation Committee to study and report on pollution of all streams. Despite lack of an appropriation or additional personnel for this work, a survey was commenced with the intent of preparing a report for the 1947 General Assembly. "The question of stream sanitation is becoming magnified each day," the board reported, "and is a problem which must be

faced in the future industrial development of the State, as well as in the public health protection of public water supplies."[155]

Stream Pollution Studies and Legislation

The stream sanitation study, started in early 1946, produced a report to the General Assembly which resulted in a small appropriation to the State Stream Sanitation and Conservation Committee for stream pollution studies in 1948. That was the year the Congress enacted the nation's first Federal Water Pollution Control Act which heralded an era of federal-state cooperative water pollution control programs that continues to this day.[156]

By 1950, J. M. Jarrett, Head of the Board of Health's Sanitary Engineering Division, reported that "water supplies are being seriously menaced in North Carolina. . .in that our streams are becoming polluted, more and more, with human and industrial waste material." "In some cases," he said, "it is impossible for a city to tap an adequate water supply because of this condition."[157]

In 1951, the General Assembly enacted the State Stream Sanitation Law creating the State Stream Sanitation Committee as an autonomous body within the State Board of Health. This legislation authorized the development and administration of a "comprehensive stream pollution control program based upon the classification of waters according to the present or contemplated best usage."[158]

As observed by Professor Milton S. Heath, Jr., of the UNC Institute of Government, the North Carolina pollution control program was "dominated during its first twenty years by two forceful and able leaders," J. Vivian Whitfield and Earle C. Hubbard. Whitfield, a former State Senator and Foreign Service Officer, was a principal legislative backer of the 1951 State Stream Sanitation Act and became chairman of the Stream Sanitation Committee in 1956. He served continuously as chairman of that committee and the successor Board of Water and Air Resources until his death in 1968. Earle C. Hubbard was named the first staff director of the State Stream Sanitation Commission in 1951 and headed the staff "for the better part of twenty years."[159]

Efforts to Eliminate Duplication of Pollution Control Responsibilities

Heath reported that the arrangement under the 1951 legislation remained essentially unchanged until 1957 when the General Assembly attempted to deal with overlap and duplication of work between the State

Stream Sanitation Committee and the State Board of Health in protecting municipal water supplies from pollution. The problem of duplication was addressed by making the Stream Sanitation Committee an independent unit within the Board of Health and designating the board (through its Division of Water Pollution Control) as the committee's administrative agent. The Division of Water Pollution Control was made responsible for administering the clean streams law and such other duties pertaining to municipal, institutional, and industrial wastewater disposal as might be assigned by the Board of Health.[160]

In 1958, the Board of Health attempted to cope further with the problem of duplication by assigning responsibility to its Division of Water Pollution Control for administration of the clean streams law as well as pertinent sections of the health code for major sources of pollution to classified waters. The board's Sanitary Engineering Division continued to administer the health code with respect to pollution of unclassified waters. Two years later, in 1959, the Stream Sanitation Committee with its Division of Water Pollution Control was transferred from the Board of Health to a new Board and Department of Water Resources.[161]

Broadened Environmental Legislation

The Water and Air Resources Act of 1967 broadened the pollution control mandate of the General Assembly to include both water and air pollution, and the titles of the administering board and department were changed accordingly. The act provided for comprehensive pollution and water-use surveys, development of surface water classifications as to best use and associated water quality standards, preparation of comprehensive pollution abatement plans, classification and reclassification of surface waters, enforcement, and other functions.[162]

Heath referred to 1971 as a "banner year for environmental legislation. . .in North Carolina." He cited new water quality laws authorizing the State's first appropriation to aid in the construction of local wastewater treatment plants and a bond referendum for additional financial aid for public water supply and wastewater treatment plants (also see Chapter XIV, State and Federal Planning Initiatives), authority for tightened definitions and enforcement procedures, strengthened pollution control monitoring and reporting, a regional water supply law (see Chapter XV, Regional Planning Initiatives), establishment by the State Board of Health of minimum standards for public water supplies, and other actions.[163]

State government reorganization legislation subsequently changed the name of the Board of Water and Air Resources to the North Carolina

Environmental Management Commission and its Division of Water and Air Resources to the Division of Environmental Management effective July 1, 1974. Both currently reside within the Department of Natural Resources and Community Development.[164]

The Sedimentation Pollution Control Act of 1973 offered an additional regulatory tool for the protection of water supply watersheds from sediment arising from land disturbing activities associated with urban and highway construction. Its principal beneficial effects were seen as improving the quality of raw water supplies, lowering the cost of water treatment, and extending the effective life of water supply storage reservoirs. The policy-making body for this program is the Sedimentation Control Commission. The program is administered by the Division of Land Resources in the Department of Natural Resources and Community Development.[165]

State Assumption of Federal Water Regulation

Since passage of the first Federal Water Pollution Control Act in 1948, the State program has been increasingly influenced by federal legislation and regulations. Major steps in this regard were the initiation of the federal construction grants for wastewater treatment plant construction in 1956, imposition of stream water quality standards in 1965, and National Pollution Discharge Elimination System (NPDES) permits in 1972. The initial emphasis on water pollution control for the protection of public water supplies had now been broadened to encompass all water uses, though water supply continues to be cited as the highest and best use of surface waters.

The 1977 General Assembly renewed the Clean Water Bond Act (see Chapter XIV, State and Federal Planning Initiatives).[166] Two years later, in 1979, the General Assembly enacted "the major water supply legislation of recent years," the North Carolina Safe Drinking Water Act. The act was designed to enable the State to assume primary jurisdiction over drinking water standards authorized by the federal Safe Drinking Water Act. It also rewrote previous water supply legislation and empowered the Health Services Commission (formerly the State Board of Health) to adopt and the Secretary of Human Resources to enforce comprehensive regulations over public water supplies.[167]

The 1987 General Assembly, responding to a continuing need for State aid to local governments for water and sewerage facilities and to federal initiatives under 1987 amendments to the federal Clean Water Act, authorized a Clean Water Revolving Loan and Grant Fund. However, the appropriations were insufficient to test the legislation's effectiveness.[168]

Heath reported in 1988 that "a number of state government programs combine to provide some protection for surface water supply or 'watershed' areas." He noted wastewater discharge permits, non-discharge permits involving the use of surface and subsurface land treatment systems, sedimentation pollution control standards, and the State's agricultural cost-share program for non-point sources of pollution from agriculture. He also cited the State Drinking Water Act, the new water supply classifications for surface waters, statutory emergency powers, and oil/chemical spill response procedures. Heath said that local governments are finding at least two important ways to participate in watershed protection through land-use controls and other means to control non-point source pollution.[169]

Ground Water Protection

"If the 1970s were the decade of 'clean rivers,'" wrote Heath in 1987, "the 1980s may go down in history as the decade of safeguarding ground water." "Neither North Carolina nor most other states has a truly comprehensive or systematic law of ground water quality," he said. "The most nearly comprehensive approach to ground water [quality]," in his view, is the ground water classification system which adapted the concepts of the traditional surface water classification system to ground water conditions. He notes that federal and state solid and hazardous waste, radiation protection, oil spill, capacity-use area, well construction, and mining laws are addressed in varying degrees to the protection of ground water quality. Recent federal initiatives concerning ground water contamination from underground storage tanks, surface impoundments, landfills, pesticides, and nitrates will, in Heath's opinion, result in further protection to ground water quality. General statutory authority has been granted for the State to adopt regulations and standards on underground storage tanks and to study further these and other sources of ground water contamination.[170]

XIII ONSET OF THE PLANNING ERA

Creation of the N. C. Geological Survey by the General Assembly in 1891 initiated a series of actions in concert with the U.S. Geological Survey that were to eventually provide much needed data on ground and surface waters in support of public water supply planning and management. While the State Survey's charge was to undertake a "thorough examination of the nature and extent of mineral and timber resources. . .," the first director, J.A. Holmes, also had drinking water in mind. He said that "the supplies of good drinking water in many portions of this eastern region is a matter of great importance to every person living in the region, and to this subject will be devoted one of the special bulletins of the Survey to be published in the near future." In Holmes' view, "A large majority of our people use as drinking water that which comes from springs or shallow wells" to which "impurities of various kinds may reach the water which we drink." It was for this reason that the State Survey undertook "to investigate the possibility of supplies of drinking water at depths below the surface sufficient to be beyond the reach of. . .surface contaminations."[171]

State-USGS Cooperative Program

Two years later, Holmes reported that "a new line of work has been started during the past year, which is the investigation of the streams in regard to the amount of water that they contain at various times throughout the year and their available water-powers." This was to initiate a cooperative stream gaging program with the U. S. Geological Survey that continues to this day. He proposed that "stations be established at one or more points on each of the more important rivers. . .[and] that at each such station a competent observer. . .measure and record the height of water in each stream each day." Once monthly, an engineer was to measure the volume of water and rate of flow.[172] By 1896, five stations had been established on the Roanoke, Cape Fear, Yadkin, Catawba, and French Broad rivers. While the primary purpose of stream flow gaging in those early years was power development, the data were soon to prove useful for the planning of public water supplies.[173]

The systematic collection and reporting of hydrologic data was probably first evidenced by a "Report on the Water Resources of the Coastal Plain Region" mentioned in the *10th Biennial Report of the N.C. Geological Survey* in 1910. A copy has not been found, but it allegedly contained descriptions of water resource availability in each of the eastern counties.[174] That biennial report also refers to a study by Holmes of the City of Marion watershed. "Being now possessed of a lavish supply of as pure and good water as any town desires," Holmes said, "the City Council is extremely anxious to do all in its power to keep the water pure and clear from any contamination."[175]

