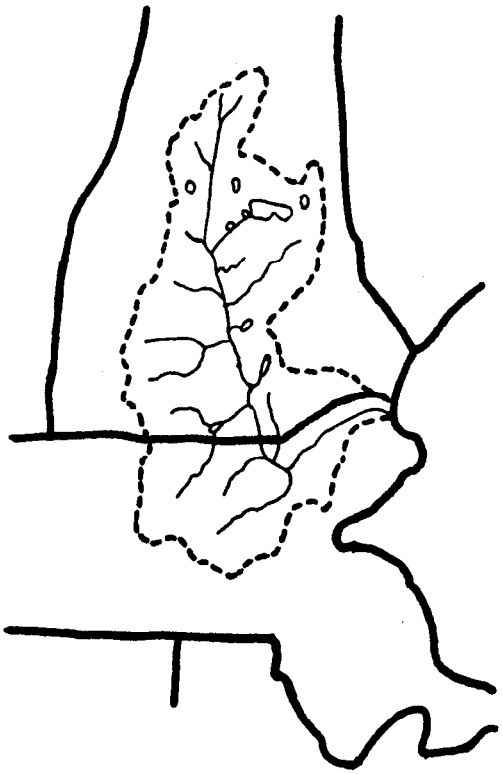
THE MERRIMACK:

DESIGNS FOR A CLEAN RIVER



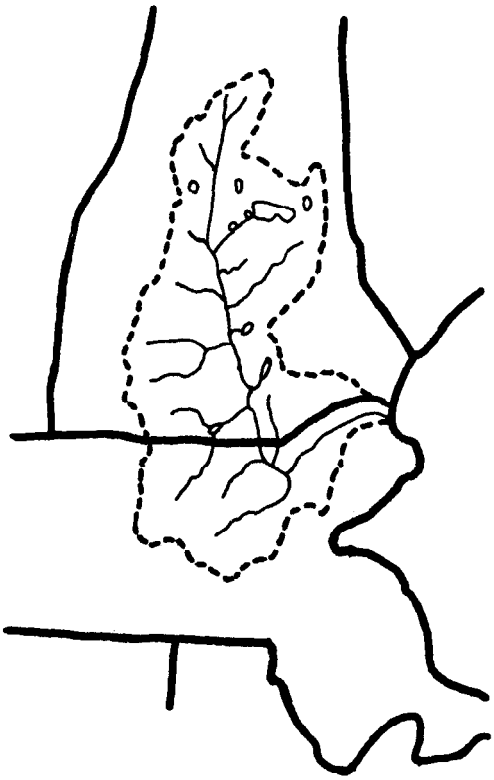
INTRODUCTION, STUDY AREA TODAY AND
STUDY AREA TOMORROW (TO 2020)

APPENDIX I & II

AUGUST 1971

THE MERRIMACK:

DESIGNS FOR A CLEAN RIVER



INTRODUCTION AND THE STUDY AREA TODAY

APPENDIX I

AUGUST 1971

THE MERRIMACK: DESIGNS FOR A CLEAN RIVER

A

FEASIBILITY STUDY

FOR

WASTEWATER MANAGEMENT

IN THE

MERRIMACK RIVER BASIN

APPENDIX I

"INTRODUCTION AND THE STUDY AREA TODAY"

THE MERRIMACK: DESIGNS FOR A CLEAN RIVER

A

FEASIBILITY STUDY

FOR

WASTEWATER MANAGEMENT

IN THE

MERRIMACK RIVER BASIN

Prepared By

U. S. ARMY ENGINEER DIVISION, NORTH ATLANTIC

CORPS OF ENGINEERS

in cooperation with

NEW ENGLAND DIVISION
U.S. ARMY CORPS OF ENGINEERS

and

REGION I OF THE ENVIRONMENTAL PROTECTION AGENCY

and

THE COMMONWEALTH OF MASSACHUSETTS

and

THE STATE OF NEW HAMPSHIRE

August 1971

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A Feasibility Study
for
Wastewater Management
in the
Merrimack River Basin

A. INTRODUCTION

The following pages present a Feasibility Study on Wastewater Management in the Merrimack River Basin in the States of Massachusetts and New Hampshire. The study has been authorized and undertaken to illustrate the practicability of rejuvenating the Merrimack River which will assure its survival, and show its potential as a water supply for its own cities and towns, Northeastern Massachusetts, Southeastern New Hampshire, and the Metropolitan Area of Boston. The study has been prepared by the Corps of Engineers in cooperation with the Enviromental Protection Agency and utilizing the expertise of other Federal agencies with contributions by State and local official and various private individuals and organizations.

The study covers six separate areas, as shown on Plate I, namely:

1. The area along the Winnipesaukee River between The Weirs and its confluence with the Merrimack and Pemigewasset Rivers in Franklin, New Hampshire.

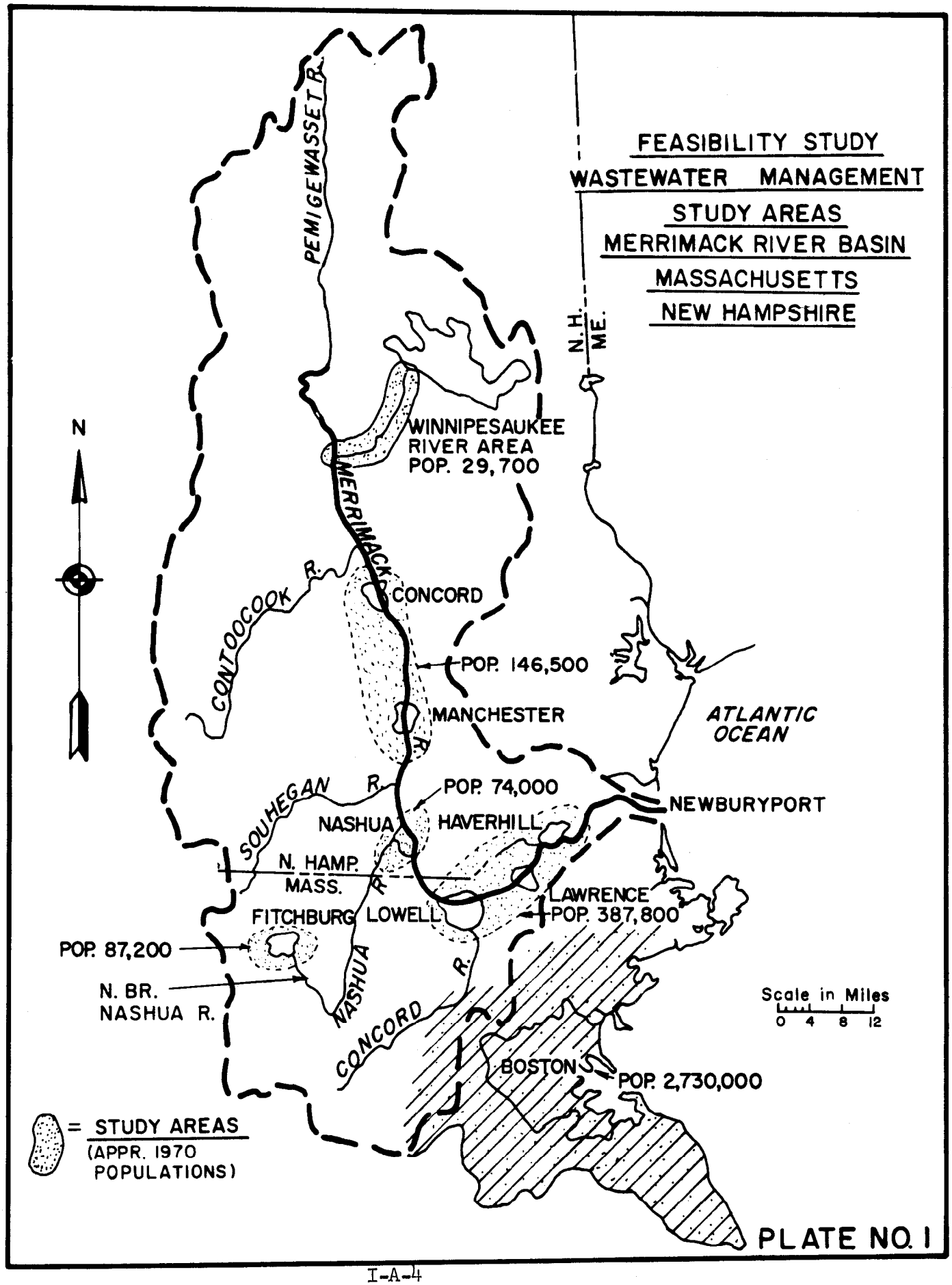
2. The urban and industrial areas of, and between, Concord and Manchester, New Hampshire.

3. The urban and industrial areas of Nashua, New Hampshire.

4. The urban and industrial areas of Fitchburg and Leominster, Massachusetts.

5. The urban and industrial areas of, and between, the cities of Lowell, Lawrence and Haverhill, Massachusetts.

The study indicates the feasibility, including estimated costs, and the effects on the environment, of proposed wastewater pollution abatement methods and alternatives for the basin. Emphasis is placed on programs that can be of immediate benefit (i.e. by 1975$^{+}_{-}$) in raising the quality standards set for the Merrimack River and in complementing the state and local pollution abatement program already in progress.


FEASIBILITY STUDY
WASTEWATER MANAGEMENT
STUDY AREAS
MERRIMACK RIVER BASIN
MASSACHUSETTS
NEW HAMPSHIRE
N
PEMIGEWASSET R.
N.H.
ME.
WINNIPESAUKEE
RIVER AREA
POP. 29,700
MERRIMACK R.
CONTOOCOOK R.
CONCORD
POP. 146,500
MANCHESTER
ATLANTIC
OCEAN
SOUHEGAN R.
POP. 74,000
NEWBURYPORT
NASHUA
HAVERHILL
N. HAMP.
MASS.
LAWRENCE
POP. 387,800
FITCHBURG
LOWELL
POP. 87,200
N. BR.
NASHUA R.
NASHUA R.
CONCORD R.
Scale in Miles
0 4 8 12
BOSTON
POP. 2,730,000
= STUDY AREAS
(APPR. 1970
POPULATIONS)
PLATE NO. 1

I. Need for the Study:

The Merrimack River is polluted by the discharge of raw and partially treated municipal and industrial wastes for most of its length in Massachusetts and New Hampshire. Everyday more than 120 million gallons of wastewater flow into the Merrimack River polluting it physically, bacteriologically and chemically. This polluted condition, which has been recognized since the turn of the century, will become progressively worse unless effective abatement action is taken. (It is noted that some constructive action has been taken by many to alleviate the pollution in the river. This will be discussed later in the study). The polluted condition of the river has serious impacts on the ecologic, esthetic, hygienic social and economic aspects of the entire river basin and its inhabitants.

The search for clean water in the Merrimack River Basin has encountered extensive water pollution which places severe limitations on the availability of water supplies. It is necessary to prepare plans assuring adequate water supplies for the basin area and, particularly, supplies to support the water dependent activities of adjacent expanding metropolitan areas. The river is polluted and the use of it for municipal and industrial purposes is becoming more suspect as well as more difficult. Its utility as a quality environment for fish and other aquatic life is seriously impaired. Water-based recreation is restricted and esthetic enjoyment of the stream reduced.

Cleaner river water is becoming a must for industry so that high costs for pretreatment can be reduced and eliminated if possible. Many of the basin industries require large quantities of river

water for their manufacturing processes. In general, six major water using industries are found in the basin which contribute to the pollution. These are namely: Tanning, Paper Manufacturing, Textiles, Plastics and Metal Finishing.

Although the Merrimack River is one of the most logical sources for large quantities of water, integrated consideration of the water supply and waste problems is essential. The Merrimack River Basin is one area in which detailed studies have been done by numerous agencies, associations, etc. The well being of the people of the Merrimack Basin and adjacent metropolitan regions depends greatly on the future management of water and their wastes.

The Merrimack River is used as a municipal water supply for Lowell, Lawrence and Methuen, Massachusetts. As the population increases, more and more communities will be turning to the Merrimack River to meet their water requirements because it is the only readily available source of sufficient quantity to meet the demand. Ten basin communities have already expressed interest in the river for this purpose. Well designed and efficient sewage treatment facilities programs for wastewater management will be necessary to assure adequate water quality.

The increasing demands for water in the eastern part of Massachusetts can only be met by looking to the Connecticut River on the west and the Merrimack River on the east, with the Merrimack River being the source nearest the heavy demand. Enhancement of the water quality in the Merrimack River would improve its potential to provide these future diversions.

Coliform densities as high as 9,200,000 per 100 milliliters (ml) were found in the Merrimack River below Lawrence, Massachusetts. This value is 1850 times the recommended maximum value of 5000 per 100 ml. This excessive bacterial pollution presents a health hazard to all who come in contact with the water.

While coliform densities indicate the magnitude of fecal pollution which may contain disease-producing organisms, detection of pathogenic bacteria is positive proof that these organisms are actually present.

Salmonellosis, the disease caused by various species of salmonella bacteria, includes typhoid fever, gastroenteritis and diarrhea. Tests for salmonella were conducted at various locations on the Merrimack River in 1965 and organisms of some types were found to be quite prevalent.

Serious depletion of the dissolved oxygen content of the river was evidenced during various testing periods. For example, during the summer months of 1964 and 1965, the minimum dissolved oxygen was less than 2.0 ppm at every station between Manchester, New Hampshire and Newburyport, Massachusetts. Zero values were found in Haverhill, Massachusetts. At no point upstream of Manchester was the minimum value in excess of 5.0 ppm. A value of 5.0 ppm for at least 16 hours a day is one requirement of the New England Interstate Water Pollution Control Commission for Class C waters. This class of water is considered acceptable for recreational boating, fish habitat and industrial supply; but not for swimming or drinking under normal conditions.

Desirable benthic organisms sensitive in their response to pollution were absent in the lower 57 miles of the Merrimack River. (It is noted

that 22 of the 57 miles are tidal). In only four areas did the river recover enoughg from its despoiled condition to permit a small number of sensitive organisms to exist before additional wastes reduced the quality of the river.

Excessive amounts of nutrients discharged into the Nashua River have caused abnormal densities of algae and aquatic plants, thereby creating a nuisance and unsightly conditions on the river and effecting wildlife.

Disposal into the river of dyestuffs and chemicals used or produced by processes in the manufacturing plants contributes to the unsightly conditions which degrade the esthetic value of the river.

The polluted condition of the river, with the problems introduced, manudates the preparation of a feasibility study directed to the clean-up of the river and to the identification of alternative solutions for waste-water arrangement to restore its waters for use as water supply as a natural resource.

2. Objective of the Study:

This study deals with the achievement and maintenance of water quality in a major river basin, specifically the Merrimack River Basin of Massachusetts and New Hampshire. In order to understand better the specific problems of this basin, it must be realized that the region varies from rural to urban and include some of the more difficult and concentrated industrial wastes to treat. These industries include the classical water quality problems

associated with tanneries, textile, metal plating, and paper manufacturing as well as the more recent problems introduced by the discharges of plastic wastes. The wastewater collection systems range from old combined sewers to recently constructed separate systems. The domestic waste component varies from relatively small volumes in some areas of the basin to significant volumes in the major urban complexes. The objective of the study is to propose a feasible wastewater management treatment system acceptable to all concerned, and to describe the potential of improving the well being of the inhabitants of the Merrimack River Basin and, to an extent, of the adjacent metropolitan regions, through the management of water and wastes. In exploring and investigating the potential for accomplishing these results, it is evident that a maximum effort should be made to clean up the entire Merrimack River rather than to only upgrade spedific river reaches to meet conditions less than those required for all water use. The basin community is entitled to a river resource which can be utilized for water supply and water-body contact recreational purposes throughout its length, except as a water supply from its tidal area.

The feasibility analyses were accomplished:

a. To illustrate that areas contributing significant amounts of pollution (Concord, Manchester, Nashua, Fitchburg, Lowell, Lawrence and Haverhill) to the Merrimack River can be cleansed and rehabilitated by using intergrated systems for water and wastewater management within the basin based on:

(1) Land and Water Disposal of treated liquid wastes

(2) Advanced waste treatment techniques

(3) Existing plans for waste treatment by Local authorities

b. To show the practicability of utilizing the Merrimack River as a source of water supply for all cities and towns along the stream and in the basin.

c. To show that the ample supply of water in the Merrimack River could be used, in part, to serve as a source for regional system needs of the Metropolitan Areas of Boston or southeast New Hampshire; and to show the feasibility of returning to the Merrimack Basin for treatment, disposal and reuse, those wastewaters resulting from the withdrawals now being exported to most out-of-basin water supply requirements.

d. To improve the environment of the Merrimack River Basin and to support regional plans encompassing all water resources related purposes.

e. To determine alternatives for wastewater disposal and their costs as well as their effect on the basin environment.

To assist those who will participate in further planning, the study:

a. Describes the economic, social and physical factors contributing to the pollution of the Merrimack River Basin; such as population, industry, land use, zoning, public attitude and drought.

b. Develops and compares alternative waste disposal systems on the basis of pollutant removal, reclamation of waste products, environmental impact, and total monetary costs.

c. Proposes preliminary site locations and develops preliminary plant layouts for the alternative systems presented.

d. Describes the environmental, social, and possible economic benefits anticipated as a result of wastewater management in the Merrimack River; particular attention is given improvement in the use of the river as a source of municpal and industrial water supply for areas in and outside the basin.

e. Finally, the study recommends an immediate action program to deal with the most urgent aspects of wastewater management in the Merrimack River Basin, as well as with future needs, and sets forth the planning steps needed to implement the study.

3. Use of Results - Prelude to Authorization Study:

The results and findings of the Feasibility Study shall be utilized for:

a. Promoting broad public communication with all concerned on the issue of the Merrimack River Basin, its survival, and potentential as a source of water supply for in and out of basin requirements.

b. Presenting feasible plans on advanced waste treatment systems and technology for use in the basin, state and federal groups will participate in the subsequent formulation of steps to be taken, or not taken, as a result of this effort.

c. Assisting those agencies and individuals who will participate in the decision process of creating water and wastewater management systems for the basin.

d. As a basis for initiating pre-authorization planning and design of a wastewater management system for the Merrimack River Basin. It is intended, providing that favorable recommendation, authorization and funds

are received, that further and more detailed investigations will be initiated.

4. Authority for the Feasibility Study:

The Feasibility Study was performed under the authority of the Northeastern United States Water Supply (NEWS) Study, authorized by Congress in Public Law 89-298 for the preparation of plans to meet the long range water needs of the Northeast portion of the country by construction, operation and maintenance of a system of major reservoirs, major conveyance system, and major purification facilities.

Also, the "Joint Agreement for Interagency Coordination for Water Quality Management Planning Assistance to State and Local governments between The Environmental Protection Agency and the Department of the Army." This interagency agreement is developed to provide additional assistance to State and Local governments toward enhancing quality of the environment and in meeting the Federal requirements for planning as published in the Federal Register on July 2, 1970 (18CFR601.32-3).

B. DESCRIPTION OF THE MERRIMACK RIVER BASIN

1. The Basin:

Location and area

The Merrimack River Basin lies in central New England and extends from the White Mountain region of New Hampshire southward into the east central part of Massachusetts. It is bounded by the Connecticut River Basin on the west and northwest; and the Saco and Piscataqua River Basins on the northeast and east; New Hampshire and Massachusetts Coastal Streams on the east and southeast; and the Blackstone River Basin, and

the Narragansett Bay Drainage Basins on the south. This basin, the fourth largest of those lying wholly in New England, has a maximum length in a north-south direction of approximately 134 miles and a maximum width in an east-west direction of 68 miles. It has an area of 5,010 square miles of which 3,800 square miles are in New Hampshire and 1,210 square miles are in Massachusetts.

2. The River:

Origin and course

The main Merrimack River is formed by the confluence of the Pemigewasset and Winnipesaukee Rivers at Franklin, New Hampshire. It follows a southerly course to Lowell, Massachusetts, where it turns abruptly and flows in a general northeasterly direction to tidewater above Haverhill, Massachusetts and then to the Atlantic Ocean near Newburyport. It has a total length of 116 miles of which the lower 22 miles are tidal. The mean range of tide at the mouth is 7.9 feet, and at Haverhill, 5.1 feet. The extreme ranges, due to the combined effect of wind and other causes, are 11.7 feet at the mouth and 8.0 feet at Haverhill. In the 94 miles of its length above tidewater, the river descends a total of 254 feet at a fairly uniform slope. Profiles of the Merrimack River and its principal tributaries are shown on Plate No. 4.

3. The Main Tributaries:

The seven principal tributaries of the Merrimack River, including its two headwater tributaries, are as follows:

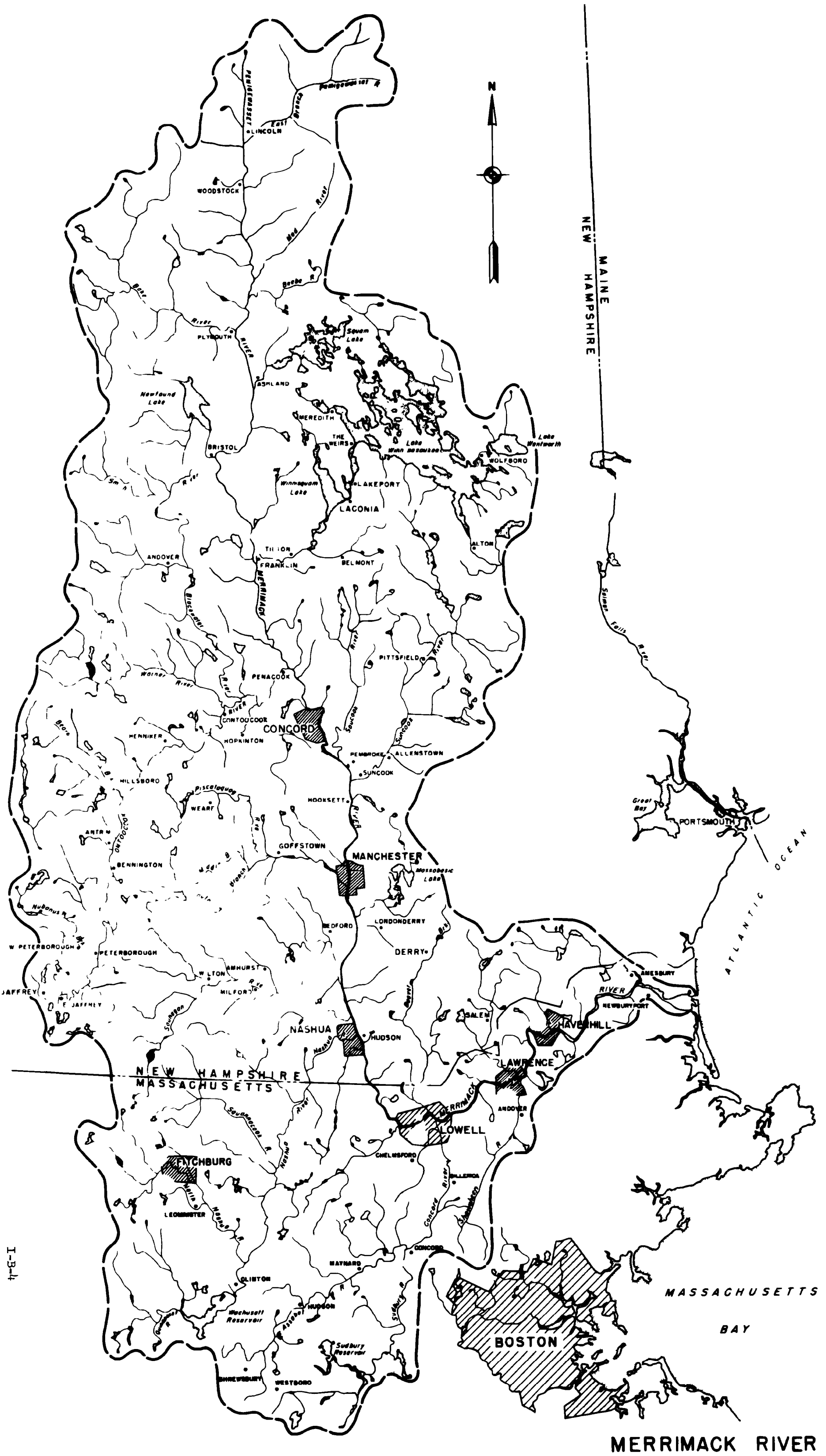
Pemigewasset River	1,210 Square Miles of Drainage Area
Winnipesaukee River	486 " " " " "

Contoocook River	766	Square	Miles	of	Drainage	Area
Soucook River	90	"	"	"	"	"
Piscataquog River	214	"	"	"	"	"
Nashua River	516	"	"	"	"	"
Concord River	395	"	"	"	"	"

Refer to Plate No. 2 which shows the Basin, River and Tributaries.

4. General Topography:

The area south and east of Manchester, New Hampshire, is essentially a plain over which the stream flows at low gradient between gentle, rolling hills of glacial till and outwash. Scattered at wide intervals on the plains are isolated, higher hills with bedrock cores which are really low monadnocks. The topographic relief in this section is generally 200 to 300 feet. The central and major part of the watershed is an area of rough bedrock hills and ridges with relatively wide main valleys and numerous lakes. Lake Winnipesaukee and other large lakes occupy a major depression that was scooped out of the upland surface on the east side of the basin by glacial action. The relief in this section is generally 400 to 800 feet with local relief in some areas adjacent to outliers of the White Mountains of 1,500 to 2,000 feet. The area north of Plymouth is a region of rugged peaks with steep slopes and narrow valleys. The higher mountains range in elevation from 4,000 to 5,000 feet with Mount Lafayette at an elevation of 5,249 feet being the highest point in the basin. The headwater lakes of the East Branch Pemigewasset River, in the upper northeast part of the watershed, are at an elevation of between 2,500 and 2,700 feet. Profile Lake, the source of the



MERRIMACK RIVER BASIN MAP

MERRIMACK WASTEWATER STUDY

SCALE IN MILES

PLATE 2

main Pemigewasset River, is at an elevation of approximately 1,980 feet.

5. General Geology

The Merrimack River Basin is underlain by unconsolidated deposits formed primarily during and partly after rather recent continental glaciation, and by bedrock formed during much earlier periods of geologic time. Most bedrock is hard and dense, having been metamorphosed (altered) from earlier sedimentary, igneous, and volcanic rocks. Some of the younger igneous rocks have not been metamorphosed.

During the Ice Age the Basin was covered by at least two glaciers that moved in a southeasterly direction, commonly smoothing the northwestern slopes of hills, but leaving the leeward slopes rough and irregular. Preglacial valleys were partly filled with material carried and deposited by the glaciers (till) and meltwater streams and lakes (stratified deposits). Now the Merrimack and its larger tributaries flow over these deposits except where erosion has exposed bedrock. Rock basins scoured by the glaciers are now occupied by lakes, such as Lake Winnipesaukee. When the climate finally warmed and the ice withdrew from the southeastern part of the Basin, part of that area was flooded by the sea and marine sediments were deposited over the earlier glacial deposits.

Northeast treading hills and valleys are commonly bedrock controlled, whereas northwesterly trends of the landscape commonly reflect the effects of glaciation.

C. GENERAL HISTORICAL AND ECONOMIC BACKGROUND

1. Merrimack River Basin:

a. General Background - The first town to be established in the Merrimack River Basin was Newburyport, Massachusetts, at the mouth of the river, which was settled in 1635 by a part of colonists sent out by Governor John Winthrop to secure this strategic position for the Massachusetts Bay Colony. Attempts at agriculture by these early colonists

were unsuccessful, but when they turned to fishing, whaling, shipbuilding and trade, the settlement began to prosper. Concord, Massachusetts was also settled in 1635 and the neighboring towns of Maynard and Sudbury were established in 1638. Agriculture and trade constituted the principal activities of these three early towns.

Haverhill, founded in 1640 on the Merrimack River 16 miles above Newburyport, first attained economic success as a fur trading and ship building center. Within three years a tannery was placed in operation and this was soon followed by the establishment of other industries, chiefly the manufacture of hats and shoes. As the potential of the Merrimack River became more apparent, a number of other successful communities began to appear along the river including Lowell, 1653, and Lawrence, 1655. Lowell later became the northern terminus of the first traction canal built in America (the Middlesex Canal, opened in 1803) which ran some 25 miles from the present city of Somerville near Boston.

The first permanent settlement on the Merrimack River in New Hampshire was established at Dunstable, now Nashua, in 1656. Its early growth, owing to the activities of hostile Indians and heavy taxation, was slow and it was not until late in the 18th century that Nashua began to evidence economic growth as a farming community. With the formation in 1822 of the Nashua Manufacturing Company, the city embarked on an era of industrial expansion.

For nearly 50 years Nashua was the only New Hampshire settlement on the Merrimack River until the founding of Manchester (1722) and Concord (1726). These three early settlements were followed by others during the middle and later part of the 18th century, and by the start

of the 19th century a number of communities were well scattered over the basin.

Agriculture, lumbering, and trading were the principal industries in most of the early settlements and small water-power plants on many of the tributary streams were used by sawmills and gristmills. In 1805 a paper mill opened in Fitchburg, Massachusetts, and shortly thereafter the value of Merrimack water power to drive textile machinery became apparent. Since 1850, the Merrimack River Basin has become famous for the industrial cities of Manchester, Nashua, Lowell, Lawrence and Haverhill. These cities, which were built during the textile boom in New England, still retain their importance to the economy of the basin as industrial centers.

In areas outside of the industrial centers, agriculture and non-urban recreation are now important economic factors. The New Hampshire portion of the basin supplies dairy products to the Boston market and the Nashoba district of the southern Merrimack River Basin in Massachusetts is famous for apple production. Lake Winnipesaukee and the White Mountain National Forest are the best known recreational centers in the basin.

The agricultural activities of the basin are confined mainly to the central and southern portions of the basin. The demand for milk and poultry in the Boston market has resulted in specialization in these products. Orchard crops and garden produce are other important sources of farm income. Although some 70 percent of the watershed is in forest land, lumber production has been on the decline since 1907, save for periodic increases during war years. There are approximately 3,600

farms in the basin (nearly one-half are residential or part-time units) and sales of farm products amounted to over $42,544,000 in 1964. Farming, in general, has been, and continues to be, on the decline.