The *1913-1914 Biennial Report of the N.C. Geological Survey* stated that "a study of the watersheds of the cities and towns of State has been started in cooperation with the State Board of Health."[176] Two years later, there was reference to "An Act to Protect Watersheds Owned by Cities and Towns From Damage by Fire," which pertained to timber harvest and cleanup within 400 feet of city watersheds.[177]

Forestry specialists of the N.C. Geological Survey said, "Many watersheds in the Piedmont area can be very much improved by reforestation of the areas. The Survey was assisting cities and towns in every way possible in planning for the reforestation and protection of their watersheds, but the amount that can be accomplished in this way is limited by the lack of realization of many of the commissioners of our cities and towns as to the need of the protection of their watersheds. Any infraction of the regulations for the protection of watersheds should be severely punished."[178]

By 1920, water resources investigations of the State Geological Survey had assumed sufficient importance to justify a new Water Resources Division. Its charge was to undertake a "water resources survey of the State looking toward the development and utilization of our unused water powers and assist municipalities or thickly settled rural communities in the acquirement of adequate water supplies and watersheds."[179] The Survey alleged that "because of the rapid growth and expansion of many of the towns and cities of North Carolina, the local water supplies are proving inadequate and resort must be had to acquiring or extending watersheds." There is reference to special investigations of Carthage, High Point, Wilmington, and Hickory water supplies.[180]

The steadily expanding network of stream gaging stations led State Geologist B. S. Drane to say in 1924 that "North Carolina maintains more stream gaging stations than all other South Atlantic States together." This was and continues to be a cooperative program with the U.S. Geological Survey.[181]

Establishment of State Water Resources Program

A Department of Conservation and Development was created in 1925 with definite responsibilities for development of the State's water resources. This encompassed the State Geological Survey and its surface and ground water programs. Public water supply apparently ranked at the top of the State hierarchy of water uses. Noted hydraulic engineer Thorndyke Saville, head of the new department's Water Resource Division and member of the faculty at the University of North Carolina, said in 1926 that "it is generally agreed that the highest uses of the water resource are: sources of public water supply, sanitation (conveyance of sewage and industrial wastes after suitable treatment), and for manufacturing and industry, power, agriculture, and navigation."[182] "Stream gaging," said Saville, "has constituted our major activity." The twelve gaging stations in place in 1920 had increased to fifty-four in 1926. Fifteen of the stations had been equipped with automatic recording gages.[183] "Recent failures in a number of municipal water supplies [were] attributed to lack of stream flow data." At this time, the State Survey was cooperating with the City of Durham in development of the Flat River as a source of water supply which led to the construction of Lake Michie.[184]

The only systematic investigation of ground water prior to 1945 appears to have been a survey of the ground water resources of the Coastal Plain in 1905 and 1906. The report of that survey served as basis for subsequent work in this area.[185]

Cooperative studies with the USGS increased in the late 1920s and early 1930s. These included the collection of ground water data for 592 wells in the Piedmont and summarization relative to geologic information, depth, and well diameter. Other studies dealt with chloride contamination in the New Bern area and ground water resources around Elizabeth City. A decade later, the USGS extended the ground water studies to include the City of Wilmington and the Jacksonville area.[186]

Corps of Engineers Planning

The first river basin-wide water resources planning was undertaken by the U.S. Army Corps of Engineers under the provisions of House Document No. 308, Sixty-ninth Congress, enacted into law as the Rivers and Harbors Act of 1927.[187] North Carolina interests were reflected in reports that were prepared for the Cape Fear, Neuse, Roanoke, and Yadkin-Pee Dee River Basins in the early 1930s. As noted by Dr. David H. Moreau, professor in the Department of City and Regional Planning at UNC-CH and

present director of the Water Resources Research Institute of The University of North Carolina, public water supply received relatively little attention in these reports.[188] No mention was made of water supply use in the Roanoke River and Yadkin-Pee Dee Basins and little attention was given to this in the Cape Fear River Basin.[189-191] The principal purposes of the "308" studies were for navigation, power, flood control, and irrigation.

With respect to water supply needs, the Cape Fear and Neuse River Basin Reports stated that:[192-193]

> In any plan. . .for the development of a stream the use of its waters for domestic consumption should be given primary consideration. A number of municipalities in the. . .river basins are dependent upon this stream or its tributaries for their water supply. Most of these cities are now adequately supplied with water for all apparent future uses for many years to come. For the most part, they are located either on the extreme upper tributaries of the stream or in its lower reaches where their sources of supply will not be materially affected by any proposed development of the other resources of the stream or its tributaries.

For the above reasons, municipal water supply was not considered further in the Cape Fear report. However, the cities of Durham, Raleigh, and Wilson in the Neuse River Basin drew more detailed consideration.[194]

> **Durham** - Flat River reservoir supply was estimated to be adequate until 1950. The report concluded that a sufficient supply for an indefinite period could be obtained by raising the crest of the dam to provide additional storage.
>
> **Raleigh** - The Walnut Creek supply proved to be adequate until the droughts of 1925 and 1926. "City was unmetered and large amount of water was wasted." Metering reduced daily per-capita use by approximately one-third. As a further safeguard, the Neuse River was considered to be a possible source, but was not adopted due to "a general aversion of the public to the use of a stream which was being polluted by untreated sewage." Raleigh finally decided to secure its auxiliary supply from Swift Creek, a tributary of the Neuse River. An intake was built at Rands Mill where there is a small pond. The report concluded, "It appears that Raleigh

is adequately supplied with a source of water supply for some years to come. The present sources. . .are not inexhaustible. . .[and] at some future date Raleigh will need a greater source of supply. Either Crabtree Creek or the Neuse River are logical sources. . .and no plans should be made for other uses of these streams which might conflict [with] their use for this purpose."

Wilson - "The City obtains its supply from Wiggins Mill Pond on Contentnea Creek, the principal tributary to the Neuse River. Growth in consumption has been at a moderate rate, partially due to the fact that metering has tended to lower per capita use. Increasing the reservoir's capacity by raising the crest of the dam at Wiggins Mill, as proposed in the plan for development of this stream. . .would be of little benefit to the Wilson water supply for many years."

Moreau reported that by 1962 when the comprehensive plan for development of the Cape Fear River Basin was released, water supply needs in the basin "had grown to such an extent that they could no longer be neglected." That study surveyed existing public water supplies and estimated basin-wide needs for a fifty-year period. It also surveyed water pollution problems and wastewater treatment works. However, the development plan for the New Hope (Jordan), Randleman, and Howards Mill reservoirs included storage to meet only 65 percent of estimated water supply needs in the basin.[195]

"Overall," concluded Moreau, "comprehensive water resource planning as it has been experienced in four North Carolina river basins can be characterized as supply-oriented and focused on large-scale projects from which large contributions to national economic efficiency are anticipated." He observed that "none of the plans. . .considered problems of distributing water services to the many municipalities in the basin nor have they embraced problems of collecting and disposing of wastes from these areas."[196]

The Missing Elements in Traditional Water Supply Planning

According to Moreau, river basin planning and urban water supply and wastewater disposal appear to have followed two disparate models. "The former," he said, "focused on development of the supply system through large-scale, multiple-purpose projects that contribute to national

economic efficiency, while the latter has sought to meet water supply demands and satisfy waste disposal needs of individual urban areas through development of least-cost, single-purpose projects. . .What appears to have fallen between these two modes of government intervention is a process for capturing economies of scale and resolving externalities that exist among urban areas in supplying a broad range of urban water-based services."[197]

The increasing demands imposed on the State's water resources by an expanding population and expanding industrial and agricultural bases underscored the need for an expanded state role in comprehensive water resource planning as well as water quality protection. The first of these efforts found expression in *Report on Water Resources - 1937* by the N.C. State Planning Board with assistance and cooperation of the federal Works Progress Administration and guidance of the National Resources Committee.[198] This pattern of federal-state cooperative planning set the stage for later water supply and water resource programs in the State. Much of the emphasis with respect to water supply planning was on the need to reverse deteriorating water quality. "In general," the report concluded, "towns lying in the Coastal Plain, Piedmont, and eastern interior region have been forced to filter and treat their water supplies because of pollution by sewage and industrial wastes and through soil erosion." "The absence of unpolluted surface waters in the Coastal Plain," it continued, "has forced many cities and towns. . .to resort to underground sources for their water supplies." The problem of stream pollution was said "to be one of paramount importance, not only to abate present pollution, but also to safeguard the future." There was little cause for optimism in the finding that "the time is surely not far off when urban centers in many areas of the state will find it increasingly burdensome and expensive to secure adequate, safe and potable supplies."[199]

The federal view of water problems at that time was stated by the Water Resource Committee of the National Resources Committee as follows:

> During the last few years it has become increasingly apparent that such orderless, unintegrated treatment of water problems, however natural or excusable it may have been under pioneer conditions, should no longer be tolerated. Water, though at times a merciless enemy of man, is perhaps the most precious natural resource of the Nation. The supply of water for essential purposes . . .is strictly limited.[200]

XIV FURTHER STATE AND FEDERAL PLANNING INITIATIVES

Public water supplies have never been the sole domain of local government. Planning and management have been increasingly influenced over the years by state and federal legislation and programs. While the initial concern for public health remains, state and federal intervention has included hydrologic and water quality studies, financial assistance for planning and construction of water supply and wastewater treatment systems, regulation, planning, and the construction of storage reservoirs.