Industry has been highly developed in the lower part of the basin, particularly in Massachusetts and the larger cities of New Hampshire. A diversified line of goods is produced with the heaviest production found in textiles, leather goods and machinery. Other items such as electronic products and paper are produced on a lesser scale. The principal industrial centers in New Hampshire are Manchester, Concord, Laconia and Nashua. In Massachusetts, Lowell, Lawrence and Haverhill comprise a highly industrialized area along a 20-mile reach of the main river. Fitchburg and Leominster on the North Nashua River and Newburyport at the mouth of the Merrimack River are other highly industrialized centers in the Massachusetts portion of the basin. As a result of this concentration of industry and population, the pollution of the river, adversely effecting the basin and its people has increased.

With its many lakes and mountains, the northern part of the basin in New Hampshire offers a large variety of recreational facilities. Lake Winnipesaukee, affording excellent opportunities for boating and swimming, has long been a noted and popular summer resort. The scenic attractions of Franconia Notch, in the White Mountain headwaters of the basin, are viewed by numerous tourists each year. Many of the slopes in this area have been privately or publicly developed for the benefit of skiers. Among the more frequented are the Cannon Mountain, the Waterville Valley and the Belknap Mountain regions. The furnishing of services and accommodations to the large number of tourists, vacationists,

skiers and sportsmen attracted to this region each year provides the inhabitants with an important source of income and contributes significantly to the general economy of the basin. In order to retain this recreational attribute, it is essential that wastewater management be practiced.

TABLE NO. 1

MERRIMACK WASTEWATER STUDY

2. The towns and cities included in the Study Areas are as follows:

a. Lowell-Lawrence-Haverhill Area

Town/City		Projected Years	
	1970	1990	2020
Essex County, Mass.			
Lawrence *	X	X	X
Methuen *	X	X	X
Andover *	X	X	X
North Andover *	X	X	X
Haverhill *	X	X	X
Groveland *	X	X	X

* Part of Lawrence-Haverhill SMSA

Middlesex County, Mass.			
Lowell *	X	X	X
Billerica *	X	X	X
Chelmsford *	X	X	X
Dracut *	X	X	X
Tewksbury *	X	X	X

* Part of Lowell SMSA

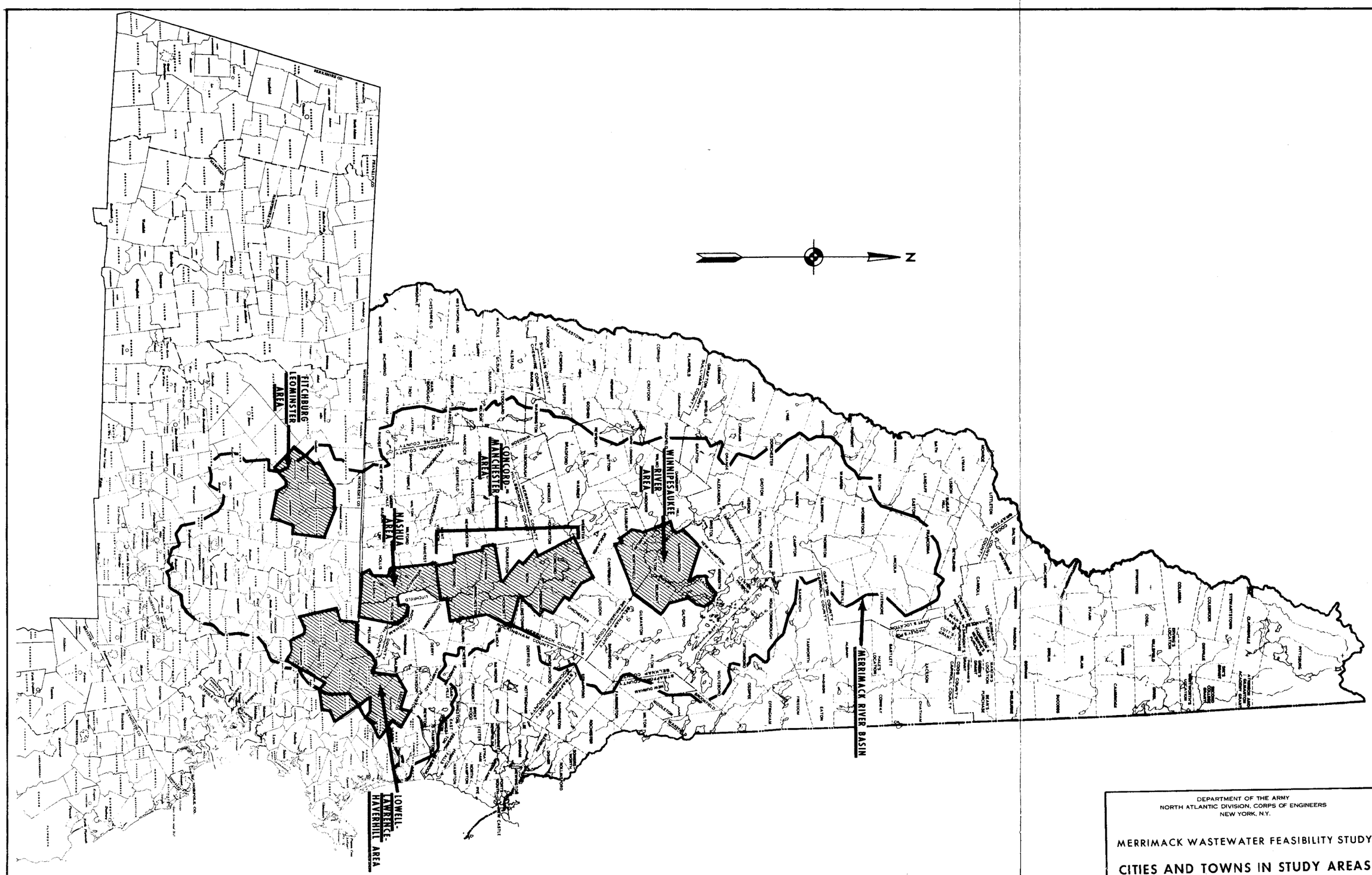
b. Fitchburg Area

Worcester County			
Fitchburg *	X	X	X
Leominster *	X	X	X
Lunenburg *	X	X	X
Westminster *	X	X	X

* Part of Fitchburg SMSA

	1970	Projected Years 1990	2020
d. Nashua, N.H. Area			
Hillsborough County			
Nashua	X	X	X
Hudson	X	X	X
Merrimack	X	X	X
e. Concord-Manchester Area, N.H. **			
Merrimack County			
Concord	X	X	X
Pembroke	X	X	X
Bow (Population included with Concord, N.H.)	X	X	X
Hooksett	X	X	X
Manchester *	X	X	X
Bedford *	X	X	X
Goffstown *	X	X	X
* Part of Manchester SMSA			
f. Winnipesaukee River Area			
Merrimack County			
Northfield	X	X	X
Franklin	X	X	X
Belknap County			
Tilton	X	X	X
Sanbornton	X	X	X
Belmont	X	X	X
Laconia	X	X	X

** Note: Although Concord-Manchester was originally considered as one area, it is noted that later in this Appendix and in the other Appendices that the two city areas are treated seperately.



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MERRIMACK WASTEWATER FEASIBILITY STUDY

CITIES AND TOWNS IN STUDY AREAS

PLATE NO 2A

a. The Fitchburg-Leominster Area

Both cities, Fitchburg and Leominster, are industrial communities and form the core of the Fitchburg-Leominster Metropolitan Area. A brief synopsis of the histroical and industrial background of each city is as follows:

(1) Fitchburg, Mass. - From the time of its settlement about 1740 until the end of the 18th century this area was an agricultural community.

The value of the North Nashua River to the heavily settled area was recognized and development centered around it. In the 1st decade of the nineteenth century, a dam and paper mill was built, followed later by the construction of cotton mills, saw mills and additional paper mills. Recent estimates indicate that approximately 27% of the production of paper and board in Massachusetts comes from plants in the Nashua River Basin.

Industry in the area is now a center for plastics fabricated metal products, with some machinery and chemicals manufacturing. Approximately 900 firms of all types are established in the city and employ more than 17,000 persons with an annual payroll of some $96 millions. Ninety-one of the firms are manufacturers employed 10,300 persons with annual payroll of $65.6 millions.

(2) Leominster, Mass. - The town was established in 1740 and incorporated as a city in 1915. For the first 50 years, the main activities were primarily agricultural; however, in 1770 the comb-making industry was born and by 1845, 24 factories were devoted to comb-making.

By 1966 more than 600 firms of all types were located in the city; of these, 129 firms were manufacturers of plastics, wearing apparel, chemicals, non-electric machinery and furniture, employing some 7,500 people with an average annual payroll of about $41.8 millions.

In the 1960's the population of the cities and towns located wholly or partially in the North Nashua River Basin was about 116,000. The bulk of this population 70,950 resided in the Fitchburg-Leominster urbanized area. The slow growth rate for the basin proper is the result of unavailable open land on which to build. Flood plains contain 68 industrial plants, 216 commercial establishments and approximately 100 dwellings and a portion of the airport. There are about 10 small sites which possible could be used for industry; however, they have drawbacks such as poor topography, lack of suitable access, etc. Only one level tract appears to meet normal standards for a large industrial site and this is presently occupied by the Fitchburg-Leominster airport, and is partially inthe flood plain.

As a result of this long period of manufacturing and the relatively densely populated areas numerous raw wastes were discharged into the river, creating serious deleterious effects are now plainly visible. With continued and increasing discharges of manufacturing wastes from the growing diversified industrial plants and untreated stormwater, have caused the river to be utilized for only recreational boating, irrigation of crops which are not to be used for consumption without cooking, habitat for wildlife and game fishes indegenous to the area, and for industrial uses. Classification of the river is shown on Table 10.

In addition, this pollution has affected, not only the use of the river, but the aesthetic values of some of the built-up areas. Cleaning up of the river would enhance the area entirely and give the inhabitants a new outlook with positive attitudes and pride as well as a sense that the river, as once before, is a tremendous asset and one to be respected.

Here, as in each of the study areas included in this feasibility report, many local and state agencies, as well as private organizations have been attempting to correct the situation. The construction of activated sludge plants in Leominster and the two proposed secondary plants in Fitchburg, and the proposed connection of Lunenburg and Westminster to the Fitchburg systems, are good examples of this initiative.

The estimated average daily flows which require treatment in the Fitchburg-Leominster Area are approximately 10.8 million gallons per day of domestic wastes; about 18 million gallons per day of industrial wastes, and an average stormwater flow of 1.3 million gallons per day. The industrial load is received from the plastics, metal plating, food processing, pupl and paper, industries as well as from and miscellaneous small industires.

The above discharges to the North Branch Nashua River, even considering the partial treatment presently given some of the discharge, leave a great deal to be desired for river improvement and eliminating the pollution in the river.

Although the dissolved oxygen in June of 1965 was above the desirable minimum of 5 mg/l in the Fitchburg area; in Leominster it

was below 2 mg/l. During the same period, the coliform count was about 1,200 per 100 ml in Fitchburg, and about 150,000 per 100 ml in the Leominster area.

b. The Lowell-Lawrence-Haverhill Area - This area has for years been engaged in manufacturing along a 20 mile long continuous reach of the Merrimack River. The main industries contributing to the polluted states of the Merrimack are paper, textiles, tanneries, rendering paper, food processing, wood scouring, dairying, and a minor amount of metal plating. Activated sludge plants are proposed for each of the three cities, including some abutting townships. However, the point discharges for municipal, industrial and stormwater waste are currently directly into the river. The present classification of the river in this reach is "C" and "SC" which is suitable for recreational boating, irrigation of crops not used for consumption without cooking, habitat for wildlife and game fishes indegenous to the area, and industrial uses. However, the present condition of the river is "D" and "U" which means that it constitutes a nuisance most of the time and is only suitable for power, navigation, certain industrial uses and supposedly transportation of sewage and waste without nuisance. Attached Table 10 shows the present condition and classification of the river. With pollution abatement facilities, the quality of the river can certainly be upgraded greatly but much is dependent on upstream wastewater management. The river is used for small boating, and has a marina affording mooring for boats which have access to the open waters of the Atlantic Ocean.

Portions of the river at Haverhill have a "SC" classification due to ocean tidal effects for the 1st 22 miles up the river from its mouth. Plate No. 5 shows the classifications of the river quality from the ocean to the Massachusetts/New Hampshire State Line.

The cities of Lowell and Lawrence utilize the Merrimack River as a water source in the amount of approximately 13 MGD and 8.8 MGD, respectively. This water is treated in individual plants at each city. Part of the Lawrence System furnishes water (about 2.5 MGD) to the adjacent town of Methuen. The other towns rely on surface and well supplies for domestic water use.

Dissolved oxygen in the river between Haverhill and Lowell, in the summer of 1964 and 1965 varied from 0 to an average of 3.5 ppm. The coliform bacteria densely varied from 5,000 up to 2,000,000 in various sections between Lowell and Haverhill. Sludge deposits averaged about .02 feet deep along this reach of the river.

Following is a synopsis of the economic aspect of the major cities in the metropolitan area of Lowell, Lawrence and Haverhill. Population projections for the study area are shown on Table No. 3.

In the Lowell-Lawrence-Haverhill area Lowell contributes about 7 MGD of municipal and industrial wastes; Billerica 1.3 MGD; the Lawrence region 32 MGD and the Haverhill area 22 MGD for a total of 62.0 MGD in 1970.

The approximate stormwater discharges about 810 million gallons annually into the river.

The breakdown of industrial flows in the total area is 0.10 MGD; textile 1.30 MGD; food processing 0.20 MGD; pulp and pumping

11.33 MGD; metal plating 90 (gallons per day); rendering about 0.12 MGD; wool scouring 1.32 MGD and tannery waste about 0.17 MGD for a grand total of 15.3 MGD. Of this total of 15.3 MGD, about 7.0 MGD is contributed by Lawrence; 4.0 MGD by Haverhill and 4.3 MGD by Lowell.

The town of Billerica has secondary treatment with chlorination and the others have none. There are approximately 70 separate outfalls into the Merrimack and Concord Rivers from the Lowell-Lawrence-Haverhill Area.

(1) Haverhill Region, Massachusetts - The Haverhill Metropolitan Region includes the city of Haverhill and the town of Groveland. The industrial and commercial center of Haverhill straddles the Merrimack River and is surrounded on all sides, except the southeast, by undeveloped land within the city boundaries. The small urbanized portion of Groveland is located to the southeast and adjacent to a built-up section of Haverhill.

Based on 1966 economic information, the city had a total of about 1000 firms with 13,000 employees and an annual payroll of approximately $57.9 millions. About 160 manufacturing firms employed about 7,100 persons in the apparel, paper, electrical and plastics industries. With a total annual payroll of $12,334,000 approximately another 3,100 persons were engaged in wholesale and retail enterprises, which had an annual payroll of some $12.3 millions.

(2) Lawrence Region, Massachusetts - The lawrence Metropolitan Region includes Lawrence and the towns of Andover, Methuen, and North Andover. Although the population of Lawrence is expected to remain about the same for the next half century, the population of the other three towns will probably increase about 2½ times in the same period

because of more area for expansion. In 1966, about 1600 Lawrence firms employed approximately 27,600 persons with an annual payroll of $143.6 millions.

Manufacturing is the predominant economic pursuit of the area and the five leading types of manufacturing in order of importance are leather and leather products, textile mill products, electrical machinery, rubber articles, apparel and other finished goods such as boxes and paper products. Wholesale and retail trade firms accounted for the employment of about 6400 persons with an annual payroll of about $28.5 millions.

Local groups of the area have made vigorous attempts to create new jobs and business environment by improving the numerous former textile mill buildings and by building industrial areas to attract new businesses. The principal highways serving the Lawrence Region, including Interstate Route 495 (an outer belt around Metroplitan Boston) and Interstate Route 93, offer additional inducements.

(3) Lowell Region, Massachusetts - The city of Lowell, like Lawrence, has experienced a loss in the textile industry and, since 1920 has had a steady population decrease. In 1965, it reached a record 50 year low of about 86,000 people. Recently Lowell has been increasing its businesses and industries, and trying to improve the highway system to create an expansion in its economy and population. It is expected to remain the business and industrial center of this metropolitan region. The population is predicted to be quite stable for the next two decades.

Lowell was established in 1826 (Lawrence in 1847) and originally

was a farming area, turning successfully to manufacturing and reaching its industrial peak as a textile center in about 1924. With its dams and water power, the Merrimack River provided the industrial impetus.

The city is primarily a manufacturing city specializing in the making of textile mill products, leather and leather goods, ordinance accessories, apparel, printing and publishing. Wholesale and retail firms employed approximately 6,700 persons in 1966 with an annual payroll of $25.2 millions. In 1966, approximately 1650 firms reported an employment of about 30,000 persons with an annual payroll of about $154.0 millions.

c. Nashua Area, New Hampshire - Originally, Nashua was part of Dunstable, Massachusetts, and was called Dunstable, New Hampshire, when the Massachusetts and New Hampshire state line was established in 1746. In 1825 the first mills were constructed and in 1835 the first rail service was introduced to the area. Its metropolitan region includes Hudson and Merrimack, as well as the city of Nashua. The town was then incorporated as a city in 1853 and has continued to experience population and industrial growth.

For the past dozen years, Nashua has grown at a faster rate than at any previous period in this century, as demonstrated by such indicators as the number of building permits issued. Its close proximity to the large Metropolitan Area of Boston makes it particularly attractive to industrial firms to establish themselves in the locality.

The city of Nashua which has some primary sewage treatment, discharges much sewage and stormwater into both the Nashua and Merrimack Rivers. The new secondary sewage treatment plant for the town of Merrimack has a plant capacity of approximately 6 MGD, and a new activated

sludge plant of about 19.5 MGD is being planned for Nashua. It is anticipated that the town of Hudson will join the Nashua system.

The Nashua River has a classification of "C" but its condition is that of Class "D" which is the lowest State classification and is only for the transportation of sewage or industrial waste without nuisance. The Merrimack River at Nashua has a State Classification of "B" down to the confluence of the Nashua River and of Class "C" below. The present condition of the Merrimack River in the vicinity of Nashua is C which is only acceptable for recreational boating, fish habitat and industrial water supply. These actual conditions do not make for the full use of the river in this area by either the local inhabitants or vacationists.

Excepting municipal and stormwater wastes, pollution in the Nashua and Merrimack Rivers from Nashua is principally derived from dischafges from food processing,metal plating, pulp and paper, and tannery industries, comprising 4.4 MGD.

In the vicinity of Nashua the dissolved oxygen content in the summer of 1964 and 1965 was slightly under 5 ppm, the colifrom bacteria density about 40,000/100 ml and sludge depths were about .02 feet deep.

The city of Nashua obtains its water supply from the Pennichuck Brook supplemented from a Souhegan River source. The Merrimack could serve as a closer water source if clean.

d. The Concord-Manchester Area

(1) Concord, New Hampshire - Concord is the capital city of New Hampshire and is the center of a propperous farming country. However, it is not expected to develop into a major industrial center.

The city was settled in about 1727 as Penacook. It was incorporated as the Town of Rumford in 1733 and became the capital seat of government for the State of New Hampshire in 1801. With the completion of the

new highways, Concord is becoming more accessible to the larger metropolitan areas and development of recreation facilities in Concord has been influential in making the city more attractive.

The main industries, exclusive of the State Government, are in the service field and include some distribution. In addition to municipal and stormwater wastes, the major polluting industries are from paper production and tanning, which together contribute about 1.6 MGD to the Merrimack River. The present municipal waste load is about 6 MGD.

The condition of the river is below its official classification of B-1, which is acceptable for bathing and recreation, fish habitat and public water supply after adequate treatment. This classification also offers a high esthetic value to the river and the area. However, the present condition is only satisfactory for its use for recreational boating, fish habitat and industrial water.

Concord utilizes ponds and wells for water supply and does not use the Merrimack River as a source. The adjacent towns of Bow and Pembroke also use wells and surface supplies for their water sources. The summers of (1964 and 1965) dissolved oxygen content in the Merrimack was slightly over 5 ppm and the coliform densities was approximately 20,000/ml. Sludge deposits on the bottom of the river were about zero.

(2) Manchester, New Hampshire - Manchester lies astride the Merrimack River, downstream of Concord, and covers about 35 square miles. The town was originally formed as Derrytown in 1751, and was given its present name of Manchester when it was incorporated as a town in 1846.

It is the largest city in New Hampshire, has a 1970 population of about 87,000 persons, excluding the towns of Bedford, Goffstown and

Hooksett in the SMSA. From the early 1940's a steady increase in population has been experienced because of diverse industries which have developed in the area. It is a large shopping and commercial center for the central part of the state, and is served by an excellent arterial highway system. Industry is still increasing in the area, due in part to the nearness of the Greater Boston market and transportation.

The river classification and its condition as it passes through Manchester is "C", which is acceptable for recreational boating, fish habitat and industrial water supply uses. It obtains its domestic water from Lake Massabesic. Bedford and Hookset are supplied by wells, and Goffstown from surface water bodies.

As can be seen by Plate NO. 4 and Table NO. 17, the Amoskeag Dam and the Hookset Dam in the area are used for hydroelectric power. These dams create two more or less level water bodies about 14 miles long.

Presently only Hookset has a sewage treatment plant in this area, and it is an activated sludge type with 0.5 MGD capacity. Other adjacent communities are in the process of planning treatment plants.

Some State plans have included the diversion of water from the Merrimack River in the vicinity of Manchester to serve southeast New Hampshire. The further treatment of sewage to the tertiary and/or Physical-Chemical types in the towns in the Manchester Vicinity and upstream would certainly provide an improved quality of water for such possible diversions, and will upgrade the river in this reach for body contact sports.

The major pollution industries in the Manchester area are from plastics, food processing, textile, and wool scouring, which contribute about 3.3 MGD on the average.

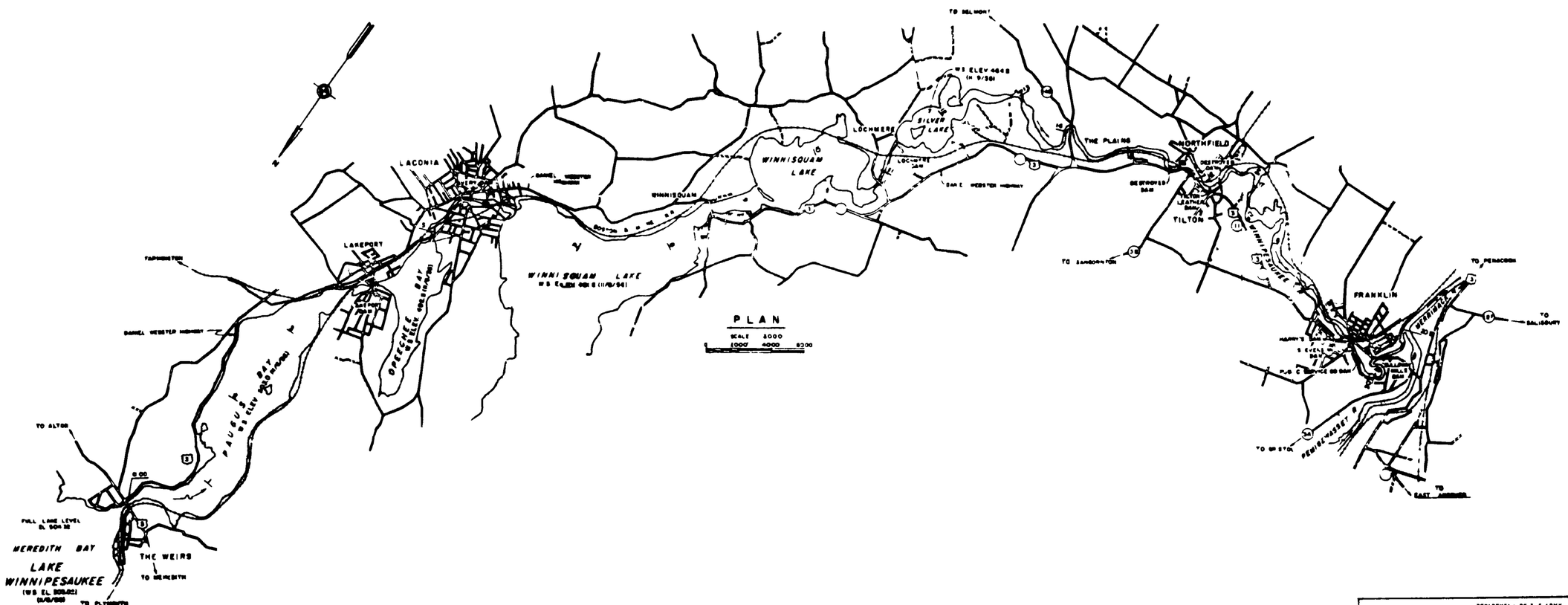
The dissolved oxygen content of the river in this vicinity during the summer of 1964-1965 varied between 0-6 ppm and the coliform bacteria count was approximately 120,000/ml.

e. The Winnipesaukee River Area - The Winnipesaukee River, one of the major tributaries of the Merrimack River, is a non-navigable, meandering stream with several lakes, minor industry, and many privately owned dams spotted along its reach. The river lies wholly in the east central section of New Hampshire and flows in a general southwesterly direction from Lake Winnipesaukee through the towns of Lakeport, Belmont, Tilton and Northfield and the cities of Laconia and Franklin, where it joins the Pemigewasset River to form the Merrimack River.

The watershed of the river is approximately 40 miles long with a maximum width of about 35 miles and has a total drainage area of 488 square miles. The watershed is mountainous in the northern part and generally hilly in the southern section with an overall good tree coverage. The headwaters of the river above The Weirs channel form Lake Winnipesaukee which has a water surface area of approximately 70 square miles. Lake Winnipesaukee is the receiving waters for approximately 75 percent of the entire drainage area of the Winnipesaukee River.

The following is a tabulation of drainage areas tributary to various cities and towns along the river which are of concern in this report.

Location	Drainage Area
The Weirs	351 sq. mi.
Lakeport	364 sq. mi.
Laconia	374 sq. mi.



DEPARTMENT OF THE ARMY
NORTH ATLANTIC DIVISION CORPS OF ENGINEERS
NEW YORK, N.Y.

MERRIMACK WASTEWATER FEASIBILITY STUDY

WINNIPESAUKEE RIVER AREA

GENERAL PLAN

DATE JUNE 29, 1971

WINNIPESAUKEE RIVER

NEW HAMPSHIRE

Location	Drainage Area
Lochmere	428 sq. mi.
The Plains	469 sq. mi.
Tilton	473 sq. mi.
Franklin (Merrimack River)	488 sq. mi.

The watershed is generally hilly with steep inclined ridges in the upper valley. The hills and a large portion of the valley are covered with first and second growth timber.

The Winnipesaukee River has one main tributary, the Tioga River, which flows into the Winnipesaukee River at a point approximately 2 miles upstream from the town of Tilton. The major source of high runoff, however, is from the many smaller brooks and streams during periods of intense rainfall and snowmelt.

An area map, drawn at a scale of 1 inch = 6,000 ft.± is included as Plate No. 3 of this report.

The Winnipesaukee River watershed has a permanent population of about 29,700 persons. During the summer and winter months, people entering the area for recreational purposes, swell the population an estimated 50%. The area above Silver Lake is a very active summer and winter resort. The lakes in this region draw tourists from every state on the east coast and some of the country's most famous ski runs are located in the area.

Lake Winnipesaukee, always an active recreational area, has since World War II, seen phenomenal growth. Recreational boating has increased many fold and shorefront property is at a premium. Lake Winnipesaukee and the surrounding area has become an increasingly more vital factor in the economy of the State.

In the more densely populated areas of Franklin, Tilton, Laconia and Lakeport is found the industrial concentration of the valley. These industries are somewhat diversified, and include production of hosiery, knitting machinery, neddles, leather products, brass and iron castings and clockmaking. A new plant, located immediately below Silver Lake, produces electrical insulating materials.

The water supply for the various populated areas along the river is obtained from the river and lakes. Several small dams along the river impound water for industrial process water or as pondage for small power developments. A number of manufacturing plants use raw river water for industrial processes and cooling, returning the major portion of this intake to the river within a relatively short time. The Winnipesaukee River has been developed for the generation of hydro-electric power and produces approximately 11,400,000 KW hours at seven plants.

These lakes in the vicinity of the Winnipesaukee River, in recent years, have become a summer mecca for people from all over the northeastern United States. Lake Winnipesaukee, the largest, by far, of the several lakes in the area, has experienced phenomenal growth in the buildup of lakefront property and recreational boating on the lake during the years since World War II. Shorefront property has greatly increased in value and the number of boats situated on the lake has increased five-fold. As a result of this growth, the area and Lake Winnipesaukee in particular, has become an ever increasingly more important part of the recreation industry of the State of New Hampshire. In the interest of upholding its recreation and economic value, the water surface elevation of Lake Winnipesaukee is regulated by the

Water Resources Board and state law. The area will probably maintain its present rate of growth in all respects, including the population and recreational elements, for many decades to come.

Laconia has a primary sewage treatment plant constructed in 1952, of about 1.6 MGD. The other communities along the river rely on spetic tanks and discharge raw sewage into the Winnipesaukee River, creating problems within the river itself and in the Merrimack River downstream.

Although the classification of the river is B-1, which is acceptable to bathing and recreation, fish habitat and public water supply after adequate treatment, these waste discharges are deleterious to the stream. With future population expansion and increased in recreational needs, it is important that advanced sewage treatment measures be implemented as soon as possible.

At a sampling station about .19 miles upstream on the Winnipesaukee River from its confluence with the Merrimack River, an abundance of fibrous material was found in the bottom sediments, as well as gases or anerobic decomposition which bubble-up from the bottom during sediment dredging. These conditions and the low oxygen content, indicate that the headwaters are highly polluted.

3. Economic, Industry and Population in the Basin:

In general, the examined historical data, and projections derived therefrom, indicate that the economy of both the Merrimack River Basin and the Boston Metropolitan Area will continue to expand and prosper in the period from 1970 through 2020. In the process of expansion, both areas will continue to export valuable services and/or manufactured

materials beyond their boundaries. Changes within and among the areas' various economic sectors are, of course, inevitable and will play a dominant role in the growth pattern of the region. Population, urbanization, employment, personal income, and the nature and composition of the industrial and businesses of the economy will be of special relevance to the water and wastewater management problems and needs of the areas.