The State-USGS cooperative program was expanded in 1954 to include additional data on water quality, quantity, and use.[201] In 1955, the N.C. Department of Conservation and Development published an eleven-volume inventory of *Water Resources of North Carolina*. Its purpose was to present information on water availability, uses, quality, quantity, watershed management, soil conservation, water pollution control, flood control, navigation, and other topics. Water use for domestic and municipal purposes was reaffirmed as the highest and best use.[202] At that time, there were 148 surface water and 157 ground water public water supplies. Surface water supplies predominated throughout all areas of the state except for the Coastal Region where use of ground water predominated. That pattern continues today. Treatment was provided for 114 of the surface water supplies and seventeen of the ground water supplies.[203]

State Board of Water Commissioners

What was characterized by Heath and Professor Warren J. Wicker of the UNC Institute of Government as a "mildly revolutionary proposal born of the extended drought of the early 1950s" was offered to the 1955 General Assembly. This would have replaced the traditional riparian reasonable-use doctrine with the rule of prior appropriation applicable to the western states. Heath and Wicker reported that the proposal had strong backing from municipal and agricultural interests but met with stronger opposition from the industrial sector and was rejected in favor of a compromise involving creation of a water policy study group–a State Board of Water Commissioners with limited authority to control water use in local water-

supply emergencies. During the late 1950s the water commissioners were led by General James Townsend, an early supporter of water law reform.

State Board of Water Resources

The Board of Water Commissioners was transformed into the State Board of Water Resources in 1959. Among its powers and duties was to notify local governments of potential shortages and emergencies affecting water supplies and to make recommendations for restricting or conserving the use of water or increasing the water supply.[204] According to Heath and Wicker, the new board was originally conceived as a single coordinating body for all state water programs to be staffed by a single Water Resources Department–also created by the 1959 General Assembly. However, the legislation created one department with two policy-making bodies: the State Board of Water Resources and the State Stream Sanitation Committee. General Townsend headed the board and former Senator J. Vivian Whitfield, the "father of the Stream Sanitation Law," remained as chairman of the Stream Sanitation Committee. Finally, in 1967, legislation unified policy direction for the Department of Water Resources under a single Board of Water Resources. The State Board of Health still retained responsibility for the regulation of public water supplies and certain aspects of surface and ground water quality related to public health protection.[205]

Auxiliary Roles of Federal and State Agencies

In their 1964 report, *Water Resources Planning in North Carolina*, Heath and Dr. David R. Godschalk of the Department City and Regional Planning at UNC-CH estimated that 46 percent of the state population was served by municipal water systems. "In recent years," they reported, "enabling laws have been enacted to broaden the powers of counties to operate water systems and to enable cities and counties to provide joint water supplies." They viewed the state and federal agencies as serving auxiliary roles. "The principal responsibilities of the N. C. Department of Water Resources," they said, "are to survey and consult on public water supplies, to anticipate potential public water supply shortages, and to regulate water use in the event of local water emergencies." "The State Board of Health," they continued, "has the basic responsibility for supervising the sanitation and safety of public water supplies. . .[and] also supervises the formulation of sanitary districts, inventories public water supplies and in cooperation with the State Stream Sanitation Committee supervises the quality of water supplies." In addition, they reported, the State Utilities

Commission regulates private water companies; the Local Government Commission supervises fiscal management and financing of public water supplies; and the Division of Community Planning provides assistance to local governments for water supply planning.[206]

Federal programs for local water supply development in 1964 included the following:

Reservoir storage - Corps of Engineers, Soil Conservation Service, and Tennessee Valley Authority

Loans and grants - Community Facilities, Area Redevelopment, and Farmers' Home Administrations

Planning assistance - Community Facilities Administration, U.S. Geological Survey, Soil Conservation Service, and U.S. Public Health Service

Among the mid-1960s water supply problems identified by Heath and Godschalk were "ill location [of cities] with respect to potential water sources, . . .poor planning, inadequate distribution systems or storage facilities, or financial starvation." They saw these problems as an opportunity "for a real contribution by. . .State Government." An "obvious first step," they said, "is the continuation of [the] comprehensive state survey of public water supplies." They concluded that "there is a large potential program area for the Department of Water Resources to explore in cooperation with other state and local officials." Included were alternative means of meeting water supply needs–whether through intensive ground water exploration and development, utilization of water from nearby surplus areas, salvage and reuse of wastewater, saline water conversion, or other methods.[207]

Concern About Loss of Reservoir Sites

It was at about this time that Dr. Daniel A. Okun of the Department of Environmental Sciences and Engineering at UNC-CH reemphasized an important theme in water supply protection that had been voiced repeatedly during the past century. "Areas suitable for reservoir construction are limited by topography, hydrology, and geology," he wrote. Noting that "the avariciousness of communities for land. . .together with lack of planning, has resulted in the loss of many. . .available sites," he emphasized the need to

give water quality equal status with quantity in water resources and reservoir planning to facilitate high quality water supply source development."[208]

Enactment of the federal Water Resources Planning and Research Acts in 1964 set in motion cooperative federal-state planning and research programs that opened new opportunities for the improvement of water supply planning and development in North Carolina.

New funds were made available under the Water Resources Planning Act through the U.S. Water Resources Council for the initiation of a State Water Plan and other studies.

Federal-State Water Resources Research Program

The Federal Water Resources Research Act of 1964 authorized a cooperative federal-state water resources research program including State Water Resources Research Institutes located at Land Grant Universities. The Water Resources Research Institute of The University of North Carolina was established in 1965 as a unit of the University of North Carolina system. David H. Howells was the first director and served until 1976. He was followed by Dr. Neil S. Grigg and later by the current director, Dr. David H. Moreau. Located at N.C. State University, the Institute has conducted its program in close association with state and local governments. Public water supply has been treated as a high priority and the Institute has sponsored more than forty research projects and symposia dealing with water supply problems.

In 1985, the Institute established the Urban Water Consortium to conduct a cooperative water supply program with several of North Carolina's larger cities and special water/sewer districts. Its primary purpose was to support research and provide technology transfer in support of high quality and more cost-effective water services to urban residents. Among its priorities were water management under drought conditions; watershed protection and management; operation, maintenance, and replacement of water distribution systems; water extension policies and financing; rate setting; computerization of operations; legal aspects of water management; and other areas of concern. The work of the consortium is cooperatively funded from local and state sources.

Federal-State Water Resources Planning Program

The federal Water Resources Planning Act of 1965 was enacted to provide for the optimum development of the nation's natural resources through the establishment of a water resources council and river basin

commission and through federal financial assistance to the states in order to increase their participation in such planning. Despite the uncertainty of federal appropriations and changing policies under different administrations, the financial assistance did permit the N.C. Department of Water Resources to strengthen its water resources planning. One of the first undertakings was to commence the development of the State Water Plan for North Carolina.

Capacity Use Area Legislation

In the first report of its State Water Plan, "Wise Management of North Carolina's Water Resources Through Law," in 1966, the Board of Water Resources reported that "the level of demand for non-compatible uses has reached the critical point or is reaching that point" with respect to ground water problems in the Coastal Region arising from "extremely large pumpage" in the Beaufort County area associated with phosphate mine dewatering.[209] These problems led to enactment of the Water Use Act of 1967 for the "management of water withdrawal and uses in designated capacity use areas as needed to conserve water resources in the areas and to maintain conditions. . .conducive to the orderly development and beneficial use of these resources." In addition to regulatory measures, the act authorized the Environmental Management Commission (formerly the Board of Water Resources and later the Board of Water and Air Resources) to "promote or sponsor any other reasonable water management measures" to protect or improve the quantity and quality of the water resource.[210] This was the first regulatory authority over the use of water to be adopted in North Carolina other than an unworkable irrigation permit law that was repealed in 1961.[211]

The Water Use Act of 1967 authorized the Environmental Management Commission to declare capacity use areas where it finds that the use of ground water or surface water requires coordination and limited regulation to protect the interests and rights of residents, property owners, or the public. The procedures specified by the act included an investigation by the Department of Natural Resources and Community Development's Division of Water Resources and a report to the commission. The commission may then act to declare a capacity-use area if it finds that withdrawals of water or discharge of pollutants have resulted or probably will result in a generalized condition of water depletion or water pollution within the area. Rules applicable to capacity-use areas can apply to water withdrawals in excess of 100,000 gallons per day and wastewater discharges in excess of the specified rate.[212]

The first declaration of a capacity-use area involved the multi-county region centering upon Beaufort County. The Castle Hayne Aquifer was seen as the principal water supply source for that region. Its capacity was threatened by the continuous large-scale pumping at the phosphate mining site, and the declaration authorized regulation and permitting of all withdrawals over 100,000 gallons per day after June 18, 1969. Well construction permits were required for all wells except those constructed for individual domestic supplies.[213]

Subsequent capacity use area studies were conducted for a portion of the Yadkin River Basin (1976), the Sandhills area (1979), and the Eno River Basin (1988). The Yadkin River study found that aggregate uses had not developed to a degree which required coordination and regulation. The Sandhills case involved a search by the town of Southern Pines for additional water supply sources. While the study recommendation for a capacity-use area designation was not accepted by the Environmental Management Commission, the action served to demonstrate how the studies can sometimes lead to alternative solutions short of capacity-use areas designation and regulation.[214]

Designation of a capacity-use area for the Eno River Basin was recommended because of the rapidly increasing competition for limited water supplies and dewatering of the Eno River. During the course of the study, local governments made known their preference for a plan that would help them resolve their own water-use conflicts rather than a solution imposed by regulation. Major water users agreed to follow the plan resulting from the study. That plan allocated the available water supply among the three major users with provisions for a minimum in-stream flow for the Eno River. Progress under the voluntary plan has been reported to be extremely encouraging.[215]