The manufacturing sectors in both the Merrimack River Basin and the Boston Metropolitan Area are projected to decline with respect to percent of distribution of employment by industry division. However, the expanding population and rising personal income indicate further advances in the urban services of finance, insurance, real estate and other non-manufacturing nature. Farming in the Merrimack River Basin is on a continuous decline as well as forestry and fishing.

The following tables indicate the trends in population, industrial activity, personal income and rates of growth for the items for the Merrimack River Basin, the Boston Metropolitan Area, New England and the United States.

TABLE NO. 2

MERRIMACK RIVER BASIN WASTEWATER MANAGEMENT STUDY

SUMMARY OF BASIN POPULATION BY STATE

Merrimack River Basin	1960	1970	1990	2020
New Hampshire Portion	569.8 (328.0)	689.2 (400.0)	1,016.0 (585.0)	1,390.0 (812.0)
Massachusetts Portion	2,390.8 (752.0)	2,652.9 (850.0)	2,755.0 (867.0)	3,371.4 (1,060.0)
Totals	2,960.6 (1,080.0)	3,342.1 (1,250.0)	3,771.0 (1,452.0)	4,761.4 (1,872.0)

Note: Figures in () are estimated population within the Basin Drainage Area.

Figures without () are the total population of all of the counties that are in or partially in the Drainage Area.

TABLE NO. 2A

AVERAGE ANNUAL EMPLOYMENT GROWTH RATE

Location	1940-1960	1950-1960	1960-2020
Merrimack River Basin	1.7	1.6	1.1

TABLE NO. 2B

MERRIMACK RIVER BASIN WASTEWATER MANAGEMENT STUDY

Total Population of the Merrimack River Basin, Metropolitan Boston Area, New England and the United States

Population (in thousands)

Location	1960	1970	1990	2020	Remarks
Merrimack River Basin					
Hillsborough, Rockingham, Merrimack/ Cheshire & Sullivan & Stratford Counties in New Hampshire	476.2	586.5	790.0	1,074.0	
Carroll, Belknap, & Grafton Counties in New Hampshire	93.6	102.7	226.0	316.0	The county figures are for the entire county. Those fig. in ( ) are in basin.
Essex, Middlesex and Worcester Counties in Massachusetts	2,390.8 (752.4)	2,652.9 -------	2,755.0 -------	3,371.4 -------	
Totals of all counties that are in the Basin = (Estimated totals within confines of Basin D.A.)	2,960.5 (1,080.0)	3,342.1 (1,250.0)	3,771.0 (1,452.0)	4,761.4 (1,872.0)	
Metropolitan Boston Area**					
Includes Essex, Middlesex, Norfolk, Suffolk and Plymouth Counties in Massachusetts. (Note: Those portions of the Essex and Middlesex Counties in the Merrimack River Basin are not included)		3,652.0	4,382.9	6,126.0	
Metropolitan Boston Area (SMSA)**	2,595.5	2,730.2	3,270.0	4,570.0	
New England	10,509.4	11,678.4	14,467.0	19,844.6	
United States (in millions)	179.3	200.3	269.7	397.6	

**These population figures are greater than the population served by the Metropolitan District Commission Water and/or Sewer Districts.

TABLE NO. 2 C

Personal Income, Merrimack River Basin, Boston Metropolitan Area
New England and the United States
Total Personal Income (in millions of 1958 constant dollars)
and Per Capita Income

Location	1960	1970	1990	2020
Merrimack River Basin	6,915.0	14,360.0	29,156.0	58,982.0
Per Capita	2,951.-	5,078.-	8,089.-	12,842.-
Relative to U.S.	1.36	1.23	1.27	1.19
	1962			
BOSTON Metropolitan Area	9,065.5	12,671.2	26,157.5	79,841.2
Per Capita	2,678.-	3,470.0	6,037.0	13,033.-
Relative to U.S.	1.19	1.14	1.13	1.05
New England				
Per Capita	26,849.4	38,041.2	79,857.5	251,922.2
Relative to U.S.	2,503.-	3,280.-	5,520.-	12,695.-
	1.11	1.08	1.03	1.02
United States (in billions of $)	419.6	624.6	1,442.1	4,934.1
Per Capita	2,258.-	3,046.-	5,346.-	12,411.-

Remarks: 1. Figures for Merrimack River Basin are based on Total County Figures that lie partially or wholly in the basin.

TABLE NO. 2 D

AVERAGE ANNUAL RATES OF POPULATION GROWTH FOR SELECTED PERIODS

Location	1940-1960	1960-1970	1970-2020
Merrimack River Basin	1.1	1.3	1.1
New England	1.2	1.1	1.1
United States	1.7	1.1	1.3

	1940-1950	1950-1960	1960-1970	1980-2000	2000-2020
Metropolitan Boston Area	0.8	0.9	0.9	1.0	1.2

TABLE NO.

AVERAGE ANNUAL RATES OF PERSONAL INCOME GROWTH FOR SELECTED PERIODS

Location	1950-1960	1970-2020
Merrimack River Basin	3.4	3.6
New England	3.4	3.9
United States	3.6	4.2

	1940-1962	1950-1962	1970-2020
Metropolitan Boston Area	2.5	3.1	3.8

TABLE NO. 2.E

EMPLOYMENT BY INDUSTRY DIVISIONS

Location	1960	1970	1990	2020
Merrimack River Basin				
Agriculture, Forestry, Fisheries and Mining	14,954	11,950	8,103	5,172
Manufacturing	314,048	316,407	345,062	432,805
Other	604,598	675,743	881,585	1,403,823
Total Employment	933,600	1,004,100	1,234,750	1,841,800
Participation Rate				
Boston Metropolitan Area				
Agr., For., & Fish.	12,491	7,304	5,400	2,500
Mining	897	-	-	-
Contract Construction	67,099	75,962	98,800	140,700
Manufacturing	414,356	423,634	420,500	502,300
T.C.P.U.	82,659	87,648	93,400	87,900
Trade	236,436	255,641	307,300	401,900
F.I.R.E.	72,157	81,805	104,200	150,700
Services	289,174	376,888	575,000	954,400
Government	69,737	84,727	116,800	175,800
Military	25,626	23,373	21,800	20,100
Industry not reported	68,846	43,824	53,200	75,300
Total Employment	1,339,478	1,460,806	1,796,900	2,511,600
Participation Rate	.399	.400	.410	.410

TABLE NO. 2F

Percent Distribution of Employment by Industry Division

Location	1960	1970	1990	2020
Boston Metropolitan Area				
Agr., For., & Fishing	0.9	0.5	0.3	0.1
Mining	-	-	-	-
Contract Construction	5.0	5.2	5.5	5.6
Manufacturing	30.9	29.0	23.4	20.0
T.C.P.U.	6.2	6.0	5.2	3.5
Trade	17.7	17.5	17.1	16.0
F.I.R.E.	5.4	5.6	5.8	6.0
Services	21.6	25.8	32.0	38.0
Government	5.2	5.8	6.5	7.0
Military	1.9	1.6	1.2	0.8
Industry not reported	5.1	3.0	3.0	3.0
Total employment	100.0	100.0	100.0	100.0
Merrimack River Basin				
Agriculture, Forestry, Fisheries and Mining	1.6	1.2	0.6	0.3
Manufacturing	33.6	31.7	28.2	23.5
Other	64.8	67.1	71.2	76.2
Total employment	100.0	100.0	100.0	100.0

TABLE NO. 2 G

AVERAGE POPULATION DENSITIES (Population per Square Mile)

Location	1960	1970	1990	2020
Merrimack River Basin (Ave)	258	293	354	506
Upper Basin	27	28	41	65
Middle Basin	140	175	228	372
Lower Basin	1369	1530	1788	2427
Metropolitan Boston Area (SMSA)	2627	2763	3310	4625
New England	102	113	141	193
United States (Conterminous)	50.5	67	89	131

Note: The above is based on the following total land and water areas.

Metro Boston Area (SMSA)	=	998 square miles
New England	=	102,745 square miles
U. S. (Conterminous)	=	3,022,387 square miles

TABLE NO. 3

MERRIMACK RIVER BASIN WASTEWATER MANAGEMENT STUDY

4. Population Projections for Specific Study Areas

	1960	1970	1990	2020
Fitchburg Area				
Worcester County				
Fitchburg	43,021	42,906	48,000	54,000
Lunenburg	6,334	7,396	12,500	19,000
Leominster	27,924	32,709	40,000	51,500
Westminster	4,022	4,199	8,000	12,000
Totals	81,306	87,210	108,500	136,500
Lowell-Lawrence-Haverhill Area				
Essex County				
Lawrence	70,933	66,216	65,000	70,000
Haverhill	46,346	45,643	47,800	55,700
Andover	17,134	23,277	27,500	37,000
Groveland	3,297	5,325	7,200	8,400
Methuen	28,114	34,986	36,000	49,000
North Andover	10,908	16,185	25,000	42,000
Middlesex County				
Lowell	92,107	92,929	92,000	94,000
Billerica	17,107	31,284	43,700	61,000
Chelmsford	15,130	31,258	43,700	61,000
Dracut	13,674	18,220	25,500	35,600
Tewksbury	15,902	22,464	32,000	40,000
Totals	327,652	387,787	445,400	553,700
Winnipesaukee River Area				
Merrimack County				
Northfield	1,784	2,157	2,800	8,700
Franklin	6,742	7,106	8,600	14,500
Belknap County				
Tilton	2,137	2,575	2,600	3,500
Sanborton	857	966	1,300	2,000
Belmont	1,953	2,435	3,800	6,000
Laconia	15,288	14,508	15,000	15,000
Totals	28,761	29,747	34,100	49,600

TABLE 3 Continued

	1960	1970	1990	2020
Concord-Manchester Area				
Merrimack County				
Concord	30,331	32,020	43,000	74,000
Pembroke	3,514	4,187	6,800	17,000
Bow (Included in Concord figures)				
Hookset	3,713	5,472	19,500	32,000
Hillsborough County				
Manchester	88,282	87,342	118,500	147,500
Bedford	3,636	5,746	22,200	47,500
Goffstown	7,230	9,115	28,000	58,000
Totals	138,046	146,429	238,000	376,000
Nashua Area				
Hillsborough County				
Nashua	39,096	55,378	81,750	110,000
Hudson	5,876	10,625	26,000	43,000
Merrimack	2,989	8,150	25,000	58,000
Totals	47,961	74,153	132,750	211,000

Notes: 1960 figure based on 1960 Census
1970 figure based on 1970 Prel. Census
1990 & 2020 figures are projections only and are based on the best available information.

D. STREAMFLOW DATA FOR THE MERRIMACK RIVER BASIN

The U.S. Geological Survey has published records of streamflow at numerous locations on the mainstream and tributaries of the Merrimack River for various times since 1948. A summary of the flow data at primary stations in the basin areas of study is shown on Table No.5

Also shown on Table No. 4 are the mean, maximum and minimum flows for the Merrimack River at Lowell and a flow duration curve at Lowell on Plate No.

The Federal Water Pollution Control Administration has established the following monthly minimum flow requirements for pollution control on the Merrimack River at Lowell, Massachusetts (Drainage Area = 4,635 square miles):

Period of Year	Min. Monthly Flow Requirements (cfs)
October - May	800
June	1,000
July	1,500
August	1,500
September	1,000

It appears that, with proper treatment, some of the future water supply needs of southeastern New England may be met from the Merrimack River in the vicinity of Lowell, Massachusetts., for portions of the year.

Run-off - The average annual run-off in the Merrimack River Basin varies from less than 18 inches (1.3 cubic feet per second per square mile) in the lower part of the basin to over 30 inches (2.2 c.s.m.) in the area above Plymouth, New Hampshire, and to an extreme of over 40 inches (3.0 c.s.m.) in the headwaters of the Pemigewasset River. The average

annual run-off for the watershed as a whole is 21 inches (1.5 c.s.m.) or approximately one-half of the average annual precipitation. About 50 percent of the annual run-off occurs in the spring months of March, April and May, with the remainder being rather uniformly distributed throughout the rest of the year. The extremes of recorded flow at Plymouth, New Hampshire have ranged from a maximum instantaneous flow of 65,400 c.f.s. (105 c.s.m.) on March 19, 1936, to a minimum instantaneous flow of 39 c.f.s. (less than 0.1 c.s.m.) on October 3, 1948. A minimum monthly flow of 107 c.f.s. (0.2 c.s.m.) was experienced in September 1923. The extremes at Lowell, Massachusetts have ranged from an instantaneous peak of 173,000 c.f.s. (37 c.s.m.) on March 20, 1936 to a minimum daily flow of 199 c.f.s. (less than 0.1 c.s.m.) on September 23, 1923. A minimum monthly flow of 1,249 c.f.s. (0.3 c.s.m) was recorded in September 1942.

Stream velocities recorded by the U.S. Geological Survey since water year ending September 30, 1967, on the Winnipesaukee and the North Branch Nashua River are as follows:

River	Location	Mean Velocity	
		Minimum	Maximum
Winnipesaukee	U.S.G.S. Station at Tilton, N.H.	.61 Fps (Aug. 6, 68)	5.47 Fps (May 8, 67)
North Branch Nashua	U.S.G.S. Station at Leominster, Mass.	.78 Fps (Oct. 23, 68)	3.92 Fps (Mar. 19, 68)
Merrimack	U.S.G.S. Station at Lowell, Mass.*		

* Also see Table 8 velocities in the mainstem Merrimack River during 7-day minimum flow.

MERRIM RIVER BASIN

STREAM FLOW DATA

TABLE NO. 4

Stream	River Mile	Location	Drainage Area	Daily Average Annual Flow (cfs)	7-Day Low Flow (10 year) cfs	Daily Maximum Flow (cfs)	Daily Minimum Flow (cfs)
Merrimack	114.70	U.S.G.S. Gauge Sta., Franklin, N.H. Junction	1507	2723	589	83,000	169*
"	93.0 ±	Concord, N.H.	2384	4176**	620	127,300**	188**
"	69.04	U.S.G.S. Gauge Sta., at Goffs Falls, Manchester, N.H.	3092	5102	663	150,000	98*
"	54.80	Nashua, N.H.	3982	6216**	870	172,000	198**
"	38.48	U.S.G.S. Gauge Sta., Lowell, Mass.	4635	7033	980	173,000	199
"	28.99	Essex Co. Dam, Lawrence, Mass.	4672	7176**	1000	174,000	200**
"	21.85	Haverhill, Mass. (Rocks River Bridge)	4900	7320**	1020	174,000	200**
North Nashua	17.2	Fitchburg, Mass. (Arden Mill)	63	117	18**	9,400	13**
	6.5	U.S.G.S. Gauge Sta., Leominster, Mass.	107	188	32	16,300	22

TABLE NO 4 Continued

Stream	River Mile	Location	Drainage Area	Daily Average Annual Flow (cfs)	7-Day Low Flow (10 year) cfs	Daily Maximum Flow (cfs)	Daily Minimum Flow (cfs)
Winnipesaukee	0.0	Franklin, N.H.	486	695**	-	3,932**	49**
"	3.0	Tilton, N.H. *	471	674	-	3,810	48
"	15.0 ±	Lake Winnipesaukee Outlet* at Lakeport, N.H.	363	518	-	2,890	0

Note: Some gauging stations are regulated by upstream flow (i.e: Lake Winnipesaukee)

The flows from Lake Winnipesaukee are controlled at the Lakeport outlet and therefore it is considered that the 7 day-10 year Low Flow does not apply. The present safe water discharge at Lakeport should not exceed 2,600 cfs(Appr. 1,733 MGD).

* = Gage Station Location.

** = Estimated quantities.

TABLE NO. 4a

MAINSTEM AND TRIBUTARY STREAM FLOW RECORDS OF THE MERRIMACK RIVER BASIN:

Location of gaging station	Drainage area (sq.mi.)	Period of record	Discharge Mean 1/ (cubic feet per second)	Discharge Maximum 2/ (cubic feet per second)	Discharge Minimum 2/ (cubic feet per second)
Merrimack River					
Franklin Jct., N.H.	1,507	1903-	2,753	83,000	225 3/
Manchester, N.H. 4/	2,854	1924-	4,669	144,000	-
Lowell, Mass. 5/	4,635	1923-	6,986	173,000	199 3/
Goffs Falls, N.H.	3,092	1936-	5,173	150,000	154 3/
E. Br. Pemigewasset River					
Near Lincoln, N.H.	104	1929-	297	17,000	13 3/
Pemigewasset River					
Plymouth, N.H.	622	1886-	1,354	65,400	39
Baker River					
Near Rumney, N.H.	143	1929-	251	21,400 6/	6.5
Smith River					
Near Bristol, N.H.	86	1918-	138	8,100	1.9 3/
Contoocook River					
Penacook, N.H.	766	1929-	1,215	46,800	48
Suncook River					
N. Chichester, N.H.	157	1921-27 1929-	228	12,900	0.4
Souhegan River					
Merrimack, N.H.	171	1909-	279	16,900	13
Nashua River					
E. Pepperell, Mass.	433 7/	1936-	503	20,900	1.1 3/
Concord River					
Lowell, Mass.	405 8/	1937-	434	3,790	7

Table 4a (Continued)

1/ For period of record or through September 30, 1951 where gage is still in operation. Adjusted for diversion where necessary.

2/ Instantaneous except where noted.

3/ Daily.

4/ At Amoskeag Dam. Records furnished by Public Service Company of New Hampshire.

5/ Below the mouth of Concord River. Records are available for Merrimack above the Concord River (drainage area 3,979 square miles) for period 1848-1916.

6/ Maximum known discharge, estimated from floodmarks, was 25,900 c.f.s. on November 3, 1927.

7/ Gross; flow from 117 square miles diverted for water supply use of Boston and Worcester.

8/ Gross; flow from 93 square miles diverted for water supply use of Boston.

River Gauging Stations - Following are the major gaging stations operated by the U.S. Geological Survey along the Merrimack, North Branch Nashua and Winnipesaukee Rivers within the limits of this feasibility study area. The stations and data are as follows:

TABLE NO. 5

U. S. GEOLOGICAL SURVEY GAGING STATIONS

Gauge No.	River Mile	River	Location	Drainage Area	Period of Records
1-0815	114.70	Merrimack	Franklin Junction, N.H.	1507	1906 - Present
1-0920	69.04	Merrimack	Goffs Falls, N.H.	3092	1936 - Present
1-1000	38.48	Merrimack	Lowell, Mass.	4635	1924 - Present
1-0945	6.50	N. Nashua	Leominster, Mass.	107	1935 - Present
1-0805	15.0 ±	Winnipesaukee	Outlet at Lakeport, N.H.	363	1933 - Present
1-0810	3.0	Winnipesaukee	Tilton, N.H.	471	1937 - Present

TABLE NO. 6

WATER QUALITY CONTROL MONITORING STATIONS

The following Federal Water Quality Control Monitoring Stations are located within the Merrimack River Basin:

OWDC Number	Agency Station Number	Station Name	Start of Record	Reporting Agency
67277	01075000	Pemigewasset R. at Woodstock, N.H.	1969	GS
56780	01076500	Pemigewasset R. at Plymouth, N.H.	1967	GS
56781	01089000	Soncook R. near Concord, N.H.	1967	GS
56782	01094000	Souhegan R. at Merrimack, N.H.	1967	GS
67278	01094700	North Nashua R. at North Village, Mass.	1968	GS
67279	01096550	Merrimack R. above Lowell, Mass.	1969	GS
66783	01097000	Assebet R. at Maynard, Mass.	1967	GS
56784	01098900	Merrimack R. AB Concord R. at Lowell, Mass.	1967	GS
56785	01099500	Concord R. below R. Meadow Brk at Lowell, Mass.	1967	GS
56786	01100000	Merrimack R. below Concord R. at Lowell, Mass.	1966	GS
67280	01100750	Merrimack R. at West Newbury, Mass.	1968	GS
55066	240019	Merrimack R. above Lowell, Mass.	1958	WQA

Note: Stations #0109470 and 01100750 are jointly operated by the USGS and the Massachusetts Water Pollution Control.

TABLE NO. 7

WATER QUALITY CONTROL MONITORING STATIONS (Continued)

The following Sampling Stations in Massachusetts have been maintained in the Merrimack River by the Massachusetts Department of Public Health:

Sta. Ref. No.	River Mile	Sampling Point
1	48.2	Station No. 10
2	47.4	Tyngsborough Bridge
3	43.3	Station No. 9
4	40.6	Canal entrance, Lowell
5	39.7	Beaver Brook at mouth, Lowell
6	38.7	Route 110 Bridge, Lowell
7	37.4	Station No. 8
8	37.0	Below Lowell
9	34.1	Station No. 7
10	31.4	Station No. 6
11	29.5	Above Lawrence
12	29.0	Canal, rear of Exp. Station, Lawrence
13	27.2	Below Lawrence
14	26.5	Alblan St. Ext., Lawrence-Methuen Line
15	26.2	Station No. 5
16	20.5	Above Haverhill
17	20.1	Station No. 4
18	19.1	Bridge above Haverhill
19	17.1	Below Haverhill
20	15.7	Groveland Bridge
21	15.7	Station No. 3
22	6.9	Above Amesbury
23	6.9	Station No. 2

Sta. Ref. No. for Fig. B.	River Mile	Sampling Point
24	6.3	Powwow River at mouth, Amesbury
25	5.1	Newburyport Chain Bridge
26	0.2	Station No. 1

Notes:

1. Coliform Counts were recorded during the years 1936-1939; and 1956-1963 at most of these stations.
2. Dissolved Oxygen was recorded during the years 1936-1945; and 1956-1963 at most of these stations.
3. BOD was recorded during the years 1936-1945; and 1956-1963 at most of these stations.
4. Data from Comm. of Mass. House Document No. 3733 dated June 1964.

TABLE 8

STREAM PARAMETERS FOR INDIVIDUAL REACHES FOR THE 7-DAY MINIMUM FLOW
(Merrimack River)

Reach	Length of Reach (miles)	River Mile at Upper End of Reach	Drainage Area at Upper End (sq. miles)	Flow at Upper End (cfs)	Estimated Velocity in Reach (miles/day)	Time of Flow in Reach (day)	k1 20° C Per Day	k2 20° C Per Day	k3 Per Day
		11.8			Rocks Village Bridge				
D	5.6		4,930	1,020	2.56	2.18	0.17	0.14	0
		17.4			Haverhill				
E	4.5		4,880	1,010	3.99	1.09	0.16	0.21	0.01
		21.9			Creek Brook				
F	5.1		4,870	1,010	5.67	0.89	0.16	0.21	0.01
		27.0			Lawrence				
G	2.1		4,745	1,000	5.67	0.37	0.16	0.32	0.01
		29.1			Essex Dam				
H	4.0		4,740	1,000	1.64	2.42	0.15	0.15	0.01
		33.1			Fish Brook				
I	1.9		4,710	1,000	10.5	0.181	0.15	0.15	0.01
		35			Above Essex Dam				
J	2.4		4,700	1,000	10.5	0.229	0.15	0.15	0.01
		37.4			Lowell				
K	1.1		4,635	990	10.5	0.104	0.17	0.35	0.01
		38.5			Concord River				
L	1.3		4,400	930	24.2	0.054	0.17	0.35	0.01
		39.8			Beaver Brook				
M	0.7		4,210	900	24.2	0.029	0.17	0.35	0.01
		40.5			Pawtucket Dam				
N	2.7		4,150	900	0.93	2.9	0.11	0.22	0.05
		43.2			Stony Brook				

Note: Refer to Profile of the Merrimack River for locating the Reaches. (See Plate 4)

Courtesy GAO Report

TABLE 8 (Cont'd)

STREAM PARAMETERS FOR INDIVIDUAL REACHES FOR THE 7-DAY MINIMUM FLOW

Reach	Length of Reach (miles)	River Mile of Upper End of Reach	Drainage Area at Upper End (sq miles)	Flow at Upper End (cfs)	Estimated Velocity in Reach (miles/day)	Time of Flow in Reach (day)	k1 20°C Per Day	k2 20°C Per Day	k3 20°C Per Day
O	1.5		4,140	880	9.7	0.433	0.11	0.22	0.05
		44.73		Sagamore Park					
Q	3.6		4,100	870	15.7	0.2285	0.11	0.22	0.05
		53.3		Nashua					
R	1.5		4,000	870	11.4	0.131	0.11	0.22	0.05
		54.8		Nashua River					
S	2.85		3,420	870	6.95	1.08	0.11	0.22	0.05
		57.65		Comas Brook (Goffe Falls)					
V	0.8		3,160	680	12.8	0.0625	0.22	0.50	0
		68.5		Manchester					
W	2.8		3,030	670	12.8	0.219	0.22	0.50	0
		71.3		Piscataquog River					
X	1.9		2,760	650	25.6	0.074	0.22	0.50	0
		73.2		Amoskeag Dam					
Y	5.3		2,705	650	2.96	1.79	0.10	0.15	0.02
		78.5		Above Amoskeag Dam - Hookset					
Z	2.6		2,700	650	16.05	0.158	0.10	0.15	0.02
		81.1		Hookset Dam					
AA	3.4		2,680	650	4.34	0. 78	0.18	0.27	0,05
		84.5		Above Hookset Dam					
AB	2.3		2,280	630	20.0	0.12	0.18	0.27	0.05
		86.8		Garvins Falls Dam					

TABLE 8 (Cont'd)

STREAM PARAMETERS FOR INDIVIDUAL REACHES FOR THE 7-DAY MINIMUM FLOW

Reach	Length of Reach (miles)	River Mile of Upper End of Reach	Drainage Area at Upper End (sq miles)	Flow at Upper End (cfs)	Estimated Velocity in Reach (miles/day)	Time of Flow in Reach (day)	$k1_o$ 20°C Per Day	k2 20°C Per Day	k3 20°C Per Day
AC	0.6		2,270	620	1.59	0.377	0.18	0.27	0.05
		87.4		Concord					
AD	4.2		2,245	620	1.59	2.64	0.18	0.27	0.05
		91.6		Franklin					
AJ	2.2		1,490	590	20.7	0.106	0.15	0.50	0
		115.7		Winnepsaukee					
AK	1.0		1,040	340	35.0	0.028	0.15	0.50	0

Note: K_1 = Rate Constant of Deoxygenation in units per day

K_2 = Rate constant for reaeration units per day

K3 = Rate constant of settling out of BOD to the bottom sediments in units per day

Data from GAO Report by Camp, Dresser & McKee

TABLE 9

IDENTIFICATION OF REACHES
(Merrimack River)

Station	Reach	Distance from the River Mouth (miles)	Length (miles)	Description	Comment
3		11.8		Rocks Village Bridge (Haverhill)	SC
	D		5.6		
4		17.4		Haverhill	RD
	E		4.5		
5		21.9		Creek Brook	SC
	F		5.1		
6		27.0		Lawrence	RD
	G		2.1		
7		29.1		Essex Dam	HC,SC
	H		4.0		
8		33.1		Fish Brook	SC
	I		1.9		
9		35.0		Above Essex Dam	FC,RD
	J		2.4		
10		37.4		Lowell	RD
	K		1.1		
11		38.5		Concord River	TR
	L		1.3		
12		39.8		Beaver Brook	TR,RD
	M		0.7		
13		40.5		Pawtucket Dam	HC,SC
	N		2.7		
14		43.2		Stony Brook	FC,TR,RD
	O		1.5		
15		44.73		Setiptyngs Island	SC
			3.6		
16		51.4		Sagamore Park	SC,OR
	Q		1.5		
17		53.3		Nashua	RD
	R		2.85		
18		54.8		Nashua River	SC, TR
	S				
19		57.65		Pennichuck Bk.	TR

(1)

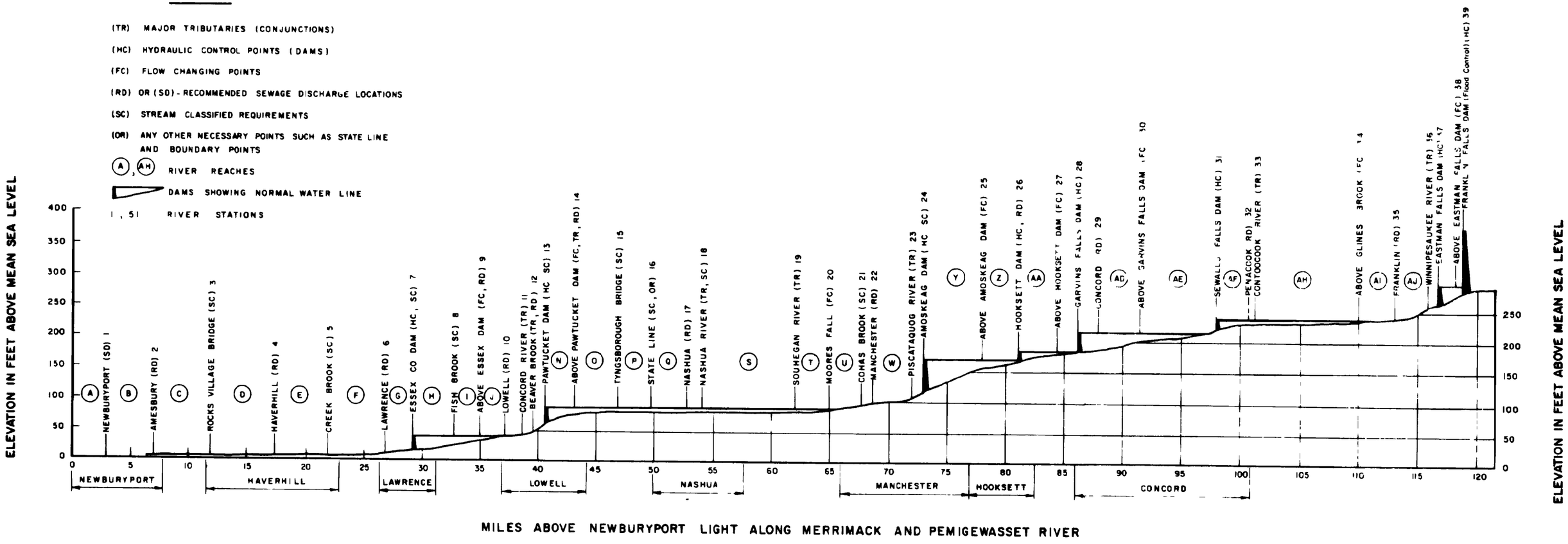
1. TR = Tributaries (Conjunction)
2. HC = Hydraulic control points (dams)
3. FC = Flow changing points
4. RD or SD = Recommended sewage discharge locations
5. SC = Stream classified requirements
6. OR = Any other necessary points, such as state line and boundary points