Well Construction, Maintenance, and Use Legislation

The Well Construction Standards Act of 1967 gave the Board of Water and Air Resources a basis for addressing ground water problems through regulation of the construction and maintenance of wells and permit requirements for wells or well systems. The act prohibits use of wells for recharge, injection, or disposal of wastes into the ground. The law is based upon a statutory finding of hazards to the public health and ground waters of the State because of improper well construction.[216]

River Basin Studies

In 1970, the U.S. Water Resources Council helped fund a joint interstate study of the Yadkin-Pee Dee River Basin in North and South Carolina under the Water Resources Planning Act. The primary functions were to identify all feasible sources of water supply within the basin, recommend which should be developed or preserved for water supply purposes, and recommend the means to be used to accomplish this. The study covered both surface and ground waters. Among the recommendations were to:

1. expand state technical assistance to local governments in solving water supply problems,

2. provide data on costs, benefits, and environmental impact for certain multipurpose reservoirs,

3. promote water conservation through education, revisions in water rate schedules, and ordinances requiring the use of water-saving devices, and

4. coordinate water supply protection programs.[217]

Proposed Change in Emphasis from Basinwide to Statewide Planning

Initial emphasis on river basin studies and reports under the Water Resources Planning Act was changed in 1976 with a proposal from the N.C. Division of Water Resources to the council to study the State as a whole. While this was not approved, federal funds were made available for a framework study "to provide a comprehensive and up-to-date overview of all important aspects of water resources in North Carolina." Its stated purpose was to bring water supply, water quality, flood management, recreation, fish and wildlife, and other uses "into a common framework that will guide State actions to meet these needs over the remainder of the century." State policy was said to "encourage planning and development of regional water supplies in order to provide adequate supplies of high quality water to the citizens of North Carolina." Among the recommendations of the framework study were that the State:

1. encourage adoption of water conservation practices in the utilization of public water supplies and the reuse of water for industrial supplies and other non-potable purposes,

2. increase its technical assistance to communities in the development of new water supplies and regional water systems,

3. promote and actively encourage communities to consider actions to protect the quality of both existing and future raw water supplies,

4. assist communities in identifying future water sources and preserving critical reservoir sites and aquifer recharge areas,

5. encourage research and measures to be taken on water pricing and other water conservation measures.[218]

State Support for Regional and Local Water and Wastewater Projects

The year 1971 brought a number of State legislative actions in support of water supply planning and construction. These included a Regional Water Supply Planning Act, discussed in Chapter XV, "Regional Planning Initiatives," and a Small Water Supply Act. The latter authorized $150 million for grants in aid for the construction of water supply and sewerage systems. This was followed in 1977 by enactment of the Clean Water Bond Act which authorized another $230 million for these purposes. Approximately half of this amount went toward public water supplies and the remainder to wastewater collection and treatment systems. Ten years later, the General Assembly enacted the North Carolina Clean Water Revolving Loan and Grant Act of 1987 which provided low-interest loans, emergency loans, and high unit-cost grants for these purposes. The revolving loan concept mirrored a similar shift at the federal level from grants to loans. Funding was modest in the first year at $5.7 million and

only time can reveal the utility of this program in an era of rapidly dwindling federal and state aid to local governments.[219]

One persistent pattern in the organization and structure of water supply planning has been the periodic reorganization of boards, commissions, and administrative departments responsible for water supply, broader water resource and water pollution control planning and regulation. This continues to be characterized by divided responsibilities among state agencies.

Creation of Environmental Management Commission

In 1973, the N.C. Executive Organization Act created an Environmental Management Commission within a new Department of Natural Resources and Community Development with the power to "promulgate rules and regulations to be followed in protection, preservation, and enhancement of the water and air resources of the State." The commission replaced the Board of Water and Air Resources and the new department superseded the Department of Natural and Economic Resources. This arrangement continues today as does the divided responsibility at the State level between the Health Services, Environmental Management, and Utility Commissions and their respective staffs.[220]

A Division of Water Resources was created in 1980 within the Department of Natural Resources and Community Development to create a focal point and increased emphasis for water resources planning and management responsibilities of the department beyond the environmental quality concerns of the Division of Environmental Management. There was to be a special emphasis on water supply and multipurpose water projects and studies. The division director, John N. Morris, has stated that some of the impetus for the new division came from a report by Dr. Maynard M. Hufschmidt of the Department City and Regional Planning at UNC-CH. The report *State Water Resources Planning and Policy in North Carolina* was published by the Water Resources Research Institute of The University of North Carolina in 1979. Hufschmidt's general conclusion was that "North Carolina water management is in a state of transition and has not yet matured so as to reflect an appropriate balance between water quantity and quality." He noted that "distorting federal government influence characterized by strong pressures for water pollution control continues, to the detriment of other important water resource problems and needs." Hufschmidt expressed the need for "much greater State leadership and capability for overall water management." Responsibilities of the Division of Water Resources include cooperation with the federal water resources

agencies, managing State-supported projects for water supply, navigation, flood control and beach protection, coordination of departmental water resource projects and policies, and review of federal policy and legislation on water resources.[221]

Federal assistance for state water resources planning under the Federal Water Resources Planning Act was sharply reduced with the change in national administrations in 1980, and work on the State Water Plan and Framework Study was correspondingly diminished. In passing, it might be noted that the idea of a dynamic framework plan to guide decision-making fell somewhat short of that goal because of difficulties in translating and utilizing the plan in the decision-making arena. Despite setbacks in federal funding, the State Division of Water Resources has maintained an important, though very limited, water supply planning program. The four capacity use area investigations, studies of the Dan River Basin in 1987, and study of water supply in Cleveland County have dealt with such questions as available supplies, safe yield, alternative sources, and intergovernmental cooperation. The division supervised allocation of water supply storage in the Corps of Engineers' Jordan Reservoir and worked closely with the Water Quality and Ground Water Sections of the Division of Environmental Management and the Division of Health Services in the protection of water supply sources.[222]

Recent Water Supply Studies

In 1977, the Division of Health Services contracted with a consulting engineering firm (Boney, Wiggins and Rimer) to conduct a *Survey of the Municipal Water Supplies of North Carolina*. This thirteen-volume report was sponsored by the U.S. Environmental Protection Agency under the Safe Drinking Water Act of 1974. Information and data covered community population and population served, status of metering, service area, date of system construction, water use, storage, distribution system and cross-connection control, fire flow, water quality sampling and analysis, source, treatment, and other aspects of the systems. Deficiencies, exemptions, variances, and recommendations were noted.[223]

A cooperative federal interagency study of water supply availability in the Upper Cape Fear River Basin was concluded by the Corps of Engineers and Soil Conservation Service in 1977. The study area included Guilford County, southern Rockingham County, and northeast Randolph County. The agencies reported population growth and industrial expansion to be "among the highest in North Carolina." Water resources needed to

supply current and projected water supply needs were found to be limited. All sources of water supply were identified.[224]

A study of the Cape Fear River Basin, sponsored by the State and the U.S. Water Resources Council, was undertaken in 1981. Among the "most critical problems" of the basin to be investigated were water supply in the headwaters region, water supply allocation for Jordan Lake in the Triangle Area, and conjunctive ground and surface water use in the Coastal Plain.[225] The 1983 study report found that while some cities had been involved in interbasin transfers for a lengthy period, its legal status was uncertain. The study questioned how much reliance should be placed on ground water as a source of supply. Most wells in the Piedmont, the report concluded, had been located for convenience rather than for geohydrologic reasons. Large ground water supplies were thought to be available if wells were properly located. Protection of remaining reservoir sites was a major concern. Lack of any policy or program to actively protect the best remaining reservoir sites was lamented. The report concluded that by the time a local government decides a reservoir site should be used, the area may have undergone extensive development and may no longer be available. Thus, communities that need additional water supplies may have little choice but to use less desirable reservoir sites.[226]

A USGS study concluded in 1983 that "current surface water supplies in North Carolina are approaching limits of capacity. . . and other water sources need to be considered as alternatives in planning for future water supplies." The authors, Dr. C. C. Daniel and N. B. Sharpless, pointed to ground water as an alternative source of supply and noted that "it is a vastly under-utilized resource. . .little used for large municipal and industrial sources of water."[227]

A Division of Water Resources report of an investigation of the Upper Neuse River Basin concluded in 1983 that the headwaters region had a limited capacity to meet increasing water supply requirements and that major water users needed to develop a long-range water management scheme.[228] One year later, the Corps of Engineers resumed an earlier investigation of water supply problems, needs, and opportunities in the Neuse River Basin. The study concluded that Wake, Johnston, and Granville counties had adequate water supplies to meet demands past the year 2020. Durham and Orange counties were projected to experience shortages in the 1990s. In the lower Neuse River, Wilson and Goldsboro were reported to be the only communities using surface waters. Wilson expected shortages by 1989-1993. Ground water aquifers available to other water supplies were deemed to be ample.[229]

Surface Water Classification for Use as Source of Public Water Supply

The long-term North Carolina practice of limiting the classification of surface waters for use as sources of public water supply to only two categories–one that was so highly protected (A-I) as to require only disinfection for treatment and one (A-II) intended to encompass all other conditions–was increasingly regarded as unsatisfactory. In 1977, Okun wrote the State Division of Environmental Management that "A-I has become almost trivial and A-II does not distinguish between protected and unprotected sources and does not provide any basis for preventing urban or industrial development on a protected watershed."[230]

In a request for authorization of public hearings on proposed new classifications in 1985, David H. Howells, chairman of the Environmental Management Commission's Water Quality Committee, said that "the present water supply classifications are viewed by most people who have studied this thoroughly as incomplete and insufficient, particularly with respect to toxics and stormwater runoff." Reasons he cited for change were (1) the present classifications provide no indication of risks and show no preference for use of less polluted sources, (2) most toxic chemicals in water supplies go undetected, (3) water treatment plants do not remove all toxic chemicals, and (4) there are few mechanisms available to control toxic chemicals originating from non-point source activities.[231]

Dissatisfaction with water supply classifications focused largely on the A-II classification. Early in 1984, for example, the Environmental Management Commission qualified its reclassification of the federal Jordan Reservoir for use as a source of public water supply because of the lack of information relative to potential public health hazards associated with upstream wastewater discharges. In speaking to this point, commission member Howells said that he would like to know what specific materials are being discharged upstream, their composition, and their potential toxicity. He said he would be hesitant to approve (the reclassification to A-II), particularly if there was an alternative better source of water available.[232]

Later the same year, reclassification of a segment of the French Broad River to A-II as an alternative source of water supply for the City of Asheville was approved by the commission contingent upon full disclosure by all upstream wastewater dischargers of components and demonstrated safety of that source of supply. Okun opposed the reclassification on the basis of numerous upstream wastewater discharges, upstream urban and industrial development, the availability of higher quality sources, and other factors.[233] A bond issue to finance the "French Broad drinking water plan"

was subsequently defeated at the polls following a campaign by citizens groups in opposition to use of the French Broad River as a source of water supply.

In 1985, following study and recommendations of its Water Quality Committee, the N.C. Environmental Management Commission upgraded surface water classifications for use as sources of public water supply. One of the principal criteria used in developing the new classifications was to find a way to bring local jurisdictions into a partnership with State government along lines of their respective authorities and traditional functions so as to better cope with nonpoint sources of pollution. Land-use regulation had long been a local government function, while the regulation of point-source wastewater discharges had been a function of State government. So it was natural to assume a *quid quo pro* whereby local government would agree to adopt ordinances and programs for the control of land-use density and stormwater management in water supply watersheds if the State would agree to reclassify the waters for water supply use and regulate point-source discharges. In this arrangement, the State would forbid wastewater discharges to the highest classification (WS-I) and permit only nominally treated domestic discharges to the second highest (WS-II). The lowest classification (WS-III) applied to segments of surface waters with no categorical restrictions on point-source wastewater discharges and no requirements for local nonpoint source control programs. However, approval of this classification by the commission carried an explicit obligation for intensified work leading to the identification of toxic chemicals in upstream wastewater discharges and their control.[234]

By 1988, there were mounting calls for a stronger state role in water supply planning. Among the recommendations were (1) consolidation of health, natural resource, and environmental programs into a single department, (2) minimum statewide standards for watershed protection, (3) consideration of new institutional arrangements to resolve intergovernmental jurisdictional conflicts over watershed land use controls, (4) authorization and funding of an expanded state water supply planning program, and (5) mandatory local government water supply plans with State financial help for planning and advance acquisition of water supply sources.[235]

XV REGIONAL PLANNING INITIATIVES

In 1961, Heath and Wicker wrote that "North Carolina's increasing industrialization and growing urban population are bringing ever larger demands for public water and sewerage services." "More and more," they said, "these demands cover areas greater than are found within the jurisdiction of a single local government unit." Legislation adopted by the 1961 General Assembly increased authority to counties to provide water and sewerage services, authorized cities and counties to jointly provide such services, and to establish, by mutual agreement, joint agencies to provide these services. The legislation was developed by the Research Triangle Planning Commission because of the immediate needs for water and sewerage services in the Research Triangle area of Durham and Wake counties. Amendments required local governments proceeding jointly to obtain approval of the State Board of Water Resources before diverting water from one stream to another or condemning water rights. They also prohibited diversion of water from any major river basin, except where permitted by law and except as to rivers whose main stem below the point of diversion is located entirely within North Carolina.[236]

Problems of Proliferation of Small Water Systems

By the mid-1960s, the State Board of Health reported more than 1470 public water supply systems serving approximately three million people. The vast majority of these served populations of less than 1000. In the board's view, such a large number of systems reflected a lack of planning and a major problem for the State in its role as overseer and guarantor of water quality. A 1966 survey disclosed a series of water supply problems encompassing inadequate planning, operation, maintenance, and management–attributed largely to a proliferation of small systems, each with its limited planning horizon, technical skills, and capital. In 1968, at a Symposium on Better Water and Sewer Services for Small Communities in North Carolina, a board spokesman, Marshal Staton, said that he believed the answer to the problem lay in the development of county-wide and regional water systems.[237]

An official of the North Carolina League of Municipalities, S. Leigh Wilson, speaking at the symposium, noted that one of the most significant changes taking place in the State at that time was the development of rural areas and the growth of small communities adjacent to cities and towns. Emerging with this development, he said, was the problem of finding a sound and politically acceptable arrangement for the provision of community water and sewer services. In his view, municipalities would have to put aside long-standing community jealousies and initiate cooperative, intergovernmental actions if they were to fulfill their role. He saw local municipal and county governments as best qualified to provide water and sewer services to urban and rural satellite communities but added that other alternative arrangements would surely be considered if they failed to do so.[238]

State Legislation Affecting Small Water Systems

In 1969, the N.C. General Assembly directed the Legislative Research Commission to study and report to the 1971 General Assembly on the need for legislation concerning local and regional water supply systems. In a statement to the commission, Okun cited findings of a National Community Water Supply Study by the U.S. Public Health Service which revealed that small water supplies are significantly inferior in quality to supplies serving larger communities. He said that the State could do much to improve water supplies by investing in water supply planning at the State level, providing financial incentives for regional water supplies, removing legal barriers to regional systems, limiting State Utility Commission approval of systems under their jurisdiction to needs neighboring cities are not willing to fill, and requiring the same rigorous design and operating standards for small systems as required for large.[239]

Resulting legislation included the Small Water Supply and Regional Water Supply Planning Acts of 1971. The former provided the State Board of Health with the authority to develop standards for small water systems relative to design and construction and required review and approval of plans prior to construction. The Regional Water Supply Planning Act established a revolving fund for loans to local governments to cover planning costs. The stated purpose was "to provide an alternative to small and inadequate systems by encouraging larger area-wide systems."[240] The fund received only a modest initial appropriation, however, and, lacking an effective method for pay-back, was insufficient to test the legislative concept.[241]

Nearly twenty years later, however, an Institute of Government report stated that inadequate water and sewer service was seen as a common problem in subdivisions and small communities not served by large and stable systems. "Unreliable supply sources, undersized lines, poor maintenance and service, under financing, and inadequate security against system failure" were said to be "all too common in rural and suburban North Carolina." The General Assembly addressed one aspect of the problem in 1987 by enacting legislation requiring a water and sewer utility company regulated by the State Utility Commission to furnish a bond between $10,000 and $200,000 as a condition for a franchise from the commission.[242]

The Emergence of Regional Government Associations

The need for new institutional arrangements to cope with multijurisdictional water supply and other problems at the local government level had become increasingly apparent by the late 1960s. Voluntary regional associations of local governments emerged as the preferred institutional form. The Federal Intergovernmental Cooperation Act of 1968, calling for closer cooperation between federal programs and state and local governments, spurred the General Assembly in 1969 to recognize the need for a uniform system of regions in North Carolina. A year later, the governor, through executive order, delineated seventeen multicounty regions. In 1979, an eighteenth region was created. These regional organizations took the form of planning and/or economic development commissions and regional councils of government (COGs). The latter predominate.[243]

Regional organizations have played a steadily increasing part in local and regional water supply planning and watershed protection in recent years. An inquiry addressed to the eighteen regional organizations of North Carolina in 1988 brought a response from twelve with sufficient information to characterize their efforts. These ranged from nothing at all to rather extensive programs involving education, facilitation, coordination, technical aid, grant and loan assistance, water quality and water supply planning, resolution of intergovernmental conflicts in watershed protection, development of criteria and guidelines, and encouragement of the regional perspective in dealing with water quality and water supply problems. Examples of regional organizations heavily involved in water supply planning and watershed protection might be the Land-of-Sky Regional Council, Piedmont Triad Council of Governments and Triangle J Council of Governments. Their programs tend to illustrate the potential contributions

of regional organizations to this important area of concern and bear closer examination.[244]

The Land-of-Sky Regional Council

The Land-of-Sky Regional Council reports that it first became involved in the mid-1970s in the development of a water resources facilities plan as a part of the urban planning process under Section 701 of the Federal Housing Act of 1954. This included the adequacy of existing water supply facilities, projections of future needs, and development of a water quality management plan for the French Broad River Basin. More recently the Land-of-Sky Regional Council sponsored local-regional-state workshops on watershed protection and completed a planning report for the Mills River Water Supply Protection Project in late 1988 for the City of Hendersonville. In the face of developmental pressures and changes in trans-watershed highways, Land-of-Sky reports that it is also involved in drawing up land-owner agreements to maintain density and buffer limits for the Brevard watershed plan. Land-of-Sky also hopes to work with Henderson, Transylvania, and Buncombe Counties to protect the French Broad River as a source of water supply for Asheville.[245]