TABLE 9 (Cont'd)

IDENTIFICATION OF REACHES

Station	Reach	Distance from the River Mouth (miles)	Length (miles)	Description	Comment
21		67.7		Cohas Brook (Goffs Falls)	SC
	V		0.8		
22		68.5		Manchester	RD
	W		2.8		
23		71.3		Piscataquog River	TR
	X		1.9		
24		73.2		Amoskeag Dam	HC,SC
	Y		5.3		
25		78.5		Above Amoskeag Dam (Hooksett)	FC
	Z		2.6		
26		81.1		Hooksett Dam	HC, RD
	AA		3.4		
27		84.5		Above Hooksett Dam	FC
	AB		2.3		
28		86.8		Garvins Falls Dam	HC
	AC		0.6		
29		87.4		Concord	RD
	AD		4.2		
		91.6		Above Garvins Falls Dam	FC
	AE		6.2		
31		97.8		Sewall Falls Dam	HC
	AF		2.5		
32		100.3		Penacook (Boscawen)	RD
	AG		0.5		
33		100.8		Contoocook River	TR
	AH		9.2		
34		110		Above Glines Brook	FC
	AI		3.5		
35		113.5		Franklin	RD
	AJ		2.2		
36		115.7		Winnipesaukee	TR
	AK		1.0		

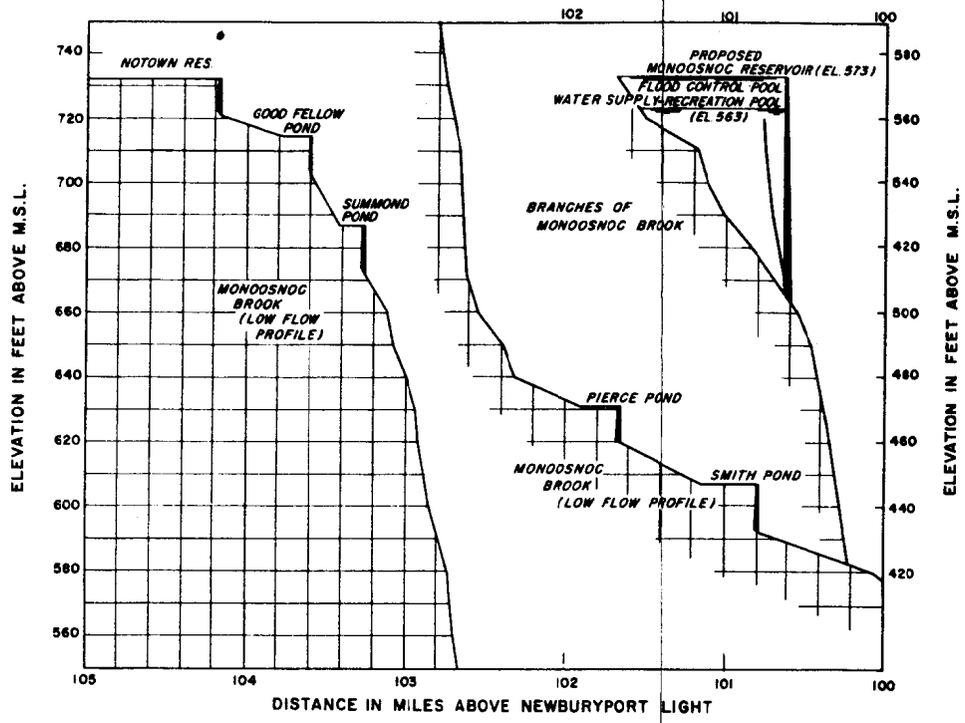
From GAO Report by CDM

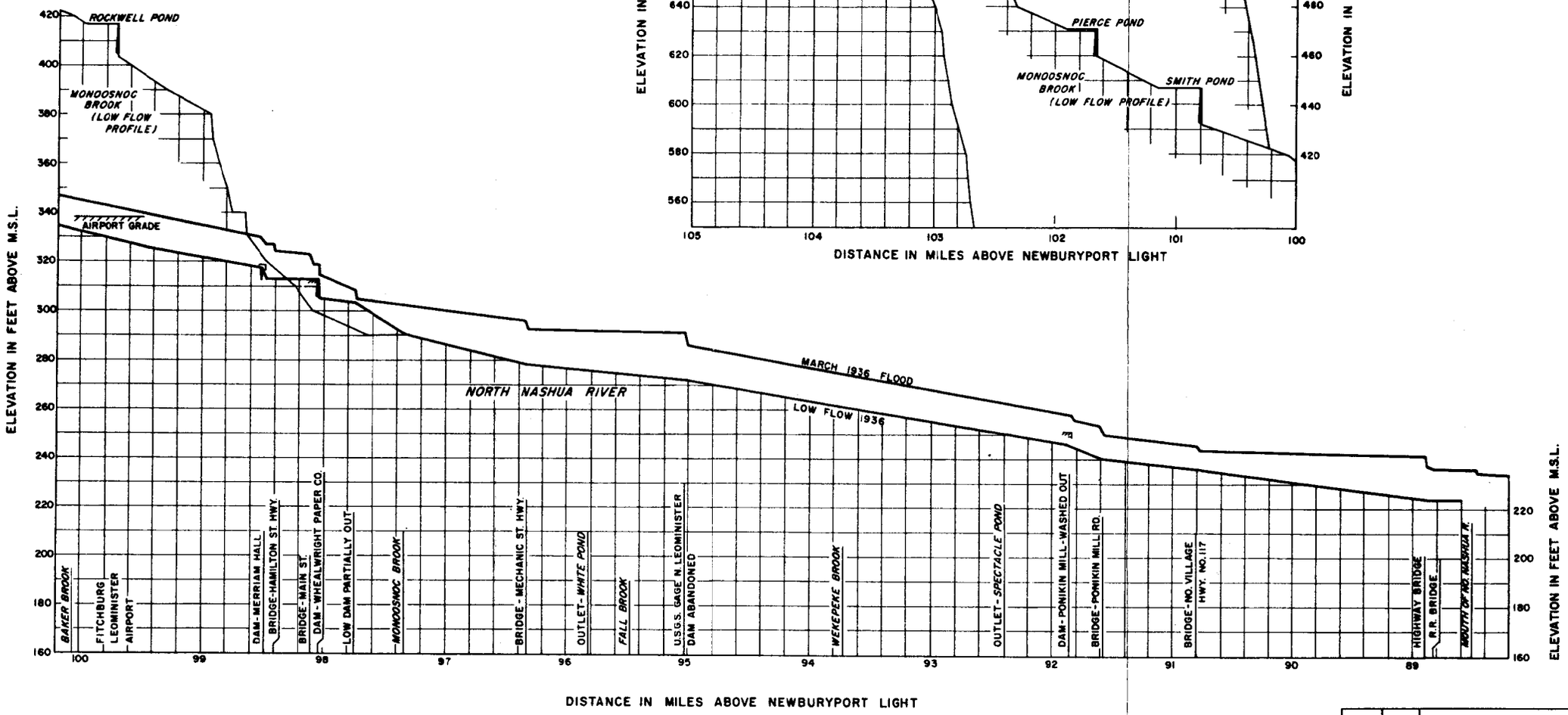


MERRIMACK RIVER PROFILE DAMS, RESERVOIRS, AND REACHES

PLATE NO. 4

Courtesy GAO Report





REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
R.W.M.	M.E.	E.P.S.

ENGINEER

CHIEF, HYD. & HYD. SECTION

SUBMITTED BY

CHIEF, PLANN. & RPTS. BRANCH

APPROVED

CHIEF ENGINEERING DIV.

DATE JAN. 1965

MERRIMACK RIVER BASIN
NORTH NASHUA RIVER WATERSHED
PROFILES
NORTH NASHUA RIVER AND TRIBUTARIES
NORTH NASHUA RIVER MASS.

TO ACCOMPANY REPORT
DATED: 25 JAN. 1965

SCALE: AS SHOWN

DRAWING NUMBER

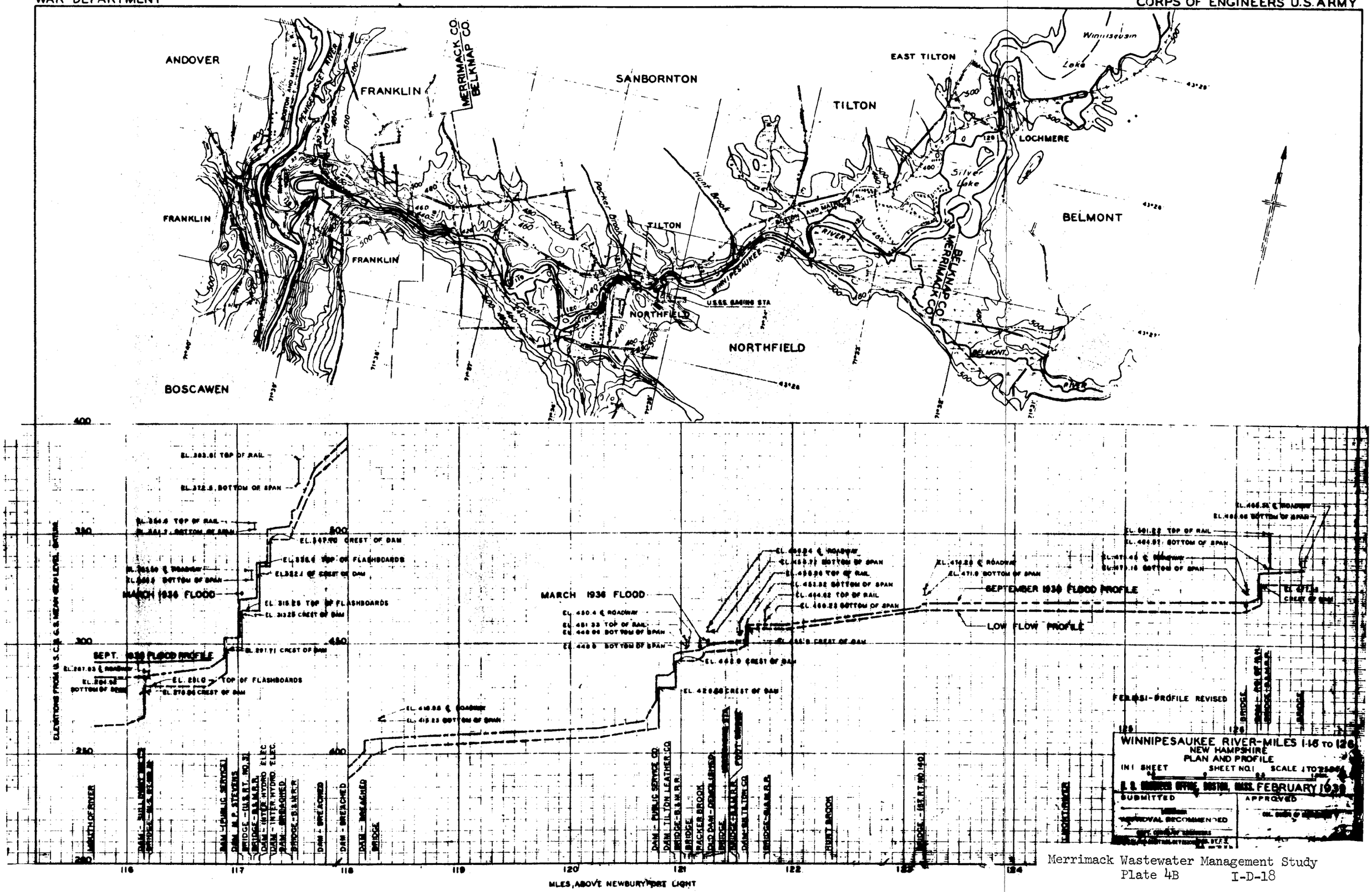
SHEET 1 OF 3

PLATE NO. C-2

Merrimack Wastewater Study Plate No. 4A
I-D-17

WAR DEPARTMENT

CORPS OF ENGINEERS U.S. ARMY



Merrimack Wastewater Management Study
Plate 4B

E. COMPARISON BETWEEN STREAM QUALITY AND WATER QUALITY STANDARDS IN EFFECT

Investigations of the stream quality of the Merrimack, Nashua, North Branch Nashua River, and Winnipesaukee Rivers were made and compared with the water quality standards in effect at this time. The rivers have been divided into various reaches and the classification for each reach is in accordance with the authorities of Massachusetts and New Hampshire.

Table No. 10 shows the river classification within each reach, the date of classification and the present stream condition of the rivers.

For information and reference the following Tables and Plates are included for stream water classifications for areas within the study:

Table No.	Title
10	Classification and Present Condition of the Rivers
11	New Hampshire Water Use Classification and Quality Standards
12	Massachusetts Water Use Classification and Quality Standards
13	New England Interstate Water Pollution Control Commission "Classification and Standards of Quality for Interstate Waters" (Rev. 4/18/67)
14	"New England Interstate Water Pollution Commission Classification and Standards of Quality for Coastal and Marine Waters" (Rev. 4/18/67)

Plate No.	Title
5	Comm. of Mass., Water Resources Commission drawing showing the Merrimack River Classification in Mass.
6	Comm. of Mass., Water Resources Commission drawing showing the Nashua River Basin Classification in Massachusetts.
7	Proposed Classification, New Hampshire Water Pollution Commission drawing showing classification of the Merrimack River and Winnipesaukee River in New Hampshire.

TABLE 10

CLASSIFICATION AND PRESENT CONDITION OF THE RIVERS

MERRIMACK RIVER CLASSIFICATION *

River Mile From - To	River Beach From	To	Present Condition	Classification	Date of Classification
		MERRIMACK RIVER			
0 - 11.80	Atlantic Ocean	Rocks Village Bridge Haverhill, Mass.	D & C	SB	3/6/67
11.80 - 21.85	Rocks Village Bridge Haverhill, Mass.	Creek Brook Haverhill, Mass.	D & U	SC	3/6/67
21.85 - 28.99	Creek Brook Haverhill, Mass.	Essex Co. Dam, Lawrence, Mass.	D & U	C	3/6/67
28.99 - 33.03	Essex Co. Dam, Lawrence, Mass.	Fish Brook, Andover, Mass.	D & U	B	3/6/67
33.03 - 40.60	Fish Brook, Andover, Mass.	Pawtucket Dam Lowell, Mass.	D & U	C	3/6/67
40.60 - 47.35	Pawtucket Dam, Lowell, Mass.	Tyngsborough Bridge Tyngsborough, Mass.	D & U	B	3/6/67
47.35 - 49.82	Tyngsborough Bridge, Tyngsborough, Mass.	New Hampshire/Mass. State line	D & U	C	3/6/67
49.82 - 54.80	New Hampshire/Mass. State Line	Merrimack R. (above conf. of Nashua R.)	C	C	4/1/67
54.80 - 68.05	Merrimack R. (above conf. of Nashua R)	Goffs Falls, Manchester, N.H.	C	B-1	4/1/67
68.05 - 73.14	Goffs Falls Manchester, N.H.	Amoskeag Dam Manchester, N.H.	C	C	4/1/67
73.14 - 115.70	Amoskeag Dam Manchester, N.H.	Eastman Falls Dam Franklin, N.H. (at conf. w/Winnipesaukee R.)	C	B-1	4/1/67

TABLE NO. 10 (CONT'D)
WINNIPESAUKEE RIVER CLASSIFICATION*

River Mile From - To	River Beach From	To	Present Condition	Classification	Date of Classification
0 - 23.0	Franklin, N.H.	The Weirs	C	B-1	4/1/67
		NASHUA RIVER CLASSIFICATION*			
0 - 9.05	Confluence w/Merrimack R. in Nashua, N.H.	New Hampshire/ Mass. State Line	U & D	C	4/1/67
9.05- 23.45	New Hampshire/Mass. State Line	Confluence of North and Branches of Nashua River in Lancaster, Mass.	U & D	C	3/6/67
		NORTH BRANCH NASHUA RIVER*			
0 - 17.2	Confluence of North & South Branches of Nashua River in Lancaster, Mass.	Confluence of Whitman River and Flag Brook in Fitchburg, Mass.	U & D	C	3/6/67

REMARKS:

1. Classification of rivers in N. H. based on Report on Water Quality Standards, N. H. Water Pollution Comm. dated April 1967.

2. Classification of rivers in Mass. based on Comm. of Mass. Water Resources Comm. Water Quality Standards dated 3/6/67.

3. *For definitions of various classes refer to the above reports.

TABLE NO. 11

NEW HAMPSHIRE WATER USE CLASSIFICATION AND QUALITY STANDARDS

	CLASS A	CLASS B		CLASS C	CLASS D
		B-1	B-2		
	Potentially acceptable for public water supply after disinfection. (Quality uniformly excellent.)	Acceptable for bathing and recreation, fish habitat and public water supply after adequate treatment. (High esthetic value.)	Acceptable for recreational boating, fish habitat, industrial and public water supplies after adequate treatment. (High esthetic value.)	Acceptable for recreational boating, fish habitat, and industrial water supply. (Third highest quality.)	Devoted to transportation of sewage or industrial waste without nuisance. (Lowest classification.)
Dissolved oxygen	Not less than 75% sat.	Not less than 75% sat.	Not less than 75% sat.	Not less than 5 p.p.m.	Present at all times
Coliform bacteria MPN/100 ml.	Not more than 50	Not more than 240	Not more than 1,000	Not specified	Not specified
pH	5.0 - 8.5	5.0 - 8.5	5.0 - 8.5	5.0 - 8.5	Not specified
Substances potentially toxic	None	Not in toxic concentrations or combinations.	Not in toxic concentrations or combinations.	Not in toxic concentrations or combinations.	Not in toxic concentrations or combinations.
Sludge deposits	None	Not in objectionable amounts.	Not in objectionable amounts.	Not in objectionable amounts.	Not in objectionable amounts.
Oil and grease	None	None	Not in objectionable amounts.	Not in objectionable amounts.	Not of unreasonable quantity or duration.
Color and turbidity	Not in objectionable amounts.	Not in objectionable amounts	Not in objectionable amounts.	Not in objectionable amounts.	Not of unreasonable quantity or duration.
Slick, odors and surface-floating solids	None	None	Not in objectionable amounts.	Not in objectionable amounts.	Not of unreasonable quantity or duration.

NOTE: The waters in each classification shall satisfy all provisions of all lower classifications.

TABLE NO. 12

MASSACHUSETTS WATER USE CLASSIFICATION
AND QUALITY STANDARDS

	CLASS A	CLASS B	CLASS C	CLASS D
	Suitable for any water use. Character uniformly excellent.	Suitable for bathing and recreation, irrigation and agricultural uses; good fish habitat; good aesthetic value. Acceptable for public water supply with filtration and disinfection.	Suitable for recreational boating, irrigation of crops not used for consumption without cooking; habitat for wildlife and common food and game fishes indigenous to the region; industrial cooling and most industrial process uses.	Suitable for transportation of sewage and industrial wastes without nuisance, and for power, navigation and certain industrial uses.
Standards of Quality				
Dissolved oxygen	Not less than 75% sat.	Not less than 75% sat.	Not less than 5 ppm	Present at all times
Oil and grease	None	No appreciable amount	Not objectionable	Not objectionable
Odor, scum, floating solids, or debris	None	None	None	Not objectionable
Sludge deposits	None	None	None	Not objectionable
Color and turbidity	None	Not objectionable	Not objectionable	Not objectionable
Phenols or other taste producing substances	None	None	None	
Substances potentially toxic	None	None	Not in toxic concentrations or combinations	Not in toxic concentrations or combinations
Free acids or alkalies	None	None	None	Not in objectionable amounts
Radioactivity	Within limits approved by the appropriate State agency with consideration of possible adverse effects in downstream waters from discharge of radioactive wastes; limits in a particular watershed to be resolved when necessary after consultation between States involved.			
Coliform bacteria	* Within limits approved by State Department of Health for uses involved.	Bacterial content of bathing waters shall meet limits approved by State Department of Health and acceptability will depend on sanitary survey.		

* Sea waters used for the taking of market shellfish shall not have a median coliform content in excess of 70 per 100 ml.

NOTE: Waters falling below these descriptions are considered as unsatisfactory and as Class E.
These standards do not apply to conditions brought about by natural causes.
For purpose of distinction as to use, waters used or proposed for public water supply shall be so designated.

TABLE 13

NEW ENGLAND INTERSTATE WATER POLLUTION CONTROL COMMISSION
CLASSIFICATION AND STANDARDS OF QUALITY FOR INTERSTATE WATERS
(As Revised and Adopted April 18, 1967)

WATER USE CLASSES	DESCRIPTION	STANDARDS OF WATER QUALITY						
		DISSOLVED OXYGEN	Sludge deposits-solid refuse-floating solids, oils, and grease - scum	COLOR AND TURBIDITY	COLIFORM BACTERIA per 100 ml	TASTE AND ODOR	pH	ALLOWABLE TEMPERATURE INCREASE
CLASS A	Suitable for water supply and all other water uses; character uniformly excellent. (See Note 1)	75% saturation, 16 hours/day 5 mg/l at any time.	None allowable	None other than of natural origin	Not to exceed a median of 100 per 100 ml nor more than 500 in more than 10% of samples collected	None other than of natural origin	As naturally occurs	None other than of natural origin
CLASS B	Suitable for bathing, other recreational purposes, agricultural uses; industrial processes and cooling; excellent fish and wild life habitat; good aesthetic value; acceptable for public water supply with appropriate treatment.	75% saturation 16 hours/day 5 mg/l at any time	None allowable	None in such concentrations that would impair any usages specifically assigned to this Class	Not to exceed a median of 1,000 per ml nor more than 2,400 in more than 20% of samples collected	None in such concentrations that would impair any usages specifically assigned to this Class nor cause taste and odor in edible fish	6.5 - 8.0	Only such increases that will not impair any usages specifically assigned to this Class (See Note 2)
CLASS C	Suitable for fish and wild life habitat; recreational boating, and industrial processes and cooling; under some conditions acceptable for public water supply with appropriate treatment; good aesthetic value	5 mg/l, 16 hours/day; not less than 3 mg/l at any time. For cold water fishery not less than 5 mg/l at any time.	None (See Note 3)	None in such concentrations that would impair any usages specifically assigned to this Class	None in such concentrations that would impair any usages specifically assigned to this Class	None in such concentrations that would impair any usages specifically assigned to this Class nor cause taste and odor in edible fish	6.0 - 8.5	Only such increases that will not impair any usages specifically assigned to this Class (See Note 2)
CLASS D	Suitable for navigation, power, certain industrial processes and cooling, and migration of fish; good aesthetic value.	A minimum of 2 mg/l at any time.	None (See Note 3)	None in such concentrations that would impair any usages specifically assigned to this Class	None in such concentrations that would impair any usages specifically assigned to this Class	None in such concentrations that would impair any usages specifically assigned to this Class	6.0 - 9.0	None except where the increase will not exceed the recommended limits on the most sensitive water use and in no case exceed 90 degree F

NOTES

1. Class A waters reserved for water supply may be subject to restricted use by State and local regulation.

2. The temperature increase shall not raise the temperature of the receiving waters above 68°F for waters supporting cold water fisheries and 83°F for waters supporting a warm water fishery. In no case shall the temperature of the receiving water be raised more than 4°F.

3. Sludge deposits, floating solids, oils, grease and scum shall not be allowed except for such small amounts that may result from the discharge of appropriately treated sewage or industrial waste effluents.

Waters shall be free from chemical constituents in concentrations or combinations which would be harmful to human, animal, or aquatic life for the appropriate, most sensitive and governing water class use. In areas where fisheries are the governing considerations and approved limits have not been established, bioassays shall be performed as required by the appropriate agencies. For public drinking water supplies the limits prescribed by the United States Public Health Service may be used where not superseded by more stringent signatory State requirements.

TABLE 14

NEW ENGLAND INTERSTATE WATER POLLUTION CONTROL COMMISSION

CLASSIFICATION AND STANDARDS OF QUALITY FOR COASTAL AND MARINE WATERS

(As Revised and Adopted April 18, 1967)

WATER USE CLASSES	DESCRIPTION	STANDARDS OF WATER QUALITY						
		DISSOLVED OXYGEN	Sludge deposits - solid refuse - floating solids - oil - grease - scum	COLOR AND TURBIDITY	COLIFORM BACTERIA per 100 ml	TASTE AND ODOR	pH	
CLASS SA	Suitable for all sea water uses including shellfish harvesting for direct human consumption, (approved shellfish areas) bathing, and other water contact sports.	Not less than 6.0 mg/l at any time	None allowable	None in such concentrations that would impair any usages specifically assigned to this class	Not to exceed a median MPN of 70 and not more than 10% of the samples shall ordinarily exceed an MPN of 230 for a 5-tube decimal dilution or 330 for a 3-tube decimal dilution (See Note S.1)	None allowable	6.8 - 8.5	Allowable Temperature Increase (Note 2) Chemical Constituents (Note 3) Radioactivity (Note 4)
CLASS SB	Suitable for bathing, other recreational purposes, industrial cooling and shellfish harvesting for human consumption after depuration; excellent fish and wild life habitat; good aesthetic value.	Not less than 5.0 mg/l at any time	None allowable	None in such concentrations that would impair any usages specifically assigned to this class	Not to exceed a median value of 700 and not more than 2,300 in more than 10% of the samples (See Note S.1)	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish	6.8 - 8.5	
CLASS SC	Suitable fish, shellfish and wild life habitat; suitable for recreational boating, and industrial cooling; good aesthetic value.	Not less than 5 mg/l during at least 16 hours of any 24 hour period nor less than 3 mg/l at any time	None except that amount that may result from the discharge from a waste treatment facility providing appropriate treatment	None in such concentrations that would impair any usages specifically assigned to this class	None in such concentrations that would impair any usages specifically assigned to this class	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish	6.5 - 8.5	
CLASS SD	Suitable for navigation, power, and certain industrial cooling water; migration of fish; good aesthetic value.	Not less than 2 mg/l at any time	None except that amount that may result from the discharge from a waste treatment facility providing appropriate treatment	None in such concentrations that would impair any usages specifically assigned to this class	None in such concentrations that would impair any usages specifically assigned to this class	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish	6.5 - 8.5	

NOTES

S.1 Surveys to determine coliform concentrations shall include those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.

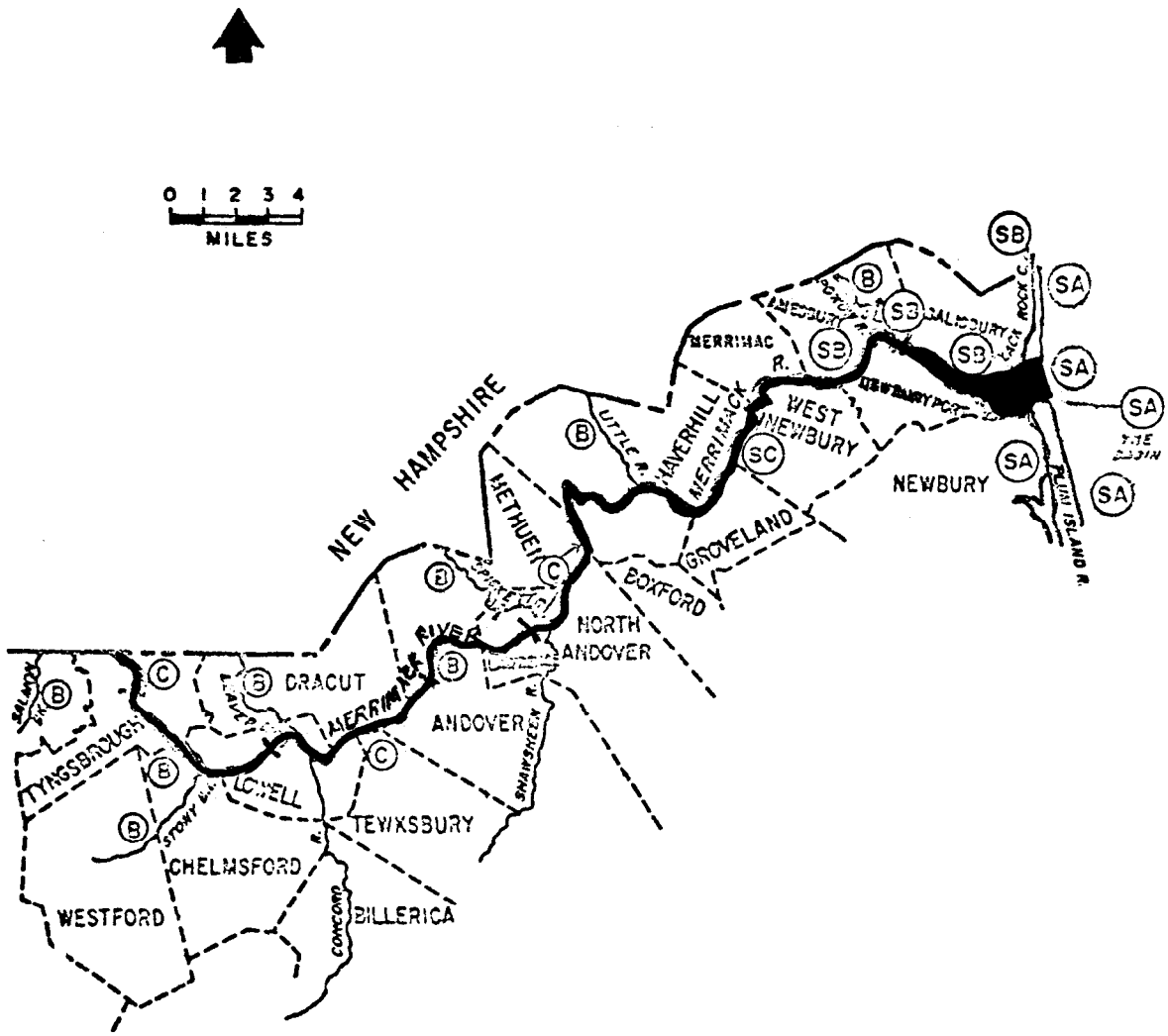
S.2 None except where the increase will not exceed the recommended limits on the most sensitive water use.

S.3. None in such concentrations or combinations which would be harmful to human, animal, or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, impair the palatability of same, or impair the water for any other usage.

S.4 The discharge of radioactive materials in concentrations or combinations which would be harmful to human, animal or aquatic life shall not be allowed.

S.5 Coastal and marine waters are those generally subject to the rise and fall of the tide.

S.6 The standards shall apply at all times in coastal and marine waters.

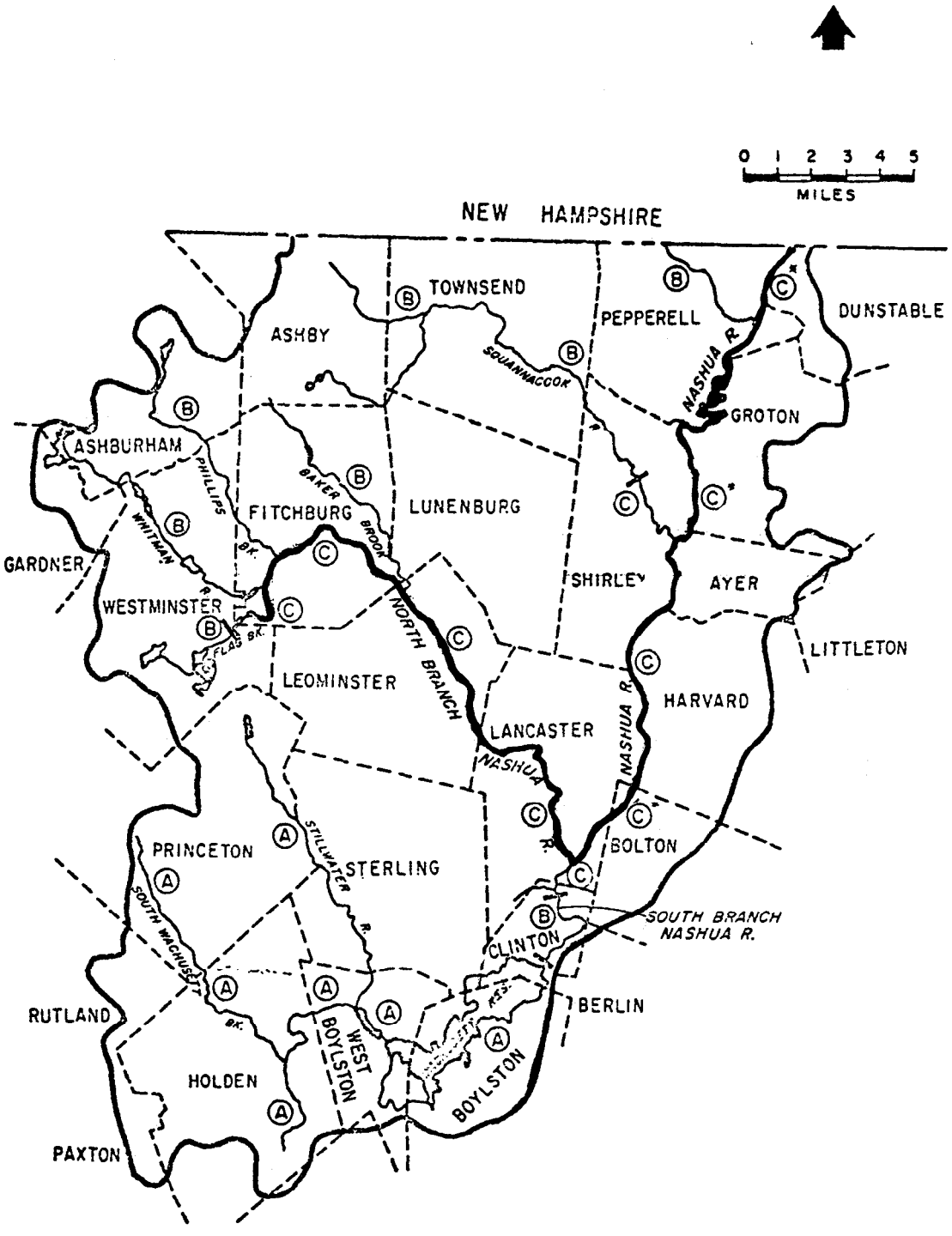


COMMONWEALTH OF MASSACHUSETTS
WATER RESOURCES COMMISSION

MERRIMACK RIVER BASIN
CLASSIFICATION

WATER USE CLASSES - (A) (B) (C) (D) (SA) (SB) (SC)
— CHANGE CLASSIFICATION

FORM WPC9 IM-2-67-944469



COMMONWEALTH OF MASSACHUSETTS
WATER RESOURCES COMMISSION

NASHUA RIVER BASIN
CLASSIFICATION

WATER USE CLASSES - Ⓐ Ⓑ Ⓒ Ⓓ Ⓒ
— CHANGE CLASSIFICATION

Plate No.6

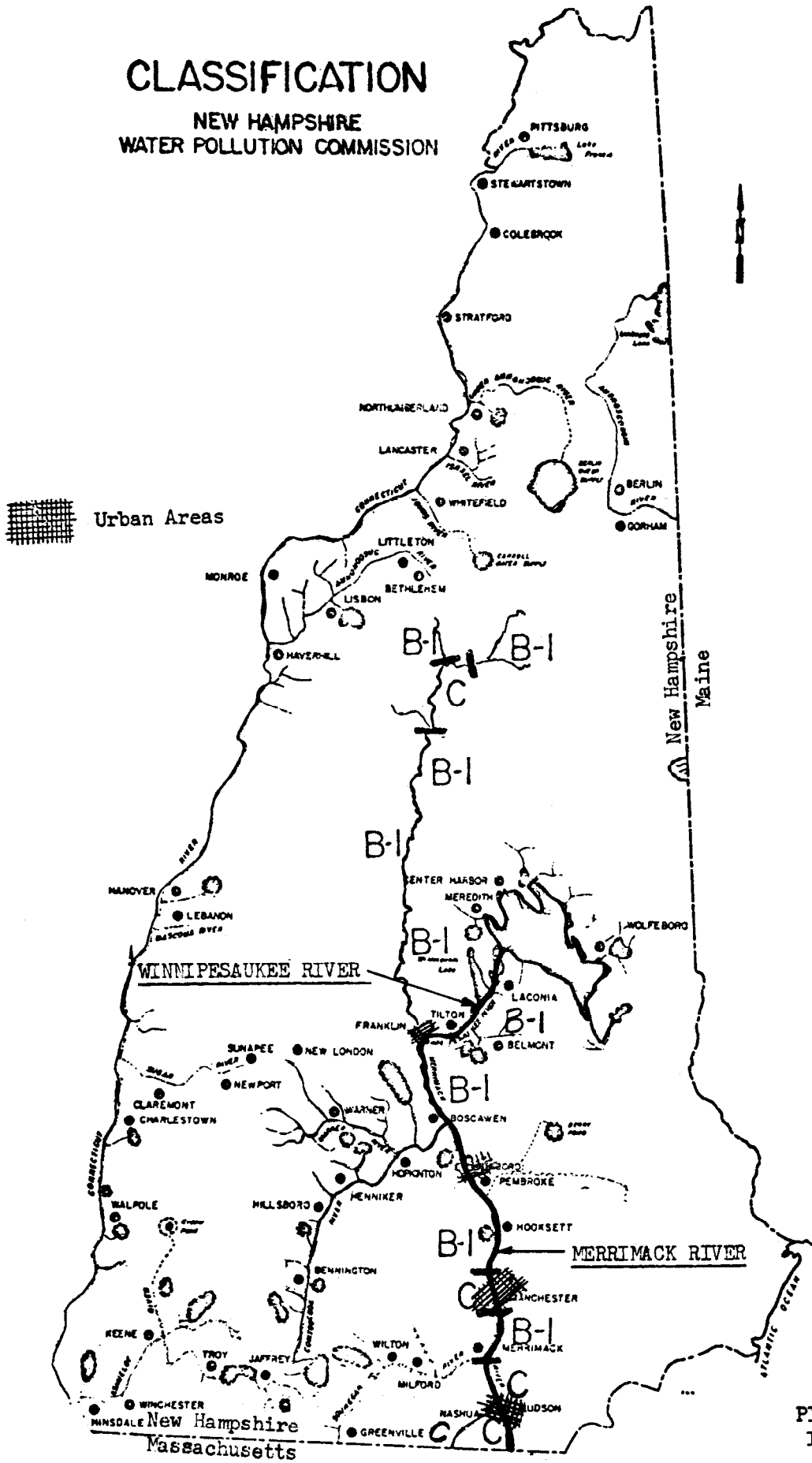


Plate No. 7
I-E-11

F. GENERAL CLIMATOLOGY

Included herein is the climatology for the Merrimack River Basin.

As noted, the elevations within the basin area vary and offer the planner added information with respect for design of sewage disposal facilities.

A brief climatic description found in the Fitchburg-Leominster Area is also included as it is more in the central part of the State of Massachusetts and is not on the mainstream of the Merrimack River.

The climate in the Merrimack River Basin can be characterized as our of moderately warm summers, cold winters, and ample, well distributed rainfall. During the 4 months of December, January, February and March, the mean daily temperature below 1,000 feet elevation will be less than 32°F. most of the time. Long time weather records indicate that below zero temperatures below the 1,000 feet elevation, will occur 15-20 days during these 4 months. Snowfall will seldom exceed 80 inches below the 1,000 foot level, but storms of 1 inch or more of snow may occur about 20 days during the 6 month winter period.

Freezing temperatures will also occur during March, April, October and November.

At elevations higher than 1,000 feet, the summers are cooler with more rain; the winters are colder with more snow cover.

During the summer months of June, July and August, the daily mean temperature will average about 65° F. Ninety degrees temperatures of or more seldom occur and there only for short duration. Nights are cool throughout the summer. Rainfall averages about 3.6 inches month and fairly well distributed from April to October.

TABLE NO. 16

AVERAGE MONTHLY AND ANNUAL PRECIPITATION
Merrimack River Basin

Station	Lincoln N.H.	Franklin N.H.	Lakeport N.H.	Concord N.H.	Fitchburg Mass.	Lowell Mass.	Haverhill Mass.
Years of record	30	49	94	30	87	126	58
Elevation (feet mean sea level)	830	390	562	339	402	85	30
Month				(Inches)			
January	3.77	3.03	3.73	2.91	3.39	3.26	3.13
February	2.75	2.70	3.52	2.30	3.24	3.15	2.95
March	3.68	3.33	3.97	3.04	3.52	3.60	3.68
April	3.83	3.53	3.40	3.08	3.51	3.56	3.66
May	3.48	3.19	3.21	3.04	3.49	3.31	2.76
June	4.36	3.73	3.33	3.62	3.59	3.32	3.40
July	4.44	3.77	3.89	3.57	3.77	3.55	3.43
August	4.01	3.47	3.54	3.10	3.92	4.03	2.91
September	4.65	3.99	3.74	3.39	3.66	3.46	3.29
October	3.82	2.88	3.35	2.80	3.48	3.46	2.90
November	4.23	3.25	3.75	3.57	3.47	3.69	3.07
December	3.67	3.05	3.59	2.81	3.19	3.41	3.32
Annual	46.69	39.92	43.02	37.23	42.03	41.80	38.50

TABLE NO. 17

AVERAGE ANNUAL SNOWFALL
Merrimack River Basin

Station	Elevation (feet, mean) (sea level)	Years of record	Average Annual snowfall (inches)
Massachusetts			
Haverhill	30	22	52
Lowell	85	25	52
Groton	320	22	63
Fitchburg	402	51	58
New Hampshire			
Nashua	125	25	59
Manchester	171	20	63
Concord	339	51	62
Franklin	390	49	70
Plymouth	500	50	79
Glendiff	1,650	35	92
Lincoln	380	20	84
Mount Washington	6,262	18	174

G. AGRICULTURE

The number of farms and acres in farms have been declining, during the last two decades. Since 1958 over 100,000 acres of farmland have been converted to urban uses. According to the 1950 U.S. Census, there were about 12,500 farms in the Merrimack Basin; in 1964 there were 3,655 of which more than 50 percent were less than 100 acres. Of the 1705 farms that were larger than 100 acres, 53 had more than 200 acres from which crops were harvested each year; 223 had from 100 to 200 harvested acres. Most of the remaining acreage in these farms was forestland. Nearly half of the farmers derive a considerable amount of their income from off-farm employment.

It is estimated that there are 153,000 acres of cropland, 41,000 acres of pasture, and 2,339,300 acres of privately owned forest land.

Sixty four percent of the cropland acreage is in hay crops, 11 percent in corn or truck crops, and the remaining 25 percent in miscellaneous uses.

For the most part, the average acreage of specific crops per farm is small. Few farms have more than 20 acres of corn; and few have more than 10 acres of truck crops except those in Hillsborough, Middlesex, and Worcester Counties. Hay crops average about 25 acres per farm, but several of the livestock farms have much larger acreages.

Irrigation is not used extensively, except on sandy soils used for growing truck crops.

Crop Potential

Crop production in most of the Basin centers around the production

of corn silage and hay crops for livestock feed. Truck crop farms and orchards are common in southern New Hampshire and parts of Massachusetts. There is ample market potential for more agricultural production, both livestock products and vegetables, but, as mentioned above, agriculture has been declining for several years.

It is possible, with irrigation that the acreage of truck crops could be increased, especially on the level sandy soils in southern New Hampshire. Most of this potential acreage is now in trees. Some farms could expand their livestock production, but it appears that this would occur to a very limited extent. Irrigation with wastewater, while it could increase crop production, is not the limiting factor in the livestock industry. Crop, and livestock management are prerequisites. Lack of farm labor, and economically sized units for present dairy farms are also important limiting factors.

A large part of the present forest land is capable of producing substantial quantities of commercially valuable timber. The Basin's potential for timber production is great and there is no doubt that, good forest management practices could contribute materially to needs of timber-based industries, and can be done without the addition of wastewater. However, the possibility of using wastewater, especially on sandy soils, for Christmas tree production should be considered.

Soil Conditions

The soils in the Basin are glacial in origin. Large areas are underlaid with glacial till, others, in the glacial outwash or glacial lakes, have sand and gravel in the substratum. A large percent of the soils are stony to extremely rocky, sandy, and steep.

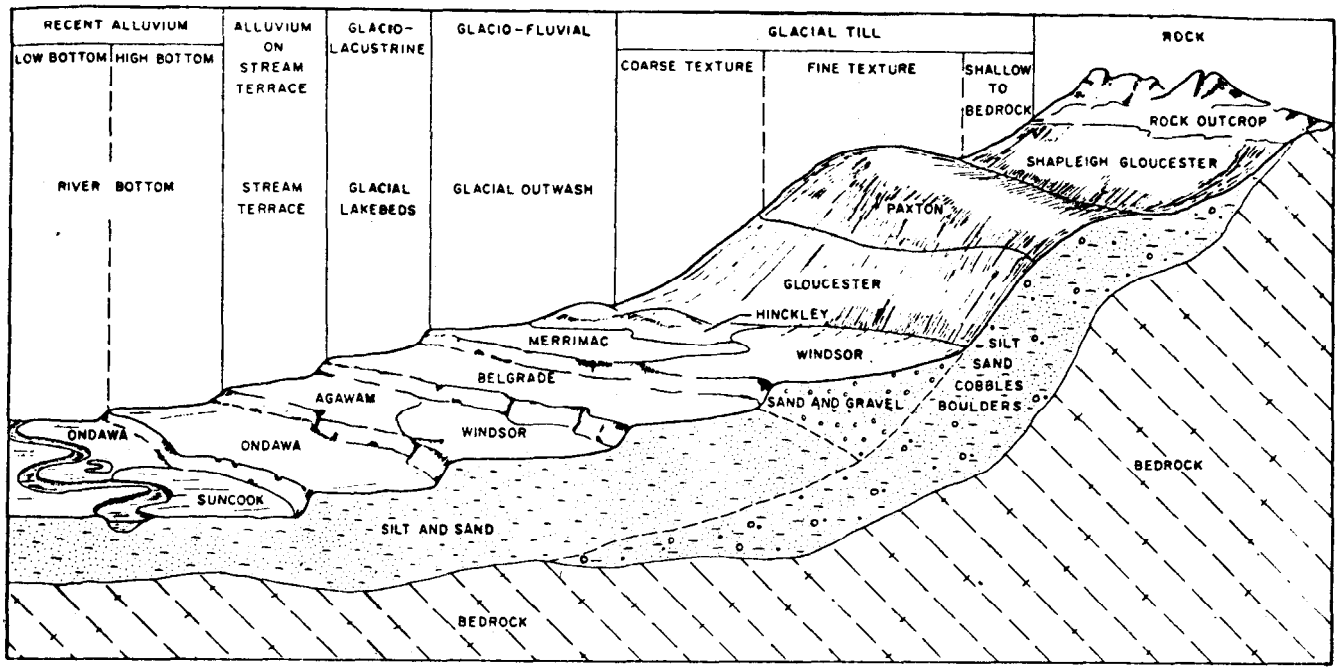


Figure 1 —Soil series in relation to topography.

Figure 1 depicts the kinds of soil in relation to topography.

Soil textures, slopes, and kinds of soils are extremely fragmented. There are few large contiguous areas of uniform soil conditions which are suitable for handling 7 million gallons of wastewater per week. Good disposal sites are interspersed with soils having severe limitations that cannot economically be overcome.

Nearly 80 percent of the soils have severe limitations for disposal of effluent. These areas are either poorly drained, excessively drained, steep, rocky, or shallow to bedrock.

Gloucester, and Paxton soils are the most common throughout the Basin. They occur in relatively large areas as compared with other major kinds of soils suitable for disposal sites. Herman, Merrimac and Windsor are three other kinds of soil that occur in large areas.

With the exception of the soils that are poorly drained, shallow to bedrock, extremely rocky, or steep slopes, all the soils could be irrigated. However, because of characteristics such as depth to an impervious layer, infiltration rates, waterholding capacity, or cation exchange capacity there are limits to the amount and rates of application. In addition, physical conditions such as size of area, slope, and stoniness affect the sutiability and efficiency of land disposal of effluent or sludge.

The following generalized soil groups describe the conditions of the major kinds of soil in the Basin.

Group 1

Deep, somewhat excessively drained sandy loams, and fine sandy

loam glacial till soils. Subsoils are usually coarser than the surface material, and stones or gravel are present at $1\frac{1}{2}$ to 2 feet of the surface and in many cases the stones are on the surface; slopes range from 3 to more than 25 percent. The lateral flow of the water in the soil profile is slow, which affects the rate and frequency of irrigation in order to avoid raising the water table to within 5 feet of the surface. These soils often occur in areas of 80 acres or more in size. Gloucester and Herman are typical of soils in this group. These soils have slight to moderate limitation for use of wastewater if the slope is less than 15 percent. There are about 980,000 acres of these soils of which about 60 percent have slopes over 15 percent. Because of steepness of slopes, and many small areas of less than 80 acres, or extreme stoniness, only about 1 percent appear to be suitable for wastewater disposal. A higher percentage is suitable for spreading digested sludge, especially the isolated fields of hay and pasture.

Group 2

Deep, droughty, rapidly permeable, glacial outwash loamy sands. Some may contain gravel in the subsoil. Waterholding capacity is usually about 0.5 inch per foot of depth. About 75 percent of these soils are on slopes from 0-15 percent. Hinckley, Merrimac, and Windsor are the most common soils in this group and frequently occur in areas of 60 acres or more. Because these soils are excessively drained, and have a low renovating capacity they have severe limitations to overcome for safe use of wastewater. There are about 374,000 acres in this soil group of which about 15 percent are suitable for applying wastewater after establishing proper measures.

Group 3

Glacial till soils that have an impervious or hard pan layer at $1\frac{1}{2}$ to 3 feet below the surface. This layer may vary from a few inches to several feet in thickness. These soils occur on slopes ranging from 3 to 25 percent. The soil above the pan is well to moderately well-drained sandy loam to loam material, with good waterholding capacity, but infiltration through the pan is slow. Although stones are often present, there are small areas that are free of stones. With the exception of Paxton soils, all other soils occur in relatively small acreages. Other soils in this group include Acton, Becket, Essex and Woodbridge. The soils in this group have moderate limitations if the slope is less than 15 percent. There are about 375,000 acres in this group. It is estimated that about 2 percent are suitable for wastewater disposal. The remainder are either inaccessible in small tracts, too steep, or too stony for good distribution systems.

Group 4

Deep, very fine sandy loams along flood plains of the major streams. These soils have severe limitations for wastewater, but can be overcome. They are well-drained and rapidly permeable. Low bottom areas are usually flooded every spring, whereas the high bottom areas are seldom affected. Subsoils usually consist of coarser material than the surface. Waterholding capacity ranges from 1.5 to 2 inches per foot. These soils occur in small acreages in the upper reaches of the Basin, but there are some large contiguous acreages of Agawam and Ondawa in the central and southern flood plains. Soils in this group total about 49,000 acres. There are a few large areas, on the high bottoms

along the Merimack that are suitable for wastewater disposal after water management measures are established. Digested sludge could be used on most of the cultivated areas.

Group 5

Deep, well to moderately drained loams and silt loams. Stones and cobbles are often present. Slopes range from 0 to more than 25 percent. When the slopes are less than 15 percent these soils have slight to moderate limitations for wastewater disposal.

Charlton is the major kind of soil in this group and occurs throughout most of the Basin. Belgrade and Berkshire soils also occur, but to a lesser degree. There are about 97,000 acres in this group. Many occur in proximity with soils in groups 1 and 2. There are a few large areas of these soils, but, for the most part, the areas are small.

Group 6

This group consists of shallow soils. They are usually droughty because of the limited depth to bedrock. They occur most often on steep forested slopes of more than 15 percent, and often in large tracts of 300 acres or more. They have severe limitations for waste disposal. These shallow soils account for nearly 20 percent of the area in the Basin. None of the soils in this group has been selected for wastewater or sludge disposal.

Group 7

Poorly drained soils with textures ranging from sands to silts. They may be seasonally to permanently wet because of the high water table. Infiltration ranges from slow to moderate. Some of the soils are non-stony, others may contain gravel and stones. Areas of soils in

this group are usually small as they occur in the intermittent drainage ways. Because of highwater tables, either all or most of the year, these soils have severe limitations for disposing of wastes. There are about 305,000 acres in the Basin; none has been selected for waste disposal.

TABLE NO. 18

ESTIMATED NUMBER OF FARMS BASED ON ACRES HARVESTED
1964 U.S. Census of Agriculture

ACRES HARVESTED	MASSACHUSETTS COUNTIES			NEW HAMPSHIRE COUNTIES									TOTALS
	Essex	Middlesex	Worcester	Belknap	Carroll	Cheshire	Grafton	Hillborough	Merrimack	Rockingham	Stratford	Sullivan	All Counties
10 - 49	53	174	161	129	14	25	135	221	243	105	18	18	1296
50 - 99	19	58	77	37	6	8	92	77f	96	57	7	5	539
100 - 199	10	30	30	10	2	6	36	44	34	16	3	2	223
200 - 499	4	8	7	5	-	2	1	13	8	3	-	-	51
500 +	-	-	-	-	-	1	-	1	-	-	-	-	2
TOTAL	86	270	257	181	22	42	264	356	381	181	28	25	2111

TABLE NO. 19

NUMBER AND KINDS OF FARMS IN THE BASIN

BASED ON 1964 U. S. CENSUS

	MASSACHUSETTS			NEW HAMPSHIRE									
	Essex	Middlesex	Worcester	Belknap	Carroll	Cheshire	Grafton	Hillsborough	Merrimack	Rockingham	Stratford	Sullivan	TOTAL
Number of farms	209	699	442	226	38	65	350	605	611	285	49	36	3655
Size of farms													
Less than 100 acres	160	540	237	114	16	27	91	290	273	162	26	14	1950
100-180 ac.	25	92	91	74	7	15	68	117	133	61	11	11	705
180-260 ac.	10	30	50	24	5	9	61	90	84	30	6	5	404
260-500 ac.	10	28	50	33	7	9	92	72	78	24	4	5	412
500-1000 ac.	3	8	12	17	3	4	30	30	39	6	2	1	155
1000+ ac.	1	1	2	4	-	1	8	6	4	2	-	-	29
Average size(ac.)	77	70	137	187	204	197	262	162	189	129	152	204	-
Kinds of farms													
Dairy	37	106	152	50	6	18	150	154	145	55	13	9	895
Other livestock	8	45	21	10	2	1	11	24	32	9	2	2	167
Poultry	24	97	50	18	5	5	14	113	74	37	4	1	442
General	11	15	21	10	3	4	22	23	24	15	2	2	152
Vegetables	15	56	10	3	-	-	2	18	11	6	.	-	121
Fruit	5	34	22	16	1	=	4	31	10	9	1	-	133
Miscellaneous	109	346	166	159	21	37	147	242	315	154	27	22	1745

Table No 20

ACRES OF CROPS AND LAND USES IN THE MERRIMACK RIVER BASIN*

County	Row Crops	Small Grain	Hay	Other Cropland 1)	Total Cropland	Open Land Formerly Cropped 2)	Orchards	Pastureland	Forestland	Other Land 3)	Total Acres
Essex	1200	45	1520	30	2795	1550	330	1540	52595	10390	69200
Middlesex	4965	160	7330	355	13310	1215	1255	2240	77330	8725	104075
Worcester	2470	240	18070	695	21475	3445	1465	9690	226440	12025	274540
Belknap	530	100	7300	1000	8930	1090	1280	1150	220300	10300	243050
Carroll	110	45	1125	55	2335	150	145	230	94485	5800	103145
Cheshire	430	215	2785	115	3545	305	20	1045	70940	3295	79150
Grafton	1025	225	14765	735	16750	4100	105	7085	314850	26600	369490
Hillsborough	3200	400	17010	3825	24435	5250	2600	4600	474100	11625	522610
Merrimack	2260	115	15530	365	18270	3610	675	10175	514300	18230	565260
Rockingham	1280	40	5200	140	6660	1090	855	865	137515	13220	160205
Stratford	130	15	1415	25	1585	20	160	325	26090	1330	29510
Sullivan	170	120	1230	245	1815	210	5	320	23440	340	26130
TOTAL	18770	1720	93130	7585	121905	22035	8895	39265	2232385	121880	2546365

* U.S. Dept. of Agriculture, 1967 Conservation Needs Inventory
1.) Temporary idle and Cons. Reserve
2.) Not used for other purposes.
3.) Non-federal land not included in other classification.

H. HYDROGEOLOGIC INFORMATION

Ground Water in the Basin:

Subsurface Units - Ground water within the Merrimack River Basin occurs in three major subsurface units: bedrock, glacial till, and stratified unconsolidated deposits. Ground-water occurrence depends on porosity of the units and movement depends on permeability (relative ease with which the unit can transmit a liquid).

Bedrock - The rocks which underlie the basin are hard and compact. The frequency and distribution of fractures (the only significant source of porosity and permeability in these rocks) are highly variable, but commonly limited to an extent that essentially prohibits any ground water management program which would include planned water storage in and transmission through these rocks.

Glacial Till - The till commonly contains an unsorted mixture of clay, silt, sand, gravel, and boulders. These deposits are widespread and commonly overlie bedrock, but the average thickness of till may be only 10 to 20 feet. Porosity may exceed 30 percent, but permeability is low because of the poor sorting and silt and clay content. These thin deposits provide limited ground water storage potential, and the low lateral permeability results in slow ground water movement. These properties present very severe limitations for any proposed ground water management program.

Stratified Unconsolidated Deposits - Most of the stratified water-laid deposits were formed during late glacial and early post glacial time.

Very fine sand, silt, and clay deposits have relatively high porosity but low permeability, similar to till. The water table is commonly close to the surface, particularly during the early part of the growing season. This limits additional ground water storage potential, and the low permeability hinder lateral water movement. Consequently, severe limitations are imposed on any ground water management program.

Sand, and sand and gravel deposits have high porosity and relatively high permeability. These deposits commonly occur within the valleys of the Merrimack River and its major tributaries. Some of these deposits form the best aquifers within the basin. Where the thickness of these deposits exceeds 30 feet and the depth to the water table is at least 10 feet, there is adequate additional storage capacity and a sufficient rate of lateral ground water movement to allow a carefully planned ground water management program.

Natural Ground Water Recharge and Discharge - The natural water table always slopes toward the streams (except perhaps for very short periods at high flows); hence, ground water is almost always recharging the streams. Recharge to the ground water exceeds ground water discharge following periods of "heavy"rainfall and during snowmelt. At these times the water table rises. The water table declines during periods of little rain and during most of the growing season. Recharge during the late fall, winter, and spring generally replaces all ground water storage deficiencies.

Average annual precipitation within most of the basin is 40 to 45 inches, but may exceed 60 inches in the White Mountains of New Hampshire.

Average annual stream runoff is 16 to 22 inches in most of the basin, but may exceed 40 inches in the White Mountains. The remainder of precipitation is "lost" as evapo-transpiration. It is estimated that ground water discharge contributes 50 to 60 percent of stream runoff in the southern and central parts of the basin and 40 to 50 percent in the northern part. Ground water recharge must equal ground water discharge because hydrographs of wells within the basin demonstrate that there are no "long'term" trends in increase or decrease of underground storage.

Potential Areas for Artificial Recharge:

Potential areas are limited to the coarser-grained stratified unconsolidated deposits. Because precipitation provides adequate recharge to ground water, there is difficulty in locating storage space for large amounts of artificially recharged water. Further, where limited space is available, any recharged water will raise and increase the slope of the water table and thus promote more rapid movement of water toward a stream or river. This additional water storage would be temporary, perhaps only for a few weeks.

The deeper it is to the water table and the thicker the saturated zone, the greater the amount of water that can be recharged in these stratified deposits. Certain high terraces along the rivers are the best areas for artificial recharge, but the high bottom flood plain terraces may have limited potential. In areas where the water table is less than 10 feet below the surface and spray irrigation of crops is practiced, discharge wells might provide limited additional

short-term storage space by lowering the water table. These areas are considered in the section on proposals for land waste disposal systems.

The possibility of forcing effluent directly into ground water by injection wells is not feasible. Even a moderate scale recharge operation would have to use relatively shallow wells in sand and gravel. For injection in this environment the effluent would need tertiary treatment to avoid polluting these aquifers. Furthermore, the additional expense of fluid injection into already full aquifers would be unwarranted.

Mineral Composition of Subsurface Units:

The bedrock units within the basin are mostly granitic rocks, gneisses, and schists. The minerals generally common to all include quartz, feldspar, mica, and iron-magnesium minerals. The till and stratified deposits were derived from the physical and chemical weathering products of the rocks. Because these deposits are young (geologically) and because they were formed primarily from physical weathering products, these deposits are similar in composition to the original bedrock.

Boulders and cobbles are generally rock fragments. Sand is commonly quartz and feldspar grains with very little mica and iron-magnesium minerals. Silt is similar to sand except it commonly has more mica. Clay is ground up clay-sized particles having a high percentage of quartz and some feldspar, mica, and iron oxides as well as the real clay minerals (hydrous aluminum silicates).

Land Disposal of Wastewater from Communities within the Merrimack River Basin:

Preliminary consideration of possible land disposal sites for disposal of

effluent from communities within the Basin is given in the seven "Proposals for Land Waste Disposal Systems" rather than particular geographic locations. Discussion of the feasibility of these proposals will include the interrelated factors of soil type, hydrogeology, and topographic position. Limited land areas suited to waste disposal occur near the communities.

The following "Criteria for Assessing Ground Water Management Sites" for various hydrogeologic conditions and topographic position are meant to focus attention on some of the important parameters and to serve as spring boards for discussion.

Sites outside of the Merrimack River Basin -

1. Coastal Lowland of Southwestern Maine - There are large areas of consolidated stratified deposits in the coastal lowlands of southwestern Maine. These deposits were formed in late glacial and early post-glacial time when sea level was considerably higher than the present time. Glacial melt-water streams transporting material derived from the glacier deposited stratified sediment in both fresh water and near-shore marine areas.

Stratified sand and sand and gravel deposits form outwash plains and deltaic deposits. Grain size is generally coarser to the northwest and becomes finer seaward. These deposits are locally thicker than 100 feet, but generally become thinner seaward. Deposits of silt and clay locally grading to silt and very fine sand occur in large areas of the coastal lowlands and the lower part of stream valleys. Layers of medium sand of varying thickness may occur within these deposits. In some areas silt and clay may underlie stratified sand and gravel.

Depth to the water table varies greatly, but in much of the area seasonal high water table is within 5 feet of the surface. Ground water management associated with spray irrigation would be possible in the sand and sand and gravel deposits, but dewatering systems would be necessary in much of the area.

East of the Sanford Airport (see Hydrologic Investigations Atlas HA-76) are 25 to 30 square miles which might be suitable for spray irrigation. This area should be investigated further.

2. Coastal Lowland of Southeastern New Hampshire - The origin of unconsolidated stratified deposits in the coastal area of New Hampshire is similar to the origin of the southwestern Maine deposits. Some areas have moderately extensive sand plains and smaller areas of sand and gravel which would permit irrigation and ground water management on a modest scale. Within 20 miles of the coast clay, silt, and sand deposits are exposed over large areas and underlie some of the sand plains. Low permeability of these deposits would make ground water management difficult.

3. Connecticut River Valley, Massachusetts - There are large areas of unconsolidated stratified deposits in the Connecticut River Valley. Except for the margins of this broad valley, most of the deposits are fine-grained outwash and glacial lake deposits. Fine sand, silt, and clay deposits are commonly thick - more than 500 feet in some places.

Depth to the water table is highly variable, but commonly close to the surface in areas of lower elevations. The predominance of silt and clay results in very low permeability. Consequently, ground water management would be very difficult. The generally distribution of these deposits are shown on Hydrologic Investigations Atlas HA-249.

4. Southeastern Massachusetts - Unconsolidated stratified deposits occur in broad areas of valleys and extensive plains. There are both sandy glacial outwash deposits and fine sand, silt, and clay glacial

lake deposits. Thickness of these deposits varies greatly from large areas of shallow bedrock to stratified deposits which exceed 100 feet in thickness.

Depth to the water table varies from at or near the surface in shallow bedrock areas to more than 50 feet in some of the higher parts of sand plains. Ground water management programs are possible where the deposits are thick, but dewatering systems may be required in some areas. (See Hydrologic Investigations Atlas HA-300 and Ground Water Favorability Map of Brockton-Pembroke Area, Mass.)

Glacial till is much sandier and thicker in southeastern Massachusetts than in the Merrimack River Basin. The permeability of till may be high enough locally to permit ground water management. On western Cape Cod, thick stratified sands and sandy till areas may offer potential for spray irrigation and ground water management.

I. POPULATION SERVED BY SEWERS IN THE STUDY AREAS

Table No. 21 indicates the existing and projected population sewered in the Areas of Study.

In general, the percentage of population sewered will increase during the future years, except in areas such as the Winnipesaukee River and the Nashua, Concord-Manchester Areas which are expected to grow more rapidly during the period of 1990 to 2020. These are basically new developable areas of considerable size and where zoning may be conducive to private type sewage disposal systems for a number of years.

In addition, there have been numerous efforts by the Federal, State and Local governments as well as interested private groups and individuals to reduce and eliminate pollution to provide high health standards. The

need for wastewater management is one of the most urgent problems facing communities of the entire region. This is basically due to the increase in population, concentrated effluents, poor subsurface conditions and overloading existing systems with insufficient treatment.

The collection and treatment of sanitary and industrial wastes must be handled properly in order to avoid serious health problems. Discharging raw sewage into a stream or into the surface of the land is an obvious health hazard. Not so obvious are the dangers resulting from inadequate or improperly functioning private septic tank systems. Often the effluent being discharged into the ground or soil eventually pollutes water supplies.

The rapid growth of the population and other activities throughout the Merrimack Basin and Boston Metropolitan Area is expected to continue and it is important that these new areas of growth be served with adequate sewerage and pollution abatement systems.

The discharge of sewage and pollutants into a stream causes severe problems from the point of discharge, throughout the stream and eventually into the receiving major body of water.

Pollution in the rivers of the Merrimack River Basin, such as the Merrimack and the Nashua Rivers create further problems because of their crossing state lines. The pollution in these cases cause abnormal coordination and concern between the Federal government and the State governments involved. The efforts are time consuming and costly.

The most important limitation of existing sewerage systems is in the degree of treatment provided. The advances of industry and the use of concentrated chemicals and their waste products involved produce

enormous problems and search for an economical and feasible disposal system. Treatment plants must become more sophisticated so that our streams can be saved for water supply sources, and aesthetic and recreational objectives.

In view of the pollution problems, which have been rapidly creeping up to mountainous proportions, it becomes necessary to coordinate land use and population, and water and waste projections for immediate and future needs.

Authorities have been cognizant of these inter-related problems and affirmative action has been taken at all echelons of government to cope with the pollution problem. Coordination and funding as well as proper planning and timing are factors requiring consideration. The definition and organization of sanitary sewerage districts will be a very significant factor in the development of an adequate plan for the total needs of the Merrimack River Basin. Logical sewerage districts, based upon costs and topographical considerations, do not usually conform to city/town or even state boundaries, so that an increasing amount of inter-community and interstate coordination and cooperation will be required if the goals of maximum economy, efficiency, official operational coordination, and monitoring of pollution abatement are to be realized.

The history of efforts by towns and groups of communities to plan and construct sewage collection, treatment and disposal systems is one of record. Various consulting engineering firms, health agencies and ecologists have made extensive studies and recommendations to solve the sewage problem for both domestic and industrial wastewater.

Throughout the Merrimack River Basin, especially in the higher populated and industrial areas, cities and towns have coordinated their pollution abatement activities because of their proximity to each other, topographical and natural drainage aspects and for the purpose of reducing costs of sewage facilities. As previously mentioned the state and county governments have augmented the planning by the towns to establish, and assist, the sewer districts.

In Massachusetts and New Hampshire the major groups of cities and towns which have formed commissions and regions for pollution control of sewage are as follows:

Massachusetts

Northern Middlesex Area Commission (Formerly Greater Lowell Area Planning Commission)

Billerica	Lowell	Westford
Chelmsford *	Pepperell	
Dracut *	Tewksbury	
Dunstable	Tyngsborough	

* Participants in the Proposed Lowell Regional Sewage Treatment Plant.

Central Merrimack Valley Region

Amesbury	Methuen **	Newburyport
Andover **	Newbury	North Andover **
Groveland *	Georgetown	West Newbury
Haverhill *	Boxford	Salisbury
Lawrence **	Merrimac	Rowley

* Participants in the Haverhill Region Sewerage Disposal District

** Participants in the Greater Lawrence Sanitary District

New Hampshire

The city of Nashua and the town of Hudson are joining to utilize the city of Nashua facilities.

The towns of Auburn, Derry and Londonderry are going to connect into the city of Manchester Sanitary System.

TABLE NO. 21

MERRIMACK WASTEWATER STUDY

Existing and Projected Population and Number of Population Sewered in the Areas of Study

AREA	1970			1990			2020		
	Pop.	Pop.Sewered	%	Pop.	Pop.Sewered	%	Pop.	Pop.Sewered	%
Boston *	2,091,938	1,880,000	90	2,535,000	2,400,000	95	2,990,000	2,940,000	98
L-L-H	411,152	268,815	65	454,400	360,000	81	553,700	459,600	83
Con-Manchester	142,744	108,922	76	238,000	203,700	85	376,100	295,000	78
Nashua	75,053	58,000	77	132,750	118,500	89	211,000	168,700	80
Fitchburg	87,974	69,600	79	108,500	98,300	90	136,500	130,800	96
Winnipesaukee	30,457	24,400	80	34,100	30,700	90	49,700	42,245	85

* Boston figures are based on those of the North and South Metropolitan Sewerage System with Sewerage Treatment Plants at Nut and Deer Islands.

Figures based on Anderson-Nichols & Co., Inc. projections.

TABLE NO. 22

EXISTING TYPES OF MUNICIPAL SEWAGE SYSTEMS

	City/Town	Type of System
Lowell-Lawrence-Haverhill		
	Haverhill Region	Combined
	Lawrence Region	Combined
	Lowell (Incl. Dracut)	Combined
	Chelmsford	None
	Tewksbury	None
	Billerica	Combined
Fitchburg-Leominster		
	Fitchburg	Combined & Sanitary
	Leominster	Combined & Sanitary
	Lunenburg	Combined & Sanitary
	Westminster	None
Nashua		
	Nashua	Combined
	Merrimack	Combined & Sanitary
	Hudson	None
Manchester		
	Manchester	Combined
	Goffstown	Combined
	Hookset	Combined & Sanitary
	Bedford	None (Some discharges to Manchester)
Concord		
	Concord	Mostly Combined
	Pembroke	Combined
	Bow	None (Some discharges to Concord)

TABLE NO. 22 (Cont'd)

EXISTING TYPES OF MUNICIPAL SEWAGE SYSTEMS

Winnipesaukee River

City/Town	Type of System
Laconia	Combined & Sanitary
Belmont	None
Winnisquam	None
Northfield	None
Tilton	Combined
Sanbornton	None
Franklin	None

J. PRESENT ESTIMATED POLLUTION IN THE AREAS OF STUDY

The rivers involved in this study, basically the Merrimack, North Branch Nashua and the Winnipesaukee Rivers are polluted by the discharge of raw and or partially treated municipal, industrial and stormwater wastes for most of their lengths. The wastewater flow into the streams pollutes them physically, bacteriologically and chemically.

Considerable effort has been undertaken by the states and municipalities to correct this polluted condition as can be seen in the implementation programs described in tables later in this Appendix.

In general, four major water using industries, namely tanning, meat packing, paper manufacturing and textiles contribute to the pollution. Two other industries which are producing problems are plastics and metal finishing. Numerous private business firms have provided, or are in the process of providing, pretreatment of wastes from their plants which will enhance the quality of the river water and simplify municipal treatment needs now and in the future.

Practically all of the sewers in the study areas are of the combined type and the separation of stormwater presents exhorbitant costs to the communities.

The estimated breakdown of Municipal and Industrial wasteloads for the various areas of study are shown in Table 23 and 23a - 23t.

In each of the areas an investigation was made to determine the number, size and location of the existing wastewater discharge points which empty directly into the streams in each study area. These discharge points are shown on Plates 8 through 12 and in general are combined type sewers which includes domestic and industrial wastewater, and stormwater effluent.

TABLE NO. 23.

ESTIMATED WASTE LOADS INCLUDING THEIR TYPES FOR 1970

	Lowell-Lawrence-Haverhill Area	Fitchburg-Leominster Area	Nashua Area	Manchester Area	Concord Area	Winnipesaukee River Area	Totals	Remarks
MUNICIPAL (MGD)	47.46	10.80	11.30	13.92	6.18	7.0	96.66	
INDUSTRY (MGD)	-	-	-	-	-	-		
Plastics	-	0.75	-	.25	-	-	1.00	
Food Processing	0.20	0.09	2.50	.57	-	-	3.36	
Metal Plating	-*	0.39	0.30	-	-	-	0.69	*About 90 gal. per day.
Pulp & Paper	11.33	15.90	0.30	-	.46	-	27.99	
Dairy	0.10	-	-	-	-	-	0.10	
Rendering	0.12	-	-	-	-	-	0.12	
Textiles	1.30	-	-	1.75	-	-	2.05	
Wool Scouring	1.32	-	-	.16	-	-	1.48	
Tannery	0.17	-	1.00	0.60	1.20	.04	3.01	
Miscellaneous	-	0.81	0.30	-	-	-	1.11	
INDUSTRY-TOTAL	14.54	17.94	4.40	3.33	1.66	.04	41.91	MGD
MUN. & IND. TOTALS (MGD)	62.00	28.74	15.70	17.25	7.84	7.04	138.57	MGD
Stormwater Runoff (MG)/yr.	8870	4755	3685	3590	3095	4150	28,145	MG/yr.

Note: The above-noted wastes and quantities are based on field investigations & available information on point sources of pollution.

Table 23a

LOWELL-LAWRENCE-HAVERHILL
STUDY AREA
SUMMARY
MUNICIPAL WASTEWATER CONCENTRATIONS

		1970
Influent *	Flow	
	mgd	59.7
	BOD	
	mg/l	171
	lb/day	85,300
	SS	
	mg/l	220
	lb/day	109,500
Effluent **	Flow	
	mgd	59.7
	BOD	
	mg/l	171
	lb/day	85,300
	SS	
	mg/l	220
	lb/day	109,500

Note: Municipal wastewater includes industrial wastes.

* Prior to treatment.
** After treatment.

Table 23b
MERRIMACK RIVER BASIN
WASTE WATER MANAGEMENT STUDY

MUNICIPAL WASTES
FITCHBURG-LEOMINSTER AREA

Municipalities Served	Population	Population Served	Average Sewage Flows (mgd)	Waste Concentrations			
				Influent		Effluent	
				BOD mg/l	Sus.Solids mg/l	BOD mg/l	Sus.Solids mg/l
Fitchburg 1970	43,343	43,300	6.3	348	348	52	52
Leominster 1970	32,939	26,300	4.5	244	244	37	37
Lunenberg 1970	7,419		No Existing System				
Westminster 1970	4,273						

Table 23c
MERRIMACK RIVER BASIN
WASTE WATER MANAGEMENT STUDY

MUNICIPAL WASTES
NASHUA AREA

Municipalities Served	Population	Population Served	Average Sewage Flows (mgd)	Waste Concentrations Influent BOD mg/l	Influent Sus.Solids mg/l	Effluent BOD mg/l	Effluent Sus.Solids mg/l
Merrimack							
1970	8,595	Negligible	2.5	1,200	500	40	100
Hudson							
1970	10,638	3,000	0.5	144	144	144	144
1990	26,000	22,000	4.4	150	240	30	36
2020	43,000	38,700	11.6	140	180	28	27
Nashua							
1970	55,820	55,000	12.7	156	200	129	154
1990	81,750	81,000	20.0	146	208	28	20
2020	110,000	110,000	32.5	142	183	28	27

Table 23d

MERRIMACK RIVER BASIN
WASTE WATER MANAGEMENT STUDY

MUNICIPAL WASTES
CONCORD-MANCHESTER AREA

Municipalities Served	Population	Population Served	Average Sewage Flows (mgd)	Waste Concentrations Influent BOD mg/l	Influent Sus.Solids mg/l	Effluent BOD mg/l	Effluent Sus.Solids mg/l
Concord 1970	30,022	32,022	7.84	184	245	184	245
Pembroke 1970	4,261	2,000	0.25	150	240	150	240
Hooksett 1970	5,564	3,900	0.5	150	240	35	18
Goffstown 1970	9,284	2,000	0.5	125	51	80	26
Manchester 1970	87,754	71,000	16.0	175	229	175	227
Bedford 1970	5,859	None	None	--	--	--	--

Table 23e
MERRIMACK RIVER BASIN
WASTE WATER MANAGEMENT STUDY

MUNICIPAL WASTES
WINNIPESAUKEE AREA

Municipalities Served	Population	Population Served	Average Sewage Flows (mgd)	Waste Concentrations Influent BOD mg/l	Influent Sus.Solids mg/l	Effluent BOD mg/l	Effluent Sus.Solids mg/l
Belmont 1970	2,493	890	0.17	279	331		
Winnisquam 1970		1,725	0.18	207	243		
Franklin 1970	7,292	5,800	4.71	90	55		
Laconia 1970	15,000	15,000	1.6	240	288		
Northfield Tilton 1970	4,772	2,700	0.30	373	216		
Sanbornton 1970	1,022		0.02	10.43	11.273		

Table 23f

LOWELL-LAWRENCE-HAVERHILL
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
1970

	Flow	BOD		S. S.		TDS	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Dairy	0.47	2,941	1,150	660	258		
Cotton Textile	0.78	408	2,855	191	1,245	588	3,825
Synthetic Textile	1.28	548	5,856	439	4,689	2,130	22,743
Food Processing	0.20	2,150	3,567	909	1,510		
Pulp and Paper	11.33	378	35,700	537	50,710		
Metal Plating	90 gal/day						
Rendering	0.12	400	400				
Tannery	0.165	1,110	1,530	3,152	4,350	4,580	6,320
Wool Scouring	1.32	666	7,330				
Miscellaneous	0.0005	1,250	5	71,250	285		
Total	15.24	458	58,190	496	63,047		

Table 23g
FITCHBURG-LEOMINSTER
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
1970

	Flow	BOD		S. S.		COD		TDS	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/da
Food Processing	0.09	1,519	1,140	286	215	1,932	1,450	1,059	795
Pulp and Paper	15.9	32	4,250	33	4,360				
Metal Plating	0.39	16	51	39	127	272	883		
Plastics	0.75	252	1,574						
Miscellaneous	0.81	13	89	0.3	2	261	1,760		

Table 23h
NASHUA
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
1970

	Flow	BOD		S. S.		COD	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Food Processing Anheuser-Busch	2.5	25	520	20	420		
Pulp and Paper	0.276	260	600	260	600		
Metal Plating	0.274	230	520	270	615	640	1,460
Tannery	1.0	690	5,750	1,735	14,500		
Miscellaneous	0.267			1,000	2,220		

Table 23i

CONCORD-MANCHESTER
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
1970

	Flow	BOD		S. S.		TDS	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Textile	1.75	471	6,880	216	3,162	639	9,325
Food Processing	0.57	1,313	6,235	1,448	6,880		
Pulp and Paper	).46	26	100	26	100		
Tannery	1.8	1,361	20,430	1,765	26,490		
Wool Scouring	0.16	735	977	111	147		
Polystrene	0.25	1,435	3,000	11	22		

Table 23j
WINNIPESAUKEE
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
1970

	Flow	BOD		S. S.		TDS	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Tannery	0.04	1,040	350	2,950	990	4,350	1,450
Total	0.04	1,040	350	2,950	990	4,350	1,450

Note: No real growth projected for the tanning industry in 1990 and 2020.

Table 23k
LOWELL-LAWRENCE-HAVERHILL
STUDY AREA
SUMMARY
MUNICIPAL WASTEWATER CONCENTRATIONS

		1970
Influent *	Flow	
	mgd	59.7
	BOD	
	mg/l	171
	lb/day	85,300
	SS	
	mg/l	220
	lb/day	109,500
* * Effluent *	Flow	
	mgd	59.7
	BOD	
	mg/l	171
	lb/day	85,300
	SS	
	mg/l	220
	lb/day	109,500

Note: Municipal wastewater includes industrial wastes.

* Prior to treatment.
** After treatment.

Table 231
FITCHBURG-LEOMINSTER
STUDY AREA
SUMMARY
MUNICIPAL WASTEWATER CONCENTRATIONS

		1970
Influent *	Flow	
	mgd	10.8
	BOD	
	mg/l	305
	lb/day	27,500
	SS	
	mg/l	305
	lb/day	27,500
Effluent **	Flow	
	mgd	10.8
	BOD	
	mg/l	46
	lb/day	4,120
	SS	
	mg/l	46
	lb/day	4,120

Note: Municipal wastewater includes industrial wastes.

* Prior to treatment.
** After treatment.

Table 23m

NASHUA
STUDY AREA
SUMMARY
MUNICIPAL WASTEWATER CONCENTRATIONS

		1970
Influent *	Flow	
	mgd	15.7
	BOD	
	mg/l	321
	lb/day	42,100
	SS	
	mg/l	246
	lb/day	32,200
Effluent **	Flow	
	mgd	15.7
	BOD	
	mg/l	115
	lb/day	15,044
	SS	
	mg/l	145
	lb/day	19,025

Note: Municipal wastewater includes industrial wastes.

* Prior to treatment.
** After treatment.

Table 23n
CONCORD-MANCHESTER
STUDY AREA
SUMMARY
MUNICIPAL WASTEWATER CONCENTRATIONS

		1970
Influent *	Flow	
	mgd	25.09
	BOD	
	mg/l	176
	lb/day	36,857
	SS	
	mg/l	230
	lb/day	48,212
Effluent **	Flow	
	mgd	25.09
	BOD	
	mg/l	173
	lb/day	36,186
	SS	
	mg/l	225
	lb/day	47,178

Note: Municipal wastewater includes industrial wastes.

* Prior to treatment.
** After treatment.

Table 23o
WINNIPESAUKEE
STUDY AREA
SUMMARY
MUNICIPAL WASTEWATER CONCENTRATIONS

		1970
Influent *	Flow	
	mgd	6.8
	BOD	
	mg/l	157
	lb/day	8,900
	SS	
	mg/l	130
	lb/day	7,400
Effluent **	Flow	
	mgd	6.8
	BOD	
	mg/l	138
	lb/day	7,800
	SS	
	mg/l	90
	lb/day	5,100

Note: Municipal wastewater includes industrial wastes.

* Prior to treatment.
** After treatment.

Table 23p

LOWELL-LAWRENCE-HAVERHILL
STUDY AREA
SUMMARY
STORMWATER CONCENTRATIONS

	1970
Flow	
mgd	43.9
BOD	
mg/l	100
lb/day	36,613
SS	
mg/l	250
lb/day	91,532

Table 23q
FITCHBURG-LEOMINSTER
STUDY AREA
SUMMARY
STORMWATER CONCENTRATIONS

	1970
Flow	
mgd	21.8
BOD	
mg/l	70
lb/day	12,727
SS	
mg/l	221
lb/day	40,180
Organic N lb (KJELDAHL)	1,610
Coliform	
MPN/100 ml	72,000

Table 23r

NASHUA
STUDY AREA
SUMMARY
STORMWATER CONCENTRATIONS

	1970
Flow	
mgd	18.6
BOD	
mg/l	65
lb/day	10,083
Organic N lb (KJELDAHL)	645

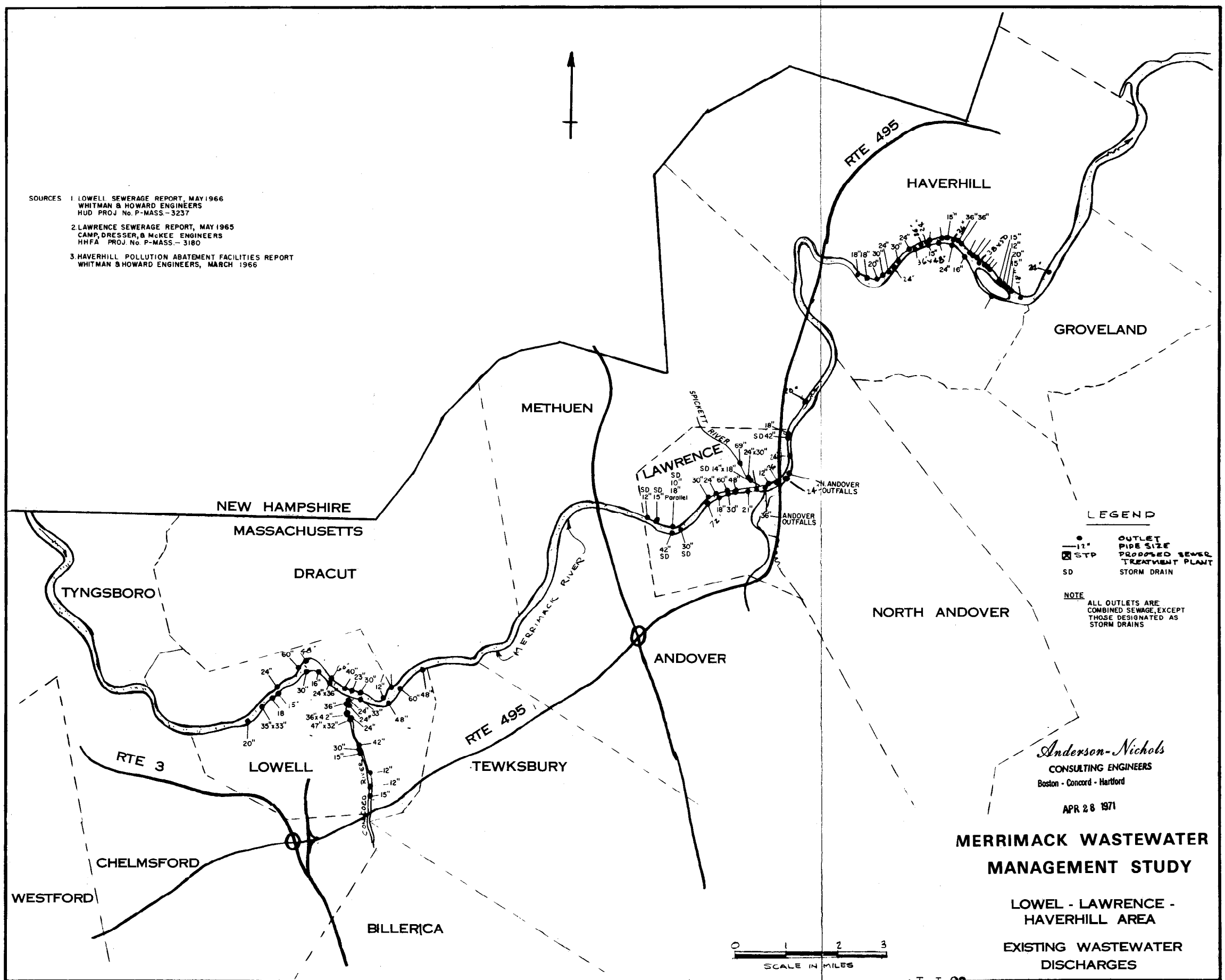
Table 23s
CONCORD-MANCHESTER
STUDY AREA
SUMMARY
STORMWATER CONCENTRATIONS

	1970
Flow	
mgd	31.3
BOD	
mg/l	126
lb/day	32,890
SS	
mg/l	209
lb/day	54,559
Organic N lb (KJELDAHL)	2,020
Coliform	
MPN/100 ml	167,000

Table 23t

WINNIPESAUKEE
STUDY AREA
SUMMARY
STORMWATER CONCENTRATIONS

	1970
Flow	
mgd	19.5
BOD	
mg/l	86.8
lb/day	14,116
SS	
mg/l	211
lb/day	34,314


SOURCES 1. LOWELL SEWERAGE REPORT, MAY 1966
WHITMAN & HOWARD ENGINEERS
HUD PROJ No. P-MASS.-3237
2. LAWRENCE SEWERAGE REPORT, MAY 1965
CAMP, DRESSER, & McKEE ENGINEERS
HHFA PROJ. No. P-MASS.-3180
3. HAVERHILL POLLUTION ABATEMENT FACILITIES REPORT
WHITMAN & HOWARD ENGINEERS, MARCH 1966
HAVERHILL
GROVELAND
METHUEN
LAWRENCE
SPICKETT RIVER
N. ANDOVER OUTFALLS
ANDOVER OUTFALLS
NEW HAMPSHIRE
MASSACHUSETTS
DRACUT
TYNGSBORO
MERRIMACK RIVER
ANDOVER
NORTH ANDOVER
RTE 495
RTE 3
LOWELL
TEWKSBURY
CONCORD RIVER
CHELMSFORD
WESTFORD
BILLERICA
LEGEND
OUTLET
PIPE SIZE
STP PROPOSED SEWER TREATMENT PLANT
SD STORM DRAIN
NOTE ALL OUTLETS ARE COMBINED SEWAGE, EXCEPT THOSE DESIGNATED AS STORM DRAINS
Anderson-Nichols
CONSULTING ENGINEERS
Boston - Concord - Hartford
APR 28 1971
MERRIMACK WASTEWATER MANAGEMENT STUDY
LOWEL - LAWRENCE - HAVERHILL AREA
EXISTING WASTEWATER DISCHARGES
SCALE IN MILES
0 1 2 3