The Piedmont Triad COG

The Piedmont Triad Council of Government (PTCOG) states that it started its first phase of a comprehensive development plan for the Triad Region in 1970. This resulted in a contract study of Regional Water Supply and Wastewater Disposal Systems. Later, in that decade, PTCOG started a detailed examination of water-short cities and counties and defined the proposed Corps of Engineers' Randleman Lake as the best long-range water source for Guilford and Randolph counties. Its first comprehensive development plan in 1977 included a study of water supply needs and sources. Environmental assessments were made to develop plans to protect existing and proposed water supplies. PTCOG reports that much has been done in recent years to implement zoning for watershed protection.[246]

In 1985, PTCOG served as lead agency for a contract study of water supply alternatives within the Upper Cape Fear River Basin. Participating communities included High Point, Archdale, Jamestown, Greensboro, Randleman, and Randolph County. Throughout this period, PTCOG coordinated efforts to obtain federal funding for the Corps of Engineers' Randleman Lake project and to work out allocation agreements. When federal funding was denied because of unfavorable project economics,

PTCOG arranged contracts for six local governments to build a modified project to meet regional water supply needs. The Piedmont Triad Regional Water Authority was formed in 1986 to develop financing and to plan and oversee construction of the water supply reservoir, treatment, and distribution facilities. In 1988, PTCOG was awarded a planning grant under Section 205(J)(1) of the federal Clean Water Act to partially fund its water-supply and watershed-protection activities in the Upper Cape Fear River Basin. PTCOG has also been active in water quality monitoring of the Haw River through a joint study with four cities.[247]

The Triangle J Regional COG

The Triangle J Council of Governments has had an innovative water quality and watershed protection program since the mid-1970s when it was the first regional planning agency in the United States to receive federal funds for studies of nonpoint 'pollution under Section 208 of the Clean Water Act.

These early studies gradually led to influential regional functions in water supply, wastewater treatment, and watershed protection. A regional water resources committee and a cadre of technical advisers meet regularly to review, discuss, and develop proposals to resolve the region's many complex problems associated with the development, allocation, and protection of a limited water supply to serve the burgeoning population of the Research Triangle.

In 1984, Triangle J endorsed a set of "Clean Water and New Development Guidelines" to protect Falls and Jordan Lakes from rapid urbanization. Included were recommendations for low density residential "critical areas" around each reservoir, vegetated stream buffers, limits on impervious cover, land use restrictions, and stormwater management requirements. Many of these were incorporated into local ordinances and regulations. However, there was still considerable disagreement about technical effectiveness and equity among cities and counties that share the same watershed and between private developers and local governments.

The most important needs identified at Triangle J's 1987 World Class Region Conference involved large WS-III water supply watersheds such as Falls and Jordan Reservoirs and downstream WS-III segments of the Cape Fear and Neuse rivers. These watersheds almost always include multiple political jurisdictions and upstream wastewater discharges and are unprotected by mandatory land use controls required for smaller WS-I and WS-II watersheds. The conference concluded that the region–and possibly the State–needs an acceptable set of water supply protection criteria and a

definitive process to ensure protection of downstream water supplies. A prototype program for the Upper Neuse River watershed which could then be applied to Jordan Lake and possibly adapted to other WS-III areas was viewed as a feasible goal.[248]

Another conference recommendation was to establish a supplemental water quality monitoring program for Falls and Jordan lakes, their major tributaries, and upstream supplies serving Durham, Hillsborough, and Chapel Hill-Carrboro. This first-of-its-kind effort was undertaken on October 1, 1988. It is a cooperative three-year program in which half the cost will be met by the U.S. Geological Survey and half, by local governments on a voluntary basis. Developed through the good offices of the Triangle J COG, the program supplemented ongoing work by the State's Division of Environmental Management by providing new information on synthetic organic chemicals which have been of increasing concern in the region's WS-III waters. It will also provide additional information on trace metals and nutrients.[249]

Treated wastewater represents an increasing portion of downstream WS-III water supplies in Region J, and the Triangle J COG was awarded a grant under Section 205 (J)(1) of the federal Clean Water Act in 1988 to analyze the regional advantages and disadvantages of different wastewater treatment configurations with special attention to their effects on Falls and Jordan lakes and other downstream water supplies.[250]

The Triangle J COG was also instrumental in negotiating a mutual aid compact for water supply emergencies in late 1988. The intent of the compact was that local governments would cooperate in utilizing water resources and facilities and, upon future mutual agreement, would enter into joint administrative, financial, engineering or construction ventures to assure a reliable, high quality water supply during short-term emergencies. Emphasis was to be given to new interconnections between water systems for water transfers between water systems.

XVI MULTIPLE PURPOSE RESERVOIR STORAGE FOR PUBLIC WATER SUPPLIES

Federal Reservoirs

The Flood Control Act of 1944 authorized the secretary of the army to make contracts with states, local governments, and others for domestic and industrial uses of surplus water available at Corps of Engineers projects. The Water Supply Act of 1958 made further provision for water supply storage in federal reservoirs. Under the 1958 act, the Corps of Engineers was authorized to include public water supply storage for municipal and industrial use in any of its reservoirs. Costs of that storage are repaid through the non-federal share of allocated project costs over a period of fifty years. An interest-free development period for up to ten years is authorized.[251]

The W. Kerr Scott Reservoir in Wilkes County, completed in 1962, included storage capacity in excess of flood control requirements to augment minimum stream flows for purposes of water supply and water quality control in the Yadkin River below the dam.[252] Water supply storage was purchased by the City of Winston-Salem, which has the right to have this water released by the Corps of Engineers as needed to meet its water supply needs.[253]

The John H. Kerr Reservoir on the Roanoke River in Virginia and North Carolina has been a source of supply to the Henderson-Kerr Lake Regional Water System since 1977.[254] However, the 1952 structure was not authorized to serve this purpose, and the water supply storage was made available as surplus water under the 1944 Flood Control Act.

Federal multipurpose reservoirs have assumed increased importance for water supply storage in recent years, particularly in the rapidly growing Research Triangle Area. The most controversial of these has been the Jordan (New Hope) Reservoir over which there was extended debate which reached into the halls of Congress. Named after its principal sponsor, the late Senator B. Everett Jordan, the reservoir was authorized by the Congress in 1963. Ground breaking for the Jordan Reservoir in 1970 was the occasion for renewed controversy. Several environmental groups expressed concern about its environmental impact and questioned its suitability for use as a source of public water supply and recreation because

of upstream pollution and potential eutrophication. Enactment of the National Environmental Policy Act (NEPA) the previous year resulted in the preparation of an environmental impact statement (EIS) by the Corps of Engineers. The Corps concluded that "there is no economically or environmentally feasible alternative to the Jordan Reservoir that would provide the multiple benefits that will be provided by the authorized project."[255] Action to allocate a portion of the water supply storage for use by nearby communities was initiated by the Environmental Management Commission in 1988. This followed a six-year period of water quality monitoring which reportedly disclosed no violations of State water quality standards for waters classified for use as sources of public water supply or for recreational purposes.[256] The standards, however, were less than comprehensive with respect to synthetic organic chemicals.

The nearby Falls Reservoir on the Neuse River was authorized by the Flood Control Act of 1965 as the key project in a recommended general plan of development of the Neuse River Basin. This multipurpose project was intended to provide 100 million gallons per day water supply storage for the City of Raleigh in addition to its flood control, water quality control, and recreation functions.[257] In 1973, a special analysis by the State concluded that the project was essential to the orderly development of a regional community water supply program and that the quality of the impounded water would be satisfactory for all intended purposes providing that pollution control measures were carried out. However, a shortfall in surface area and storage volume was discovered in the late 1980s which disclosed reduced storage for low-flow augmentation and water supply. Corrective action will be required to assure the City of Raleigh its full allocation of water supply storage.[258]

Another Corps of Engineers project, Randleman Dam on the Deep River, was planned as a multiple purpose reservoir for flood control, water supply, water quality, and recreation.[259] It was not funded and alternate plans were developed for a smaller, single-purpose, water supply reservoir to serve local sponsors through the Piedmont Triad Water Authority, as noted in "Regional Planning Initiatives."

The U.S. Soil Conservation Service was authorized by Public Law 83-566, the Watershed Protection and Flood Prevention Act of 1954, to include water supply storage in its reservoirs when so requested by local sponsors. Unlike Corps of Engineers projects, such storage must be paid for by local beneficiaries "up front" as a part of project cost. Only two projects presently include water supply storage. They are the 1972 Stewarts Creek Reservoir supplying Mt. Airy and the 1984 Country Line Creek Reservoir supplying the town of Yanceyville. A pending project, the Townfork Creek

Watershed in Stokes County, is being designed to include water supply storage.[260]

The Tennessee Valley Authority (TVA) was created by Congress in 1933 as an independent federal agency with broad responsibilities for the development of the resources of the Tennessee Valley. This included development of water resources for navigation, flood control, and hydroelectric power generation. Four reservoirs were constructed in western North Carolina. These included the Hiwassee, Apalachia, Chatuge, and Fontana reservoirs. One TVA reservoir in Georgia (Nottely) releases water to North Carolina streams. At the time of closure of these projects (1940-1944) the inclusion of water supply storage in multipurpose projects was not a recognized priority or justifiable project purpose. However, there are presently no prohibitions on the development of water supplies from these TVA reservoirs or the downstream reaches to serve local needs. Fontana Village Resort and Murphy now withdraw water from Fontana Reservoir and the Hiwassee River between Chatuge and Hiwassee Reservoirs, respectively.[261]

Public Utility Reservoirs

The use of streams for power production has been a historical preoccupation of private as well as public leadership from the days of water-powered grist mills to modern electric power plants. As noted by Moreau, the first development of a major water resource in North Carolina was undertaken by the Fried Manufacturing and Power Company of Winston-Salem. In 1898, the company (now Carolina Power and Light) constructed the Idols Dam on the Yadkin River. The first major project was Blewett Falls Reservoir on the lower Yadkin River.[262] This was followed by a series of reservoirs throughout the utility's service area. One of these, Lake Tillery, is the source of the Norwood public water supply.[263]

The Tallassee Power Company (Alcoa) constructed three hydroelectric projects on the Yadkin River during the period 1919 to 1927.[264] The first of these, Badin Lake, also provides water supply to the communities of Albemarle and Badin.[265]

Reservoirs of the Duke Power Company have had by far the largest impact on public water supply. Starting as the Southern Power Company in 1905, Duke entered into a major construction program on the Catawba River in 1921 with the Lake James, Lookout Shoals, Mountain Island, and Rhodiss projects.[266] The following eight cities now look to Duke reservoirs on the Catawba River as their sources of water supply:

Charlotte and Mt. Holly - Mt. Island Lake
Granite Falls, Lenoir, and Valdese - Lake Rhodiss
Davidson, Huntersville, and Mooresville - Lake Norman

Additional public and private water systems obtain their supplies indirectly from Duke reservoirs on the Catawba River through purchase from these cities.[267]

XVII IMPACT OF FEDERAL DRINKING WATER LEGISLATION

Enactment of the Federal Safe Drinking Water Act in 1974 markedly changed the federal-state balance of powers with respect to the regulation of public water supplies. With this legislation, arising out of a national campaign fueled by the discovery of toxic chemicals in many of the nation's water supplies, the federal role changed from guarantor of the safety of water supplies used on interstate carriers to the principal driving force behind safe water supplies nationwide. From that point on state water supply regulations largely mirrored federal regulations as had state water pollution control regulations following enactment of federal water pollution control legislation. This trend was reinforced by the General Assembly in 1973 when it forbade the adoption of water pollution rules "more restrictive than the most nearly applicable federal effluent standards."[268]

The Safe Drinking Water Act of 1974

The Safe Drinking Water Act of 1974 required the U.S. Environmental Protection Agency (EPA), which assumed the federal water supply regulatory function from the U.S. Public Health Service, to set interim primary drinking water regulations which required all water supplies to meet the 1962 Public Health Service Drinking Water Standards. The Act also required EPA to establish Recommended Maximum Contaminant Levels (RMCL's) for each contaminant which might have an adverse effect on health. The second tier Maximum Contaminant Levels (MCL's) or remedial treatment techniques were to be promulgated by September 1976 and Secondary Drinking Water Regulations, a year later. Because of failures to meet schedules set forth in the act–particularly with respect to toxic chemicals–major amendments to the federal act were adopted in 1986.

1986 Amendments to SDWA

Enactment of the Safe Drinking Water Act Amendments of 1986 amid rising public concern over contamination marked the passage of drinking water utility managers from the "good old days" and the "don't rock

the boat" mentality into a new era of regulation, according to American Water Works Association President Richard Miller. In his address to the association's annual conference on June 25, 1986, Miller said the amendment came at a time when there was growing evidence of both contamination and shortages of drinking water supplies around the United States. In passing the legislation, Congress found that safe drinking water is a matter of "fundamental public health protection." "The public," it said, "is willing to pay any additional cost that may be needed to ensure its safety." The Congress concluded that setting health-based standards for drinking water is a federal responsibility.[269]

The 1986 amendments–adopted by reference by the North Carolina Health Services Commission–required:

1. compulsory revisions to Drinking Water Regulations in a timely manner for new contaminants;

2. definition of treatment techniques for each contaminant regulated;

3. treatment techniques where infeasible to ascertain the level of regulated contaminants;

4. filtration for all surface water supplies, with certain exceptions;

5. disinfection of all water supplies;

6. prohibition of the use of lead products in all drinking water conveyances; and

7. protection of ground water sources.

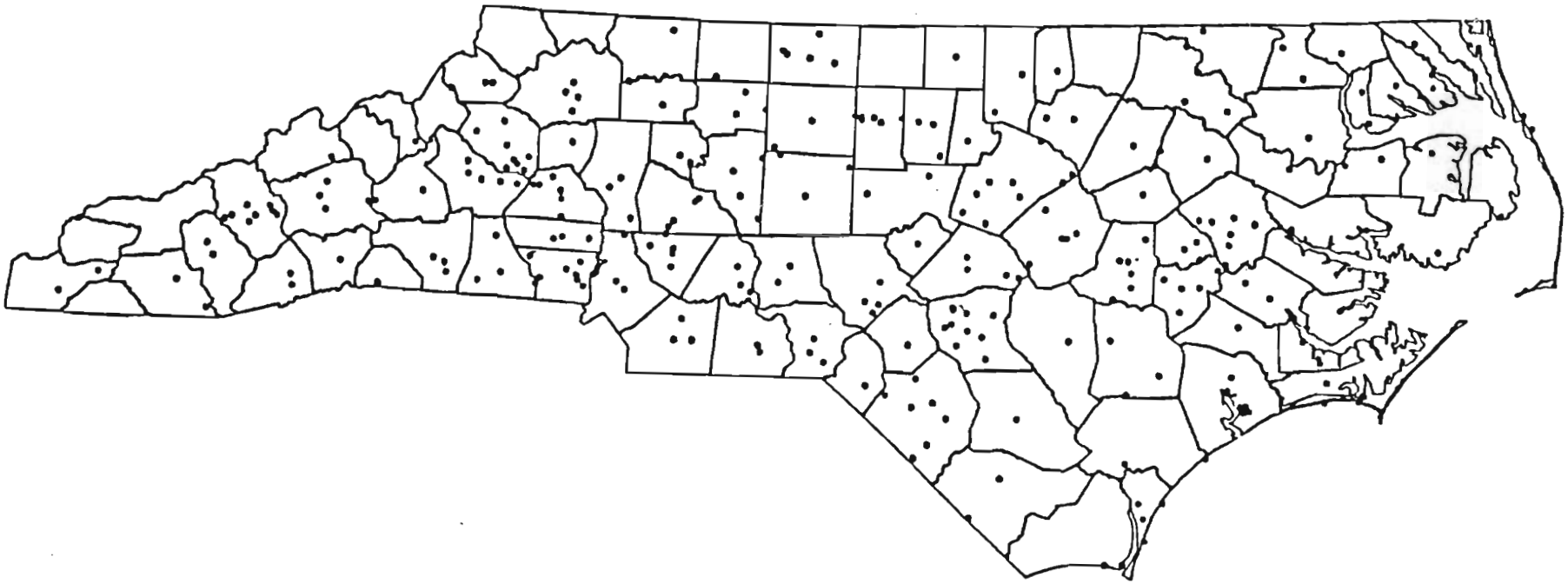
The amendments stipulated the simultaneous use of MCL's (enforcement standards) and Maximum Contaminant Levels Goals (MCLGs) and specified lists of contaminants to be regulated by deadlines concluding on June 20, 1989. The lists included fourteen volatile organic chemicals, thirty-six other synthetic organic chemicals, twenty-three inorganic chemicals, five microbials, and five radionuclides. Rising concern over a newly recognized water-borne disease, giardiasis, was demonstrated through

inclusion of the pathogenic protozoan, *giardia lamblia*, in the new list of microbial contaminants. Because of the expanding use of synthetic organic chemicals in industry, commerce, and the home, a steady increase in this category of contaminants over the years ahead is anticipated. This is reflected in the legislative mandate that EPA is to require all community water supplies to monitor for fifty volatile organic chemicals in addition to those subject to regulation. The amended act requires that MCLG's be set at a level at which no known or anticipated health effects occur. The enforceable MCL's must be set as "close as feasible" to the MCLG's. The states must adopt regulations for surface water treatment, including disinfection, by June 19, 1989.[270]

Increasing concern over the health effects of disinfection by-products such as trihalomethanes in drinking water was expressed by a Congressional spokesman who noted that Congress expected the U.S. Environmental Protection Agency to revise the standard for allowable levels in drinking water and determine the types of reduction in disinfection by-products that could be achieved through activated carbon filtration even though these substances were not included on the list of eighty-three contaminants for which the sgency must set new standards.[271]

There can be no question that federal drinking water legislation was borne on the wings of public disclosure of toxic chemicals in drinking water. The problems associated with the protection of surface and ground water supplies from contamination by toxic chemicals are complex and remedial actions often costly. They underscore the importance of protecting the remaining high quality sources of water supply and effectively controlling discharge of toxic chemicals to less protected sources.

Figure 4: Public Water Supplies Serving Populations of 2500 and over in 1988



XVIII CENTENNIAL PERSPECTIVE OF PUBLIC WATER SUPPLIES IN NORTH CAROLINA

The twelve public water supplies in the largely rural North Carolina of 1888 have since expanded to 2,950 community water systems serving 4.5 million people in 1988–nearly 70 percent of the State's total population of about 6.5 million. Data on these systems are summarized by population group and type of source as follows:

Active Community Public Water Supplies
North Carolina
October 31, 1988

Population Served	Source: Surface Water Number Systems	Surface Water Pop. Served (1000)	Ground Water Number Systems	Ground Water Pop. Served (1000)	Total Number Systems	Total Pop. Served (1000)
Under 2,500	146	159	2,558	585	2,704	744
2,500-5,000	57	202	48	167	105	369
5,000-10,000	40	306	34	234	74	540
10,000-50,000	38	855	16	325	54	1,180
50,000-75,000	5	300	0	0	5	300
75,000-100,000	2	188	0	0	2	188
Over 100,000	6	1,207	0	0	6	1,207
Total	294	3,217	2,656	1,311	2,950	4,528

Source: Water Supply Branch, Environmental Health Section Division of Health Services, N.C. Dept. Human Resources

synthetic organic chemicals. Thus, conventional tre... alone is not sufficient to assure a safe drinking water supply where chemicals can enter the source through wastewater discharges, accidents, stormwater runoff, and other sources. Supplemental treatment consisting of activated carbon adsorption will substantially remove some synthetic organic chemicals, but not all and not with uniform efficiency. So, protected sources are absolutely essential to the integrity of public water supplies in the modern era. This applies equally to surface watersheds and ground water recharge areas.