I-J-29

PLATE 8

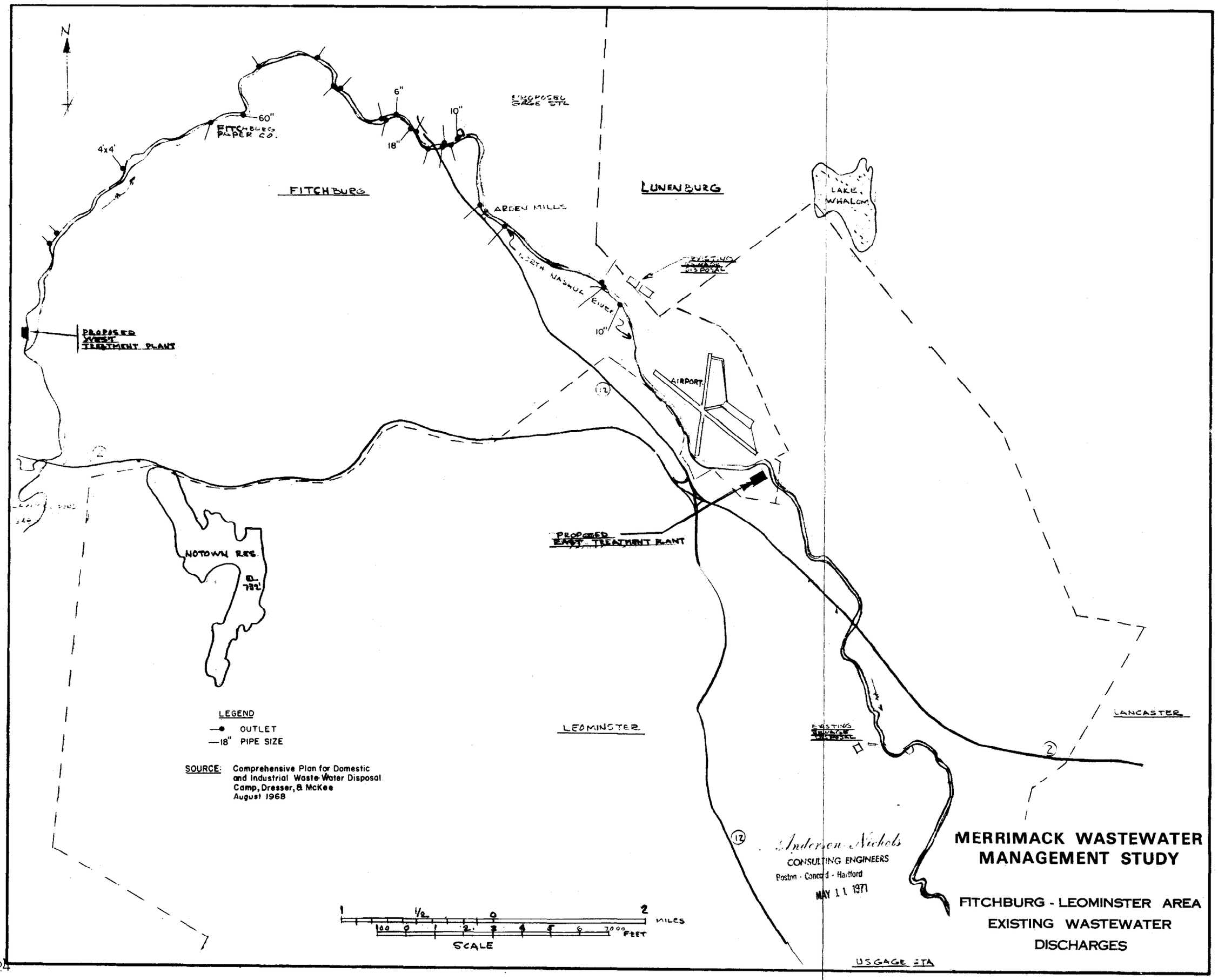

N
FITCHBURG
LUNENBURG
LEOMINSTER
LANCASTER
60"
FITCHBURG PAPER CO.
4'x4'
6"
10"
18"
ARDEN MILLS
NORTH NASHOE RIVER
10"
PROPOSED WEST TREATMENT PLANT
PROPOSED EAST TREATMENT PLANT
AIRPORT
LAKE WHALOM
NOTOWN RES.
EL. 732'
LEGEND
OUTLET
18" PIPE SIZE
SOURCE: Comprehensive Plan for Domestic and Industrial Waste Water Disposal Camp, Dresser, & McKee August 1968
1 1/2 0 2 MILES
100 0 1 2 3 4 5 6 7000 FEET
SCALE
Anderson-Nichols
CONSULTING ENGINEERS
Boston · Concord · Hartford
MAY 11 1971
MERRIMACK WASTEWATER MANAGEMENT STUDY
FITCHBURG - LEOMINSTER AREA
EXISTING WASTEWATER DISCHARGES
USGAGE STA

PLATE 9

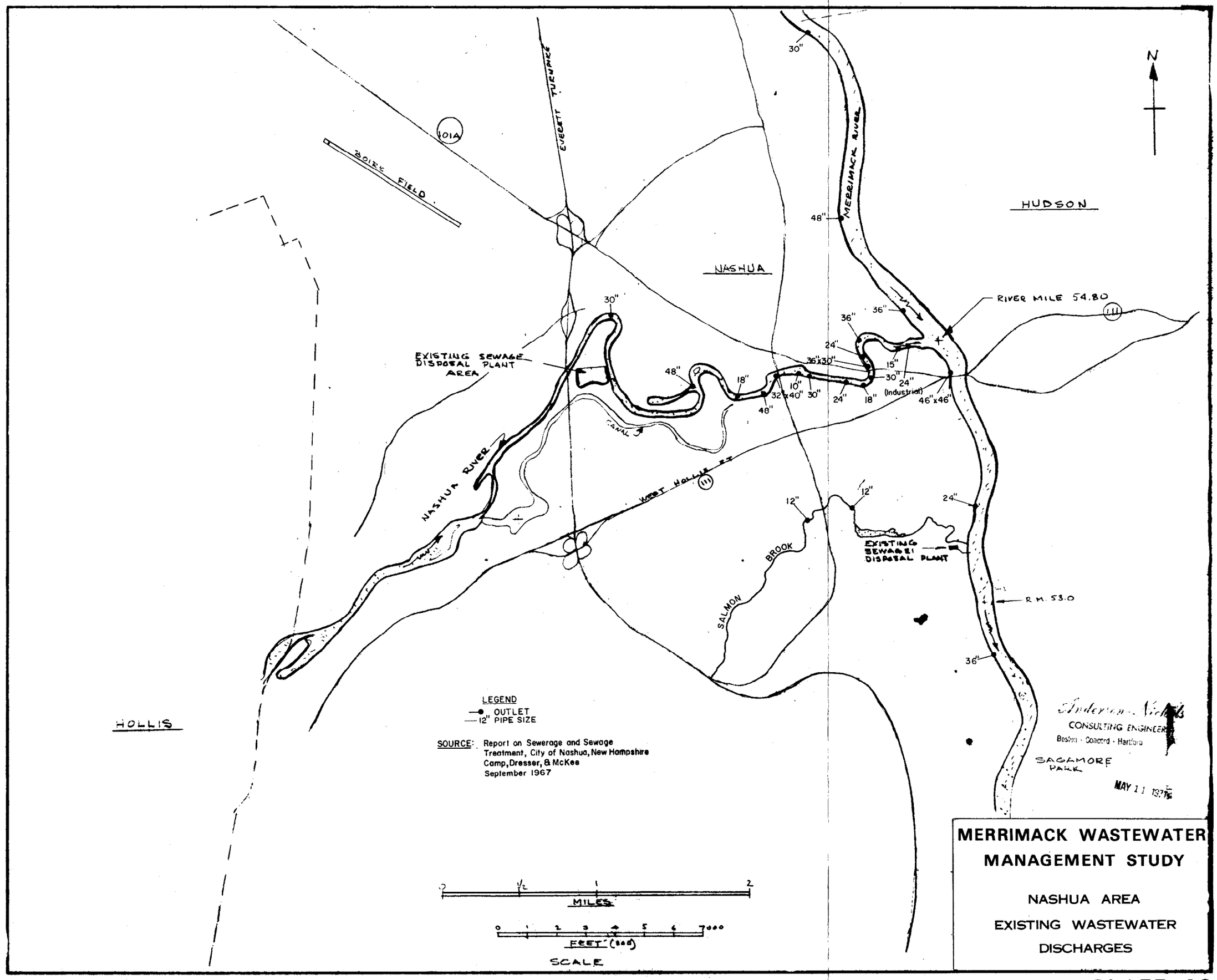

N
HUDSON
NASHUA
HOLLIS
BOIRE FIELD
101A
EVERETT TURNPIKE
MERRIMACK RIVER
NASHUA RIVER
CANAL
WEST HOLLIS ST
111
SALMON BROOK
RIVER MILE 54.80
R.M. 53.0
EXISTING SEWAGE DISPOSAL PLANT AREA
EXISTING SEWAGE DISPOSAL PLANT
SAGAMORE PARK
30"
48"
18"
36"
24"
36"x30"
15"
30"
24" (Industrial)
46"x46"
10"
32"x40"
12"
LEGEND
OUTLET
12" PIPE SIZE
SOURCE: Report on Sewerage and Sewage Treatment, City of Nashua, New Hampshire Camp, Dresser, & McKee September 1967
MILES
FEET (000)
SCALE
Anderson-Nichols
CONSULTING ENGINEERS
Boston · Concord · Hartford
MAY 11 1971
MERRIMACK WASTEWATER MANAGEMENT STUDY
NASHUA AREA
EXISTING WASTEWATER DISCHARGES

PLATE 10

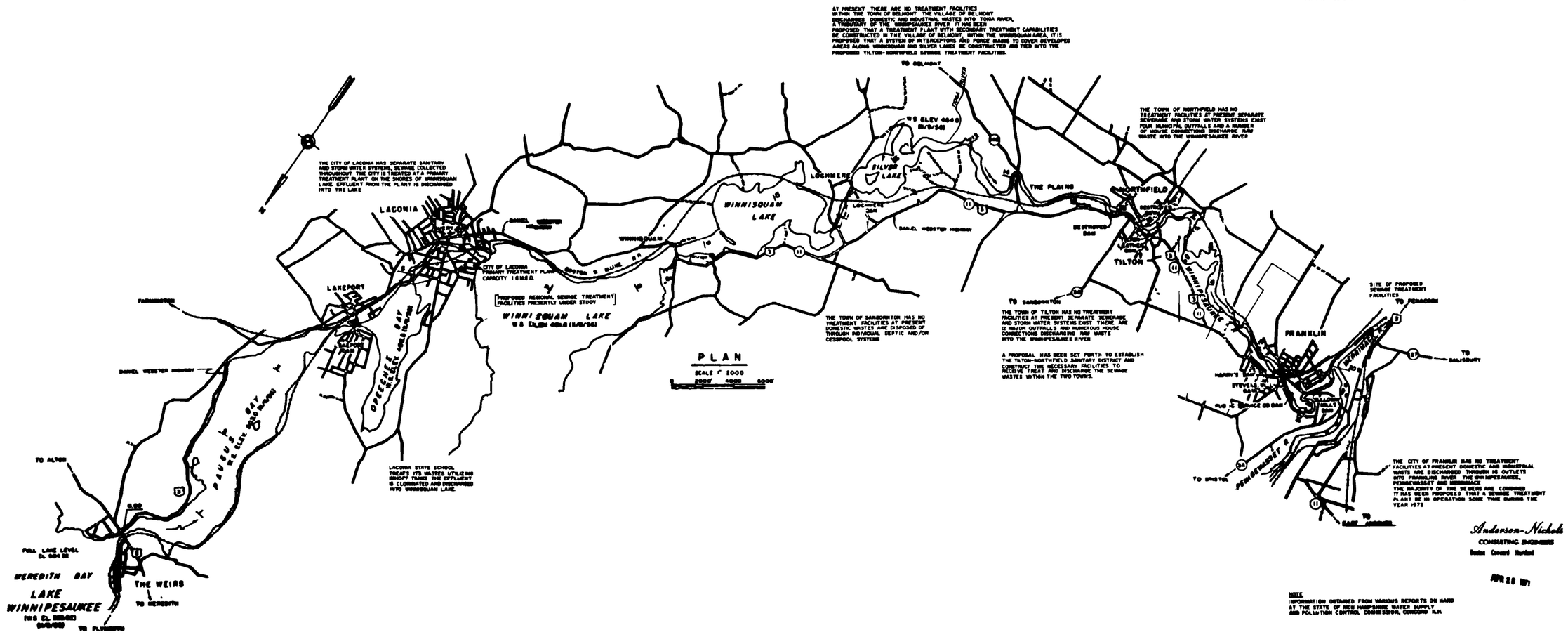
MERRIMACK WASTEWATER MANAGEMENT STUDY

CONCORD & MANCHESTER AREA
EXISTING WASTEWATER DISCHARGES

PLATE 11

I-J-26

Note Exact sewage discharge locations are not shown on this plan.



MERRIMACK WASTEWATER MANAGEMENT STUDY

WINNIPESAUKEE RIVER AREA EXISTING WASTEWATER DISCHARGES

K. CURRENT INSTITUTIONAL ARRANGEMENTS FOR WASTEWATER MANAGEMENT

In order to cope with the pollution abatement problem, Federal, State and Local governments as well as quasi and private organizations have instituted arrangements for wastewater management in the Merrimack River basin,as well as in other parts of their states.

The organizations responsible for wastewater management are:

a. The Office of Water Programs of the United States Environmental Protection Agency, established by the Federal Water Quality Act of 1965. This organization is responsible for monitoring and implementing pollution abatement programs on a national level. This responsibility includes coordination, enforcement, implementation and establishing water quality criteria for interstate pollution situations.

b. Administrative Structure for the Commonwealth of Massachusetts:

(1) Interstate

(a) New England Interstate Water Pollution Control Compact. The New England Interstate Water Pollution Control Commission (NEIWPCC) was established by an interstate compact adopted by the Commonwealth of Massachusetts and the states of Connecticut, Rhode Island, New York, Vermont, New Hampshire, and Maine between 1947 and 1955. The area of jurisdiction of the Commission includes all interstate waters of signatory states and tidal waters ebbing and flowing past the boundaries of any two signatory states. The waters under the jurisdiction of the Interstate Sanitation Commission (New York, New Jersey, and Connecticut) are excluded.

The Commission consists of five commissioners from each signatory state. The purpose of the Commission includes the establishment of water quality standards for various classifications of use in the water bodies under its jurisdiction, and to formulate programs to meet established standards. In accomplishing its purpose, the Commission is acting as an action agency with abatement and control of pollution its primary function. The Commission works very closely with the pollution control agencies of each of its member states in carrying out its purpose. Any comprehensive planning function would be undertaken by the New England River Basins Commission with the NEIWPCC advising on matters concerning the quality of water.

At the present time the Commission is carrying out various programs in relation to its function of pollution abatement and control including:

(1) Research programs pertaining to methods of treatment.

(2) Standards (criteria) Development for various uses of water bodies as a continuous program.

(3) Training of existing sewage treatment plant operators.

(4) Public information and education.

(5) Coordination of interstate water pollution control activities.

(6) Studies of specific problems which are of significant concern to the area as a whole. For example, pollution from small boats.

In order to further alleviate water pollution of the interstate waters, the Commission hopes to add to its present programs by undertaking the following:

(1) Obtain the powers of enforcement of standards where in interstate waters, individual states are unable to gain compliance. These enforcement powers would be with the approval of the states involved.

(2) Conduct a training program for new operators to aid in filling the need for qualified persons presently unavailable for operating the many treatment facilities presently understaffed and additional facilities which will be constructed in the near future.

(3) Establish a continuing surveillance program on interstate waters to observe quality and aid in enforcing quality standards.

The commission's major goal may be summed up as follows:

----- To design and construct necessary major additions and improvements to the metropolitan water, sewerage, and flood control systems within the metropolitan area.

It is the commission's objective to continue studies necessary to determine water and sewerage needs to meet future demand and to construct such improvements as are needed therefore.

Basic information collected by the commission includes rainfall data (in watersheds which contribute to supply sources within the system); quality samples of water from reservoirs, aqueducts and pipelines; air temperatures; evaporation test results; consumption data; river flows (gaging by U.S.G.S.). Information is manually filed in the central office of the MDC with copies sent to interested agencies.

The MDC presently serves about 40 communities with sewerage, and 42 communities (including 10 outside its district) with water.

Because of its large service area, the even larger area of influence of its water resources and reservoirs (extending 70 miles ± west of Boston), and its experience and expertise in providing systems of such magnitude, the MDC is an extremely important "partner" in the planning and management of water resources in Massachusetts.

(b) Commission on Interstate Cooperation. Legislation passed in 1937 established in the department of the Secretary of State, a thirteen member Commission whose duties include the formulation of proposals for cooperation between this commonwealth and other states, and with the Federal government, and to organize and maintain facilities for accomplishing these purposes.

(c) New England River Basins Commission. The New England River Basins Commission (NERBC) is one of several such commissions that are authorized to be set up throughout the country under Title II of the Federal Water Resources Planning Act of 1965 (PL 89-80). The area under the jurisdiction of the Commission includes all of New England and the bordering parts of New York State with the exception of the Hudson River and Lake Champlain Areas.

The Commission, which was formally established late in 1967, is designated to serve as the principal agency for the coordination of Federal, State, interstate, local and non-governmental plans for the development of water and related land resources in its area. It is also charged with preparing and maintaining a comprehensive, coordinated, joint plan for development for its area.

All matters being undertaken by the Commission are decided by a consensus of its members. Membership includes a chairman appointed by the President of the United States, representatives of the member states (a vice chairman is elected by them), representatives of Federal agencies having substantial interest in the Commission's work, and representatives of interstate agencies whose jurisdiction extends to the waters of the area for which the Commission was created.

The first major project of the NERBC is participation in the completion of the on-going North Atlantic Regional Water Resources Study which is a "framework" study of the needs and resources of water to the year 2020. The Commission is also participating in the Northeastern United States Water Supply Study and the Connecticut River Comprehensive Study. All three of these studies are presently under the direction of the Corps of Engineers and are funded, for the most part, fully by Federal monies.

The Commission has programmed studies to be accomplished under their jurisdiction. These include:

(1) A comprehensive study for southeastern New England.

(2) A study of small dams in New England including aspects of resource value, safety, and measures needed to salvage existing dams.

(3) A study of flood plains including methods of applying zoning or other applicable controls, methods of acquiring land for public use, and other methods which would reduce future flood hazards.

(4) A project to promote coordination between electric power development and other resource and environmental values.

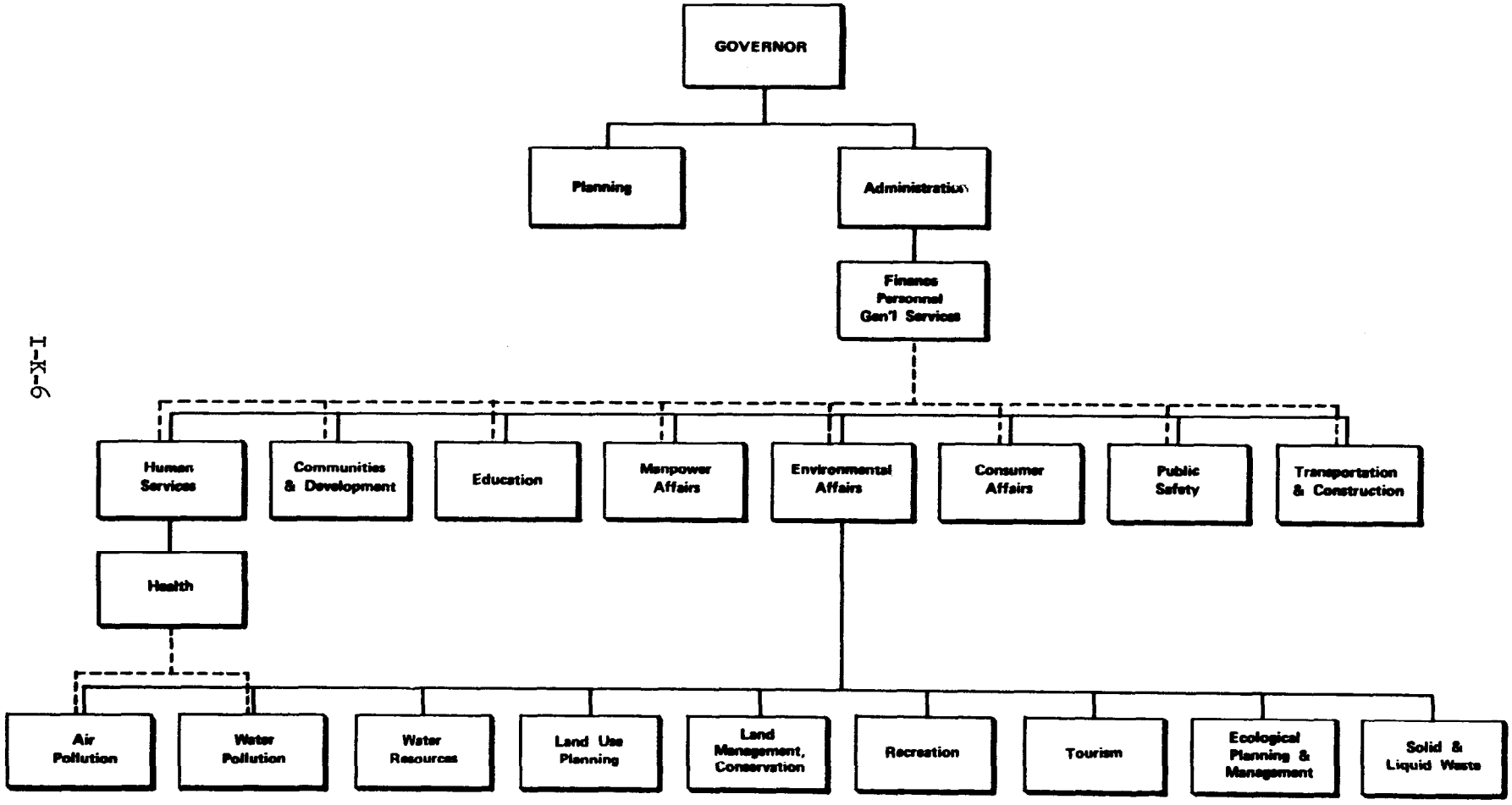
It is expected that in order to successfully complete the studies presently programmed, technical assistance will be required from many of the Federal agencies which are involved in water resources. Input from various state agencies will also be necessary to achieve the objective of a comprehensive coordinated joint plan.

The New England River Basins Commission has, by resolution, assented to the Water Resources Council that future multi-purpose water and land resources investigations within its area should be carried out with the Commission serving as the leading and coordinating agency, with Federal agencies carrying out specific study elements in accordance with an overall plan of study.

It will be necessary for the Commission to overcome several administrative and budgeting problems to successfully assert itself as the principal agency in water resources planning. Such items as Federal provision of coordinated budgets and the elimination of legislation assigning certain studies to individual Federal agencies will be necessary to effectively place the coordination of all water resources studies in the hands of this one agency, the New England River Basins Commission.

(2) State Departments and Agencies

(a) Massachusetts Water Resources Commission



ORGANIZATION OF MASSACHUSETTS STATE AGENCIES
To Be Implemented Beginning April 30, 1971
(Fig. 2)

(1) Division of Water Resources

The Division of Water Resources was created by Chapter 620 of the Acts of 1956 within the Department of Natural Resources, but under the control of a special eleven-member Water Resources Commission. The Commission of the Department of Natural Resources is the chairman of the commission. Other members include representatives of the Department of Public Health, Public Works, Commerce and Development, the Division of Fisheries and Game, and four citizens appointed by the Governor.

The Division is charged with the following general responsibilities:

Coordinate all water and related land resource activities of State, Interstate, and Federal agencies as they affect Massachusetts.

Guide the formulation of water resource policy and law based upon the interests of agriculture, industry, recreation, wildlife, conservation, domestic consumption, and flood protection.

Study the needs, supplies and resources of the Commonwealth with respect to water conservation and flood protection.

Supervise programs provided for by the Watershed Protection and Flood Prevention Act. (PL-566).

Contract for ground-water favorability studies upon local application.

Administer comprehensive water and land related resources planning program under the Water Resources Planning Act (PL 89-80), and to receive Federal Funds under Title III of the Act.

The above responsibilities have been translated into the following goals:

To develop scientific and equitable methods for the management of the state's water resources through coordination of basic data collection, establishment of effective planning, and formulation of necessary regulatory measures.

To prepare and guide programs based upon planning recommendations to insure the optimum use, conservation, and development of state water and related land resources through the organization of cooperative state interagency, local-state and state-federal partnership efforts.

The Division has proposed a number of objectives which define the items to be included in a work program necessary to achieve these goals. These objectives were used for the most part as a starting point in developing the program presented in Chapter III, and therefore are not included herein.

The Division, as the coordination agency for water resources activities as they affect Massachusetts, is responsible for providing the state input and guidance required in many of the water resources programs of the Corps of Engineers, the Soil Conservation Service, the Geological Survey, and the Water Resources Council.

(2) Division of Water Pollution Control

The Division of Water Pollution Control was established in the Department of Natural Resources, under the control of the Water Resources Commission by Chapter 685 of the Acts of 1966. The Division is broadly responsible for improving the quality and value of the Commonwealth's water resources. The principal duties and responsibilities are contained in Chapter 687 of the Acts of 1966 and in the establishing act. These duties and responsibilities are:

Establish a program for the prevention, control, and abatement of water pollution and encourage the adoption and execution of this plan by users of the waters of the Commonwealth.

Study, research, and demonstrate new and improved methods of pollution abatement.

Adopt standards of water quality applicable to the waters of the Commonwealth and plan for the implementation and enforcement of the standards.

Examine periodically the water quality of the waters of the Commonwealth.

Propose water pollution abatement districts.

Cooperate with appropriate Federal agencies, agencies of other states and interstate agencies in matters related to water quality control, and shall receive and dispense funds from any such agency as may be available for the prevention, control and abatement of water pollution.

Regulate the construction and operation of new disposal systems for the discharge of sewage or industrial wastes or the effluent therefrom by the issuance of permits.

Regulate, by order, the operation of water pollution control facilities to insure adequate treatment prior to discharge to any watercourse.

The Division has taken a sentence out of its establishing act as its goal, which is "To enhance the quality and value of water resources in the Commonwealth through a program for the prevention, control, and abatement of water pollution." The following specific objectives have been set forth to pursue this goal:

Encourage, and if necessary, require the adoption and execution of plans for abatement of 190 known sources of pollution by 1970 and 345 known sources by 1975.

Conduct research and demonstration programs in the areas of combined sewers, eutrophication, waste oil disposal, effects of the disposal of toxic wastes in the ground and at sea, advanced waste treatment, thermal pollution from watercraft, and the disposal of dry wastes through sanitary sewers.

Establish 36 monitoring stations by 1973.

Establish a technical school specializing in courses on the methods of water pollution control and the operation of water pollution abatement facilities.

Authorize and direct a total of 50 cities, towns, political subdivisions and water pollution abatement districts by 1970 (120 by 1975) to apply for Federal grants applicable to the capital outlay cost of pollution abatement facilities.

Construct or enlarge reservoirs throughout the Commonwealth for the purpose of providing low flow augmentation by 1975.

The Division of Water Pollution Control works closely with the Federal Water Pollution Control Administration, particularly in regard to stream standards and enforcement on the interstate waters of the Commonwealth. These two agencies transfer information and data gathered, and the FWPCA provides technical assistance to the Division. Often working together in cooperative programs, these two agencies provide for the collection, analysis, and publication of water quality data on a continuing basis.

The Bureau of Envrionmental Health Engineering and the Division shares deep interest in the control and abatement of water pollution since contamination in many cases accompanies pollution. The sections of the water quality standards adopted by the Division and approved by the Department of Interior relating to public health were formulated with the approval of the Commissioner of Public Health. The two agencies have attempted to reduce the difficulty arising from the overlapping of functions by a mutually agreed upon schedule of operating procedures.

The Division has just oriented an extensive program of water quality monitoring. Up to this time, the Division has provided a limited amount of first person data mostly in the form of grab sample analysis. The data presently available is stored on laboratory report sheets in the central office of the Division and is not generally published except in conjunction with a specific report. However, the Division continues to be a prime source of water pollution control information, particularly, in the form of engineering reports, special studies, enforcement proceedings, and permits. The primary functions of the Division at the moment are: to encourage and promote the development of water pollution abatement facilities, review and endorse applications for Federal grants and loans for pollution control projects (HUD), review and endorse reports, designs, and specifications for water pollution abatement facilities, monitor water quality in the waters of the Commonwealth, and administer the state construction grant program for water pollution abatement facilities.

The Division has not to date initiated a comprehensive planning program. The Division in the short time since being established has directed itself to the more pressing problems of classification and enforcement.

(b) Massachusetts Department of Natural Resources

(1) Division of Acquisition and Construction

The Division of Land Acquisition and Construction was departmentally organized recently to serve the other Divisions within the Department of Natural Resources by providing legal and engineering services in matters pertaining to the acquisition and disposition of lands, and to the development of recreational areas under the jurisdiction of the Department. In particular the Division performs the duties required to complete the land transactions, contracts for project design, reviews the plans and specifications, and acts as the contracting body for construction projects.

The Division of Land Acquisition and Construction uses data collected by other divisions of the Department of Natural Resources and by the Department of Public Health. This data includes water quality (for swimming purposes), runoff (for dams), depths and contours of ponds (for swimming), aquatic weed control, and insect pest control.

Acquisition and Construction, being a service division, is by its nature project oriented and does not in itself carry out any long range planning.

(2) Division of Conservation Services

The Division of Conservation Services was established within the Department of Natural Resources by Chapter 664 of the Acts of 1963. This act abolished the State Soil Conservation Committee in the Department of Agriculture and added the Division of Conservation Services to the Department of Natural Resources.

The legislation also established a State Committee for the Conservation of Soil, Water and Related Resources in the Division. This committee is composed of seven voting members and one non-voting advisory member. The seven voting members include the Commissioner of Agriculture, Commissioner of Natural Resources, the Dean of the College of Agriculture at the University of Massachusetts, together with four appointed members suggested by the Massachusetts Association of Conservation Commissions, the Executive Committees of the State Grange and the Farm Bureau Federation, and the Association of Soil Conservation Districts.

(c) Massachusetts Department of Public Health

(1) Bureau of Environmental Engineering

The Bureau of Environmental Health Engineering resulted from recent reorganization and expansion of the Division of Sanitary Engineering as authorized and approved by the Public Health Council. The Bureau consists of five functional divisions and one administrative support division. Each of the five functional divisions will oversee and regulate one aspect of environmental health engineering. These divisions are: (1) Division of Air Use Management and Radiological Health, (2) Division of General Environmental Control, (3) Division of Water Quality Evaluation, (4) Division of Land Use Management, and (5) Division of Laboratory Support Services. The Bureau will continue to staff and maintain four district offices which perform much of the field work and supply field information to the central office.

The principal powers and duties of the Bureau are included within the provisions of Chapter 111 of the Massachusetts General Laws, particularly Section 5. In addition, the Bureau has additional responsibilities delegated by Special Acts and other sections of the General Laws, including Chapters 40, 83, and 130.

Some of the principal duties of the Bureau are as follows:

Oversight of inland waters, including surface and subsurface water, and sources of water supply, and control the pollution or contamination of any or all of the lakes, ponds, streams, tidal waters and flats within the commonwealth and of the tributaries of such tidal waters and flats.

Regulate the application of chemicals for weed and aquatic nuisance control by private individuals.

Control algae, weeds, and other aquatic nuisances in such lakes, ponds, streams, and other bodies of water within the commonwealth.

Regulate any city, town or district water supply by requiring such treatment facilities as are needed to insure the delivery of a safe water supply to all consumers.

Advise communities or persons as to the most appropriate source of water supply and the best method of assuring its purity, and the best method of disposing of sewage or drainage.

Examine water from water supply systems to ascertain their purity and fitness for domestic use.

Regulate the discharge into coastal waters of sewage or other substances injurious to health.

Examine coastal waters and flats of the Commonwealth to determine whether these areas are contaminated.

Control and direct operations of all water resources for communities during disaster emergencies.

Investigate the utilization of low lands and swamps by draining, for the protection of public health.

In order to carry out the responsibilities as stated above and, in general, to promote the public health the Bureau has formulated goals to guide future actions. One of the goals refers to its role in water resources management and is stated as follows:

To promote the public health, safety, and convenience associated with water and related land uses by assuring plentiful supplies of safe and suitable water to be furnished for human consumption and related uses, to eliminate environmental health hazards associated with harvesting shellfish from contaminated water and contamination of bathing waters, and control of aquatic nuisance plants and organisms.

The Bureau has set forth several objectives for carrying out this goal. The most significant with respect to long-range water resources planning and management are:

To maintain a current inventory of basic engineering data for each public water supply in the Commonwealth in a form useful for water supply system design, municipal and regional planning, and emergency operations.

To develop an on-going 25-year plan for development of additional water sources (and related land) to fulfill projected safe water needs of 350 community water systems.

Maintain a program for engineering surveillance of all public water supply sources and facilities including treatment works.

To complete a sanitary survey and classification of all shellfish growing areas in the Commonwealth, comprising approximately 2,000 miles of coastline and over 50,000 acres, and to develop capability for conducting resurveys and reclassifications of each area once every year in accordance with National Shellfish Program Standards.

To expand the program for conducting biological surveys review and approve of proposals, and preparing contracts for chemical treatment and supervising control work on lakes, ponds, streams and other bodies of water within the Commonwealth.

To achieve a fully adequate engineering surveillance program and review of plans for existing and new liquid waste treatment plants, to insure compliance with public health laws, rules, and regulations.

To establish an on-going program for public health surveillance of streams.

Close liaison is maintained by the Bureau with the Public Health Service in the U.S. Department of Health, Education and Welfare. The Bureau also exchanges information and receives cooperative assistance from other Federal agencies including U.S. Corps of Engineers, U.S. Geological Survey, U.S. Soil Conservation Service, the U.S. Department of Housing and Urban Development, and the Federal Water Pollution Control Administration. The Bureau reviews and endorses applications for Federal planning funds, reviews engineering reports on sewerage and water (some being done with Federal funds), performs analyses on shellfish (interstate shipments), supplies statistics, and cooperates in analytical work. The Federal agencies supply the Division with technical and research data.

The Bureau of Environmental Health Engineering continually cooperates with other state agencies as well as local community agencies in most matters pertaining to sanitation and water supply. In addition to providing laboratory facilities for testing and analysis, the Bureau reviews plans and reports for water and sewerage improvements, and reviews proposals for developing wetlands from a public health standpoint.

The Bureau participates in the comprehensive planning process continually by such activities as discussion of proposals and feasibility studies, and review of plans from a public health standpoint.

A large amount of staff time is spent participating in the planning process as differentiated from regulatory or research activities.

The Bureau of Environmental Health Engineering collects and maintains a considerable amount of basic data and information pertaining to water resources. This data and information includes water quality analysis, water consumption data, statistical data, and engineering reports. Analyses information is stored alphabetically by community and is available at the central office of the Bureau and at the Lawrence Experimental Station. Water consumption data are also filed alphabetically and are available in printed summaries periodically.

(d) Massachusetts Department of Public Works

(1) Division of Waterways

The Division of Waterways was established within the Department of Public Works to carry out the provisions of Chapter 91 of the General Laws. The duties and responsibilities of the Division are contained in Chapters 91 and 648 together with a number of special acts. These duties and responsibilities include:

To undertake shore protection, harbor development, stream clearance and flood control work.

Coordinate Federal harbor development and flood control projects.

Charge of great ponds, public rights in lands, flats, shores, and tide waters belonging to the Commonwealth.

Improvements, maintenance, and protection of tidal and non-tidal rivers and streams and shores along public beaches.

Control of use and construction, by others, on lands under its jurisdiction by licensing powers.

In order to carry out its prime responsibilities under the statutes, the Division has formulated the following goal:

To protect the shorelines of the State while providing the public with safe, functional and convenient access to, and upon, the public waters of the Commonwealth. These waters include the coastline, harbors, rivers and Great Ponds.

For the purpose of carrying out their goal, the Division has set forth approximately ten objectives. Five of these objectives relate directly to water resources management. They are:

To regulate control of all filling and structures erected in public waters.

To provide interstate cooperation in the use of mutual boundary waters.

To conduct hurricane and flood control construction studies and construction projects.

To provide State cooperation with Federal agencies in river and harbor projects.

To provide State cooperation in regional compacts with noncontiguous states.

The Division of Waterways, because of the similarity of certain work performed relates to the U.S. Corps of Engineers, especially in projects requiring dredging for navigation purposes. For projects of mutual interest the contracting agency would provide the other agency with copies of plans or reports.

The Division of Waterways does not currently maintain water resources data on a regular basis. When needed for specific projects, the Division conducts surveys to provide study or design information and data. The Division obtains certain basic data including tide information, stream flows, and rainfall data from the U.S. Coast and Geodetic Survey.

The Division carries out an interrelationship of its undertakings with water resources planning by:

1. Having a representative on the Massachusetts Water Resources Commission, and

2. Reviewing proposals for developing wetlands in cooperation with the Department of Public Health, the Division of Water Resources, and the Division of Conservation Services, Department of Natural Resources.

(e) Massachusetts Department of Commerce and Development

The Department of Commerce and Development was established in 1964 under Chapter 23A of the General Laws. Many of the duties of the Department are in relation to housing and urban renewal which are contained in Chapters 121 and 121A of the General Laws.

The broad powers included in the enabling legislation include provisions for all facets of comprehensive planning. The Department, as organized, incorporates a deep involvement in the planning process but does not have a program for statewide planning. The Planning Division administers the Federal 701 planning program for local communities and acts in an advisory capacity in regional and metropolitan planning in the state.

Other activities of the Department include economic development, tourism, housing, and industrial and urban renewal. The availability of water in adequate quantity and quality is recognized as vital to all the activities within the domain of commerce and development and therefore the Department is expected to exert a great influence on any water resources planning which is undertaken. The Department should provide a large input in studies undertaken in the realms of economic and

population projections. One example of where a study of water resources could be combined with efforts of the Department of Commerce and Development is in the area of developing offshore resources of the state.

Recently (November 1, 1968), a new State Department of Community Affairs has come into being. Under legislation passed during 1968 under Chapter 23B of the General Laws, several of the functions of the Department of Commerce and Development have been transferred to the new department including housing, urban renewal, relocation and planning assistance.

At the present time, it is not expected that the new department will have an increased role in water resources planning over that presently undertaken by DCD. It is also expected that the Department of Administration and Finance will coordinate the several planning documents, including water resources, that will make up the state's comprehensive development plan.

(f) Metropolitan District Commission

The Metropolitan District Commission was formed in 1919 by reason of a state constitutional amendment requiring that all state boards and commissions be organized into not more than twenty departments. The Commission as organized under Chapter 92 of the General Laws encompasses functions of providing sewerage, water and parks systems in the Boston Metropolitan Area.

In the field of water resources, the Commission has been charged with the construction, maintenance and operation of water and sewer systems, sufficient to serve its member communities. The Commission has separate divisions for the operation and maintenance of its separate functions pertaining to water, sewerage, and parks. The Construction Division incorporates the function of long-range planning of facilities and resources needed to meet future demands.

The Metropolitan District Commission does not carry out a fully comprehensive planning program since its responsibility is limited to that of a service function. It does, however, conduct and carry out a planning program wherein it is continually investigating and programming the measures needed to serve the expanding needs of its member communities in the field of its jurisdiction.

The existing systems evolved from long-range planning efforts, that although essentially "single-purpose" in nature, contain the element of providing for projected future needs.

The commission's major goal may be summed up as follows:

To design and construct necessary major additions and improvements to the metropolitan water, sewerage, and flood control systems within the metropolitan area.

It is the commission's objective to continue studies necessary to determine water and sewerage needs to meet future demand and to construct such improvements as are needed therefore.

Basic information collected by the commission includes rainfall data (in watersheds which contribute to supply sources within the system); quality samples of water from reservoirs, aqueducts and pipelines; air temperatures; evaporation test results; consumption data; river flows (gaging by U. S. G. S.). Information is manually filed in the central office of the MDC with copies sent to interested agencies.

The MDC presently serves about 40 communities with sewerage, and 42 communities (including 10 outside its district) with water.

Because of its large service area, the even larger area of influence of its water resources and reservoirs (extending 70 miles ± west of Boston), and its experience and expertise in providing systems of such magnitude, the MDC is an extremely important "partner" in the planning and management of water resources in Massachusetts.

(g) University of Massachusetts

(1) Water Resources Research Center

During 1965, the University at Amherst established a Water Resources Research Center, the chief objectives of which were:

1. To conduct basic, developmental and applied research relevant to water resources and their efficient use.

2. To stimulate the development of curricula and research programs within the framework of the Graduate School to provide professional workers with advanced training for the water resources fields.

The Center, while basically funded under Public Law 88-379, the Water Resources Act of 1964, has received yearly grants to conduct special studies for the Massachusetts Water Resources Commission. It is hoped that employees of the Commission's two divisions will be able to

avail themselves of advanced training courses in Water Resource Management which may be arranged on an in-service training basis.

Current studies involving the Connecticut basin include a study to be conducted in cooperation with the wildlife unit concerning wetlands classification, an evaluation of discontinuities in regional population projections, watershed responses to hydrologic influences and many others.

(h) Department of Community Affairs

The Department was created by the amendment of the General Laws inserting Chapter 23B, sections 1-26. Among other functions it is concerned withzoning, planning, and training of personnel at the community level. The legislation was passed in 1968 and directs the new agency to "formulate in cooperation with the related state agencies and submit annually to the governor and the general court beginning on or before December 4, 1970 and from time to time thereafter biannually a five-year Community and Environmental Development Program, including, but not limited to: establishment of the number and location of areas requiring the need and priority for area improvements involving sewer, water, parks, public safety, urban beautification, solid waste, health welfare education and recreation centers, traffic and public works, establishment of unified code enforcements personnel training and evaluation procedures; and establishment of a financial program which shall identify the required participation by federal agencies, Commonwealth, and municipalities, and which shall give consideration to the Commonwealth contributing one half of the federal share;..."

(i) Future Administrative Structure

A new administrative structurewill be placed in operation on April 30, 1971. (See Figure 2). The many agencies of the Commonwealth will be grouped in eight executive offices, each headed by a secretary to be appointed by the governor. While each existing agency shall be transfered intact, provisions have been made for the shifting of certain functions of specific agencies as is found to be appropriate.

Functions concerning water and related land resources are largely to be grouped under Environmental Affairs. Agencies specifically listed include the following: Department of Agriculture; Department of Natural Resources, including the Division of Fisheries and Game and Water Resources Commission; the Metropolitan District Commission; The Outdoor Advertising Board and Division; and several other lesser boards and commissions.

Provisions are included to permit the later inclusion of The Pesticide Board and the air and water pollution control functions of the Department of Public Health. The remainder of the functions of the Department of Public Health will be placed under the Executive Office for Human Services.

The Executive Office of Communities and Development will contain the Departments of Commerce and Development. The Department of Community Affairs and The Metropolitan Area Planning Council. The office will, among other duties, plan for and promote the economic development of the Commonwealth.

c. Administrative Structure for the State of New Hampshire

This section contains a brief description of the State agencies, boards, and commissions and related organizations in the natural resources field in New Hampshire; in fact, most directly concerned with plans and projects for the Connecticut River Basin.

Having jurisdiction over these agencies are the New Hampshire General Court and the Governor and Executive Council.

The New Hampshire General Court, consisting of a Senate and House of Representatives, was provided for in the New Hampshire Constitution adopted in June 1784. The General Court meets biennially, in odd-numbered years. The Senate has 24 members and the House of Representatives about 400.

The State Constitution (Part Second, Article 41) vested the executive power of the State in the Governor. It states that the Governor shall be responsible for the faithful execution of the laws. An Executive Council of five members advise the Governor (Constitution, Part Second, Article (60). They meet frequently with the Governor to consider many projects requiring his approval.

(1) Interstate

(a) Atlantic States Marine Fisheries Compact

The purpose of the compact, whose members are the coastal states from Maine to Florida, is "to promote the better utilization of the fisheries,marine, shell and anadromous, of the Atlantic seaboard by the development of a joint program for the promotion and protection of such fisheries, and by the prevention of the physical waste of the fisheries from any cause." One of the powers of the Compact Commission is that it shall "have power to recommend to the states...the stocking of the waters of such states with fish and fish eggs."

Legal basis: R.S.A., Chapter 213, Laws of 1955.

(b) New England Interstate Water Pollution Compact

New Hampshire participates in regional planning for water pollution control through its membership in the New England Interstate Water Pollution Control Commission, initiated by the New England Interstate Water Pollution Control Compact approved by an act of Congress in 1947, and ratified by all seven state legislatures by 1955. The Commission aims toward a sound and equitable solution to pollution control problems through a coordinated interstate program. Because all the major river basins in New Hampshire - the Connecticut, Merrimack, Androscoggin, and Saco - are interstate drainage basins, this program is of importance to the State.

The main function of the Commission is the approval of classifications for the interstate, inland, and tidal waters of the seven-state Compact area (the six New England States plus New York State). This classification system, much the same as New Hampshire's system, permits a balanced use of the area's waters to meet the various degrees of water quality required. Each of the seven states agreed to prepare classifications of its interstate waters according to present and proposed highest use, and to submit them to the Commission for approval.

A second part of the Commission's work has been a program of surveys, investigations, and research in connection with pollution abatement programs.

Legal basis: R.S.A. Chapter 488, Laws of 1955.

(c) New England River Basins Commission

The Commission was established under the authority of the Water Resources Planning Act by President Johnson on September 6, 1967, at the request of the New England Governors' Conference.

In accordance with Title II of the Water Resouces Planning Act the Commission shall:

(1) serve as the principal agency for the coordination of Federal, State, interstate, local and non-governmental plans for the development of water and related land resources in its river basin:

(2) prepare and keep up-to-date a comprehensive plan for public and private development of water and related resources:

(3) recommend long-range schedules for data collection, investigation, planning and construction of projects; and

(4) foster and undertake such studies of water and related land resources problems in its river basin as are necessary for preparation of the comprehensive plan.

New Hampshire Commission on Interstate Cooperation

The New Hampshire Commission on Interstate Cooperation has the following functions:

1. To carry forward the participation of New Hampshire as a member of the Council of State Governments.

2. To assist in establishing governmental machinery to facilitate cooperation between New Hampshire and other states, both regionally and nationally.

3. To endeavor to advance cooperation between New Hampshire and other units of government by means of adoption of compacts, enactment of reciprocal statutes, adoption of uniform administrative rules, and other methods of cooperation of government offices and officials.

Legal basis: R.S.A. Chapter 19, New Hampshire Laws of 1955.

STATE

(a) New Hampshire Department of Agriculture

The New Hampshire Department of Agriculture has the following functions:

1. Promote agriculture and the agricultural interests of New Hampshire.

2. Cooperate with extension work at the University of New Hampshire.

3. Gather, tabulate, and maintain a file of information pertaining to agriculture within the State.

4. Collect and publish information on the agricultural resources of the State and disseminate this data throughout the nation.

5. Investigate the control of insects and ragweed, and cooperate with town and regions to eliminate trouble areas.

6. Advocate supplemental irrigation to increase agricultural production.

Legal basis: R.S.A. Chapter 426, Laws of 1955.

(b) Department of Fish and Game

The Department of Fish and Game is involved in fish and game propagation and maintenance, surveys, technical assistance to other agencies and to individuals, protection of wildlife, habitat development, rescue and search parties, preservation of marshes, dam construction, stream and pond stocking, and eradication of rough fish species.

The Department constructs, operates, and maintains small water impoundments for the improvement of fish and game; cooperates with Federal and State agencies for water project planning and pollution abatement; reviews applications for water barriers; reclaims ponds and lakes; maintains water areas for the protection of water fowl; stocks waterways with fish; maintains migratory bird refuges; carries on studies of algae and other water growths; makes periodic surveys of most of the State's lakes and ponds, showing depth and bottom conditions; operates pheasant farms, fish hatcheries, and game refuges.

The Department also investigates needs for public access to water; advises on stream channel control to reduce sediment; cooperates with schools in teaching the children basic conservation and the safe use of firearms; makes available services of game biologists to owners and managers of forest properties; develops methods of opening up more private land to sportsmen; provides wildlife lecturers, films, educational assistance.

Legal basis: R.S.A. Chapter 206, Laws of 1955.

The Department, through the Public Works Division, serves as the construction agency for the Division of Parks, supplying construction crews and supervising the work of independent contractors for major developments within the parks. It also maintains the park roads.

A significant milestone in the evolution of public recreation and of the increasing importance of recreation is the Federal directive issued several years ago by the Bureau of Public Roads, U. S. Department of Commerce, which calls for a review of plans for Federal Aid Highway construction by representatives of the U. S. Forest Service, Wildlife Service, and the Fish and Game Department, as well as the Department of Public Works and Highway, in order to achieve a maximum coordination of public highway improvements with the requirements of fish and wildlife resources.

The Department has undertaken, also in cooperation with the other State agencies, a study of a scenic road system for New Hampshire, in accordance with a request from the Bureau of Public Roads.

Legal basis: For organization of Department - R.S.A. Chapters 228 and 229, Laws of 1955.

(c) Department of Resources and Economic Development

The Department of Resources and Economic Development was established in 1961 by the Legislature with the purpose of improving "the administration of state government by providing unified direction of policies, programs and personnel in the field of resources and economic development making possible increased efficiency and economies from integrated administration and operation of these related functions of the state government."

The Department, under the executive direction of a commissioner appointed by the Governor for a term of four years, consists of the Division of Resources Development; Division of Economic Development which includes the subdivisions of research and planning, industrial development, and promotion; and Division of Parks. The Water Resources Board and State Port Authority are a part of the Department for housekeeping administrative purposes only.

A commission that is advisory to the Commissioner consists of seven members and is appointed by the Governor. The commission's duties are to "consult with and advise the Commissioner of Resources and Development with respect to the policy, programs and operations of the department upon a continuing basis."

Legal basis: Chapter 223, Laws of 1961.

(d) Division of Resources Development (Forestry Division)

The Division of Resources Development manages the State Forest lands by a multiple-use plan. Elements of this management plan include timber production, wildlife management, watershed protection, insect and disease control, fire control, and forest demonstration areas.

The Division cooperates closely with the Division of Parks in State Parks where land is deivided into recreational and timber production zones.

The Division is responsible for the overall prevention and control of forest and brush fires throughout the State except within the boundaries of the White Mountain National Forest. The Division, upon request, can cooperate with counties, towns, corporations, and individuals in preparing plans for the protection and management of trees, woodlots, and timber tracts. The Division carries on a forest pest and disease research and control program in the State.

Legal basis: R.S.A. Chapters 216 through 226, Laws of 1955; and Chapter 223, Laws of 1963.

(e) Division of Parks

The Division of Parks is responsible by State statute for the design, development, administration, operation and maintenance of the recreational facilities in State public areas of recreational significance, to wit:

1. The Division of Parks will preserve and develop unusual scenic, scientific, historical, and recreational areas and facilities within the State;

2. The Division will develop these areas and facilities for public recreational, educational, scientific, and related uses;

3. The Division will expand the facilities within the present system of State Parks, historic sites, wayside areas and scientific areas to achieve and derive maximum increase in value of these facilities as tourist attractions, in relation to the growing needs for such facilities;

4. The Division will give equal consideration to the recreational needs of all sections of the State;

5. The Division will develop the present parks and facilities thereon to their optimum capacity for skiing, camping, and other income-producing activities;

6. The Division will develop any other lands and facilities that the State now owns for optimum recreational potential; and

7. The Division will acquire new areas and facilities believed to have sound potential for development, use, and operation as State Parks, historic sites, or wayside areas.

The Division of Parks cooperates with the Department of Fish and Game in the management of State Park lands which have fish or wildlife production potential.

The Division of Parks also cooperates with the Water Resources Board, the Division of Resources Development (Forestry), and the Department of Public Works and Highways in the maintenance of dams, in forest management practices, and in the development of park facilities, respectively.

Legal basis: R.S.A. Chapters 216 and 218, Laws of 1955; and Chapter 223, Laws of 1963.

(f) Division of Economic Development
Office of Planning and Research

The Office of Planning and Research is the central planning agency of the State and is responsible for the collection, compilation, and analysis of data bearing upon industrial, commercial, social, and physical factors which influence the present and future welfare of the State, its economic well-being, and the conservation of its natural resources.

The Office conducts special studies, administers Federal planning grants on the state, regional, and local levels, coordinates the planning functions of the Federal, state, and local resource agencies, and gives assistance to public, quasi-public, and private agencies and individuals involved in resource planning and research.

Legal basis: R.S.A. Chapter 12, Laws of 1955; and Chapter 223, Laws of 1963.

(g) Office of State Geologist

The Office of State Geologist was established in 1967 by the State Legislature to have the following duties:

1. To collect and distribute geologic mineralogic information;

2. To coordinate cooperative projects with U. S. Geological Survey and other agencies;

3. To research the geology and mineral resources of the state;

4. To serve as editor of state geologic publications;

5. To make studies related to geology of the State;

6. To cooperate with federal agencies in collecting data on geologic activity and mineral industries; and

7. To assist in educational programs in geology and mineral resources at state educational institutions and public school.

Legal basis: Chapter 96, Laws of 1967.

(h) New Hampshire Council of Resources and Development

The Council was formed to coordinate the activities of State agencies concerned with the State's natural resources.

"The Council shall consult upon common problems in the field of natural resources and their development; consult with, negotiate with and obtain information from any federal or state agency that may or could be involved or concerned with any of its problems, reports, recommendations or studies; make such reports and recommendations as may be desirable in its opinion to the governor and council; and, subject to the approval of the board, commission or commissioner of the agency or department affected, make such studies and recommendations upon its own initiative, or upon request, to the general court concerning such changes as it may deem advisable to coordinate effectively the work of the agencies which have membership in the council. Its decisions shall be advisory only."

The Council is composed of the head of each of the following State agencies: Department of Agriculture, Department of Education, Fish and Game Commission, Department of Public Works and Highways, Water Pollution Commission,

Water Resources Board, Department of Resources and Economic Development, Division of Economic Development, Division of Resources, and Division of State Parks. The Director of the Office of Planning and Research serves as the permanent chairman.

Legal basis: Chapter 212, Laws of 1965.

(i) Public Utilities Commission

The Public Utilities Commission has the power and duty "to keep informed as to all public utilities in the state, their capitalization, franchises and the manner in which the lines and property controlled or operated by them are managed and operated, not only with respect to the safety, adequacy and accommodation offered by their service, but also with respect to their compliance with all provisions of law, orders of the commission and charter requirements." (R.S.A. Chapter 374:4). The utilities covered by the Commission include those for electricity, gas, steam, telephone, telegraph, water, municipal utilities, railroads, express, street railways, toll roads and toll bridges, motor vehicles (carriers of passengers and common and contract carriers of property), and carriers by water.

Legal basis: R.S.A. Chapters 362 through 382, Laws of 1955.

(j) State Conservation Committee

The State Conservation Committee was established to serve as an agency of the State. It has nine members - four State agency heads and five others appointed by the Governor. The Committee serves without compensation and has the following duties:

1. To offer assistance to the supervisors of the Soil Conservation Districts of the State in formulating and carrying out any of their programs;

2. To keep the supervisors of each District informed of the activities of all other Districts, and to facilitate an interchange of advice, experience, and cooperation among such Districts;

3. To coordinate the programs of the several Districts so far as they may be done by advice and consultation.

4. To seek the cooperation, and technical and financial assistance of the United States, of this State, and of town and county governments, in the work of such Districts;

5. To keep the public informed throughout the State, concerning the activities and programs of the Districts; and

6. To establish satisfactory cooperative arrangements and to avoid duplication between the Districts and other federal, state, or county agencies which have similar responsibilities.

Legal basis: Chapter 366, Laws of 1967.

(k) Water Resources Board

The New Hampshire Water Resources Board is concerned primarily with conservation of State water resources and the regulation of stream flows.

A major responsibility of the Water Resources Board is flood control and protecting riverbank property from water damage. To carry out this responsibility, the Board cooperates with the U. S. Army, Corps of Engineers, and the Soil Conservation Service in their respective flood control programs. The Board is required to approve all water resource projects contemplated for New Hampshire and to provide technical advice in both the planning and construction states of such projects.

The Board supervises and, in some cases, assumes ownership of all dams and dam sites in New Hampshire. Those dams which have become State property are maintained and improved by the Water Resources Board. The Board is authorized to investigate facilities for hydroelectric power on the State's streams.

With the objective of regulating the flow of streams, the Board constructs and operates conservation reservoirs, which may be released when stream flow downstream reaches a certain minimum flow. Control of stream flow is important for diluting sewage and other wastes, and for fish and wildlife uses.

The provision of recreation facilities at Water Resources Board installations is only incidental to its primary goals; however, the Board allows the public to gain access to the water at most of its damsites.

The Water Resources Board is responsible for investigating and considering requests for permits to dredge and/or fill in the public waters of the State under Chapters 307 and 274, Laws of 1967.

Legal basis: R.S.A. Chapters 481 and 482, Laws of 1955.

(1) Water Supply and Pollution Control Commission
Pollution Control Activities

Authority to control industrial, municipal, and private sources of water pollution in the State of New Hampshire is vested in the State Water Supply and Pollution Control Commission. The Commission, acting under New Hampshire Water Pollution Control laws and through the courts, may exercise this authority by enforcement of established legislative classifications of surface waters and of recently passed legislation controlling sewage disposal systems near shorelines.

New Hampshire has had a comprehensive program on water pollution control since 1947, when the Legislature first established the Water Pollution Commission and its program. In the 1967 Session of the Legislature the Commission's duties were expanded and its title changed to "New Hampshire Water Supply and Pollution Control Commission."

The powers and duties of the agency may be summarized as follows:

1) To study and investigate all problems connected with the pollution of the surface waters of the state;

2) To conduct scientific investigations and research on the elimination of various types of pollution;

3) To cooperate with other public or private agencies in the conduct of such investigations and research.

4) To perform all necessary work relative to classification of state surface waters;

5) To require filing of plans and specifications for wastewater treatment plants;

6) To investigate and consider all requests for permission to subdivide land near any shoreline, or to construct sewage or waste disposal systems on any land bordering on the surface waters of the state and/or within one thousand feet of the water line at maximum water line elevation;

7) To investigate and approve applications for state and federal aid for the construction of municipal pollution abatement projects;

8) To work with other states to eliminate pollution of interstate waters; and

9) To employ personnel and purchase necessary equipment.

Legal basis: Chapter 147, Laws of 1967.

(m) Water Supply Activities

The Sanitary Engineering Division of the Water Supply and Pollution Control Commission is responsible for the protection of sources of water and ice.

The following are the Division's main activities:

1) "The Commission is empowered to investigate the sanitary conditions and methods pertaining to the source, treatment, and distribution of all public water supplies[1] for the domestic use, and to require the application of any treatment or improvement in conditions and methods as it may deem necessary to insure fitness and safety and adequate protection of the public health." (R.S.A. 148:22).

Any person constructing a new public water supply system or enlarging any existing system must submit plans for the proposed construction to the Water Supply and Pollution Control Commission.

2) The Division regulates the cutting of ice used as a source of a public water supply for domestic purposes for man.

3) The Water Supply and Pollution Control Commission is authorized to study the probable domestic water supply requirements of groups of towns and/or cities which appear likely to have increased industrial and population growths for the next fifty years. The Commission shall find out the most feasible and economic sites for sources of water supply for such long-range planning. (R.S.A. 148-A)

Legal basis: R.S.A. Chapter 148.

1. A public water supply system, by law, is any such system that accommodates thirty or more people, including not only municipality systems but also institutions, subdivisions, etc.

(n) University of New Hampshire - Agricultural Experiment Station

The State Agricultural Experiment Stations conduct research and gather information relating to land use, farm characteristics, population, and zoning, as well as a wide range of physical and biological data useful for planning and developing recreation enterprises. The stations, in cooperation with the National Agricultural Experiment

Station, are now carrying out or are planning a number of studies bearing directly on the use of human, land , and water resources for recreation. These include surveys of recreation facilities and services on farms and potentials for further development, demands of urban residents for outdoor recreation, and sports (swimming, skiing, and so on) and indoor recreational activities (bowling, crafts, arts, and the like).

(o) Water Resources Research Center

In July, 1964, the Governor of the State of New Hampshire designated the University of New Hampshire as the educational institution at which a Water Resource Research Center would be located in New Hampshire. The Center was authorized by the Water Resources Research Act of 1964, Public Law 88-379, July 17, 1964, as amended by Public Law 89-404, April 19, 1966, which authorized State Water Resources Research Centers in each of the fifty states and Puerto Rico.

The Center was established to plan and coordinate water resource research and graduate training in water resource research in the colleges and departments of the University. It also provides the mechanism for cooperation in water resources research with other research institutes and agencies throughout the State. In May, 1967, ten research projects projects were underway though funds provided under Public Law 88-379.

(3) Political Subdivisions

Soil and Water Conservation Districts

The Districts, one for each of ten New Hampshire Counties, are organized under the provisions of Chapter 366 of the laws of 1967. The governing body of each of the districts consists of five supervisors (who shall be land occupiers in the district) appointed by the State Conservation Committee. The supervisors receive no compensation for their services except expenses.

The Districts do not have any funds to do the jobs listed below, but serve in an advisory capacity and work with federal agencies who plan and carry out the projects.

The Districts have the following powers:

1. To conduct research relating to soil erosion, floodwater, sediment damages, land drainage, and the conservation and development of natural resources;

2. To conduct demonstration projects within the district on publicly or privately owned lands in order to demonstrate conservation and development methods;

3. To carry out preventative and improvement measures for the conservation and development of the soil