Renewed Calls for Source Protection

Research sponsored by the Water Resources Research Institute at the Center for Urban and Regional Studies and the Department of City and Regional Planning at UNC-CH contributed increased insight and guidance for the strengthening of watershed protection in North Carolina. Drs. Raymond J. Burby, David J. Brower, and Dale Whittington reported in 1985 that available sources of high quality water in North Carolina are limited and that pollution spawned by sprawling urbanization and continued land erosion limit the number of streams suitable as sources for drinking water. It is time, they said, that state and local governments begin thinking about what they need to do to preserve the high quality of water supply sources that can be economically tapped for future use. They concluded that local governments need and want help from the State.[273]

The review of existing State policies and programs by these investigators revealed a number of gaps that need to be filled. They specifically recommended a State water supply master plan and continuous planning process, mandatory local water supply plans, state grants-in-aid, classification of streams so as to indicate future use as drinking water sources, and an executive order directing State agencies to avoid actions that could lead to the degradation of water quality in streams designated as future sources of drinking water. Also recommended was a legislative authorization for local ordinances to designate and protect future water supply reservoir sites together with a state revolving loan fund for advance acquisition. There were additional recommendations to strengthen the control of point and nonpoint sources of pollution. These included the prohibition of new point sources of pollutants to upland watersheds designated as potential future water supply sources, a more effective targeting of sediment pollution controls, legislation to require local governments to formulate and administer comprehensive watershed protection programs, and other measures.[274]

Increased Reliance on Treatment Technology

The earlier emphasis on watershed protection as the primary means of assuring a safe drinking water supply from surface waters has given way under pressure of events to a decreasing emphasis on watershed protection and increasing reliance on wastewater and water treatment technology.

As stated by Okun, the introduction of filtration in the late nineteenth century and chlorination early in the twentieth century led to the impression that "almost all polluted waters could be made safe from infectious disease by filtration and chlorination." "As a result," he said, "the principle of 'best available sources' was largely abandoned in favor of more economical sources. But the chemical revolution changed this with its wide array of synthetic organic chemicals, many of which have been found to adversely affect human health as a result of exposure to even trace concentrations over long periods of time. More recently, chemical by-products of disinfection have also become of concern. The steady increase in number and type of potentially toxic chemicals in the environment, said Okun, has been accompanied by increasingly sever maximum concentration limitations for drinking water with the result that those responsible for water supplies "are aiming at a rapidly moving target." Because of this, Okun concluded that the principle of use of the "best available source needs to be revived in water supply planning."[272]

All new or expanded water supplies are now required to provide full conventional water treatment regardless of the degree of watershed protection. Advanced water treatment techniques will be increasingly called for where chemical contaminants cannot be removed through conventional treatment. But these steps alone fall short of the long-held practice of providing two lines of defense consisting of source protection and water treatment on the premise that human and technological failure are almost certain to occur.

Source protection applies to surface and ground water alike. While three-fourths of the population served by community water supplies derive their water from surface waters and only one-fourth from ground water, the role of the latter looms much larger when the individual supplies serving the 2 million rural population are added to the 1.3 million served by community systems utilizing ground water sources. Indeed, it then becomes evident that slightly more than half of the North Carolina population of 6.5 million depend upon ground water supplies, the majority of which are individual wells.

Conventional water treatment technology was developed primarily to meet physical and bacteriological standards and is largely ineffective for

The Dimensions of Watershed Protection

In early February of 1985, Burby told the Environmental Management Commission that the key problem with watershed management is that no single party is in charge. "State Government needs to take the lead," he said, "to bring everyone involved to the table to see what their responsibilities are so that this problem can be adequately dealt with."[275]

Watershed protection now has many more dimensions than heretofore, including (1) type and density of land uses, (2) stormwater management, (3) erosion and sedimentation control, (4) agricultural and silvicultural best management practices, (5) regulation of wastewater discharges, (6) pretreatment programs to control industrial wastewater discharges to municipal sewer systems, (7) emergency response to accidents at industrial sites and along transportation corridors, (8) periodic watershed sanitary surveys to identify illicit wastewater discharges, (9) water quality monitoring, and (10) maintenance of minimum stream flows upon which discharge permits are based. All are essential links in the chain of protective measures needed to guard surface water supply watersheds in the late twentieth century.

Some of these measures are also at least partially applicable to ground water protection. The integrity of ground water sources is particularly threatened by improper use, storage, and disposal practices involving solid and hazardous wastes, pesticides, surface and subsurface wastewater disposal, leaking underground storage tanks, and other sources of contamination. The importance of proper well location, construction, maintenance, and closure on abandonment remain important considerations in the protection of ground water sources as was recognized a century ago when improperly constructed wells were the principal sources of water-borne disease.

A recent study, *Watershed Protection in Western North Carolina*, by Dr. David H. Moreau, Mary Jo Moubry, and Dr. Daniel L. Gallagher gave special attention to the Pigeon River upstream of Canton in western North Carolina. They recommended the mandatory adoption of watershed protection regulations by local government; strengthening of one of the State's three surface water supply classifications; a reporting system on pesticide use; the proper storage, use, and disposal of toxic chemicals upstream of public water supply intakes; the periodic assessment of potential sources of contamination of surface waters used as sources of public water supply; and enhanced understanding of the physical, chemical, and biological processes that threaten the quality of drinking water supplies on the part of the public and professionals alike. They noted the lack of

zoning, subdivision regulations, erosion control ordinances, and flood plain regulations at the local government level and proposed corrective steps.[276]

The Rationale for Increased Watershed Protection

Bahnson's admonition in 1889 that protected water supply watersheds should be secured without delay has clearly been "more honored in the breach." A disproportionate number of people now are being served by water supplies taken from sources which have no categorical restrictions on point source wastewater discharges and no requirements for local nonpoint source control programs. The nature of watershed and ground water protection has become vastly more complex than in earlier years but is no less important. A vast and increasing array of chemicals threaten the safety of the more exposed sources of water supply in ways that are as yet poorly understood. Surely, the only prudent course of action is to move swiftly to protect the remaining high quality sources and to gradually reduce exposure in the less protected WS-III waters through more rigorous permitting and associated regulatory programs. Indeed, the time has come for a state policy decision to settle for no less than high quality sources of water supply throughout North Carolina and to mandate that the quality of all WS-III waters will be upgraded to meet that objective. Many existing discharge permits contain only fragmentary information about synthetic organic chemicals in wastewater discharges. Full disclosure of toxic chemicals manufactured, stored, and used in manufacturing and maintenance operations at locations impacting surface and ground water sources of water supply is fundamental to meaningful regulatory permits, sound monitoring systems, and sensible research priorities.[277]

Recommended Legislative and Executive Actions

Proposals for enhanced statewide protection of water supply sources took form in late 1988. These included a series of legislative and executive actions based on the studies led by Burby and Moreau and on other bodies of experience. At the legislative level these included consolidation of State agencies responsible for water supply, authorization of new institutional arrangements for the resolution of jurisdictional conflicts, mandatory local water supply plans, an expanded state water supply planning program, and minimum standards for water supply watershed protection. Recommended executive actions included an executive order directing State agencies to avoid actions that could lead to degradation of future water supply sources, rigorous enforcement of regulations protecting water supply sources, creation

of an interagency watershed protection task force, full disclosure of all chemical and toxic components of wastewater discharges to water supply sources, and strengthening of state and local sedimentation control programs to protect water supply watersheds.[278]

On November 23, 1988, the Watershed Protection Committee of the Legislative Research Commission unanimously approved a report to the commission recommending legislation directing the Environmental Management Commission to adopt minimum state standards, limitations, and management practices for the protection of water supply watersheds and directing the Department of Natural Resources and Community Development and the Department of Human Resources to develop a state water plan. The latter legislative recommendation would require local jurisdictions to develop local water plans for review by the State. A similar step was taken with respect to consolidation of the State's health, natural resources, and environmental protection programs. With respect to the consolidation proposal, there may be something to be learned from the experiences of 1957-1959 when overlap and duplication were addressed through de-consolidation from the State Board of Health by transferring the Division of Water Pollution Control to a new Department of Water Resources, leaving water supply and some water pollution control activities behind. The fact that overlap and duplication flourished under both consolidation within the Board of Health and when separated between two State Departments, as it continued to be through 1988, appears to argue for the importance of executive leadership as well as organizational structure if unified and efficient programs are to be realized in the closely allied fields of water supply protection and water quality management.

Concluding Remarks

The year 1988 brought a renaissance of interest in the protection of public water supplies. But the hour is late and many opportunities have already slipped away. What the next 100 years has to offer will have to be measured in retrospect. One can only hope that it will reflect prompt corrective steps to assure safe water supplies for all of North Carolina during the centuries yet to come.

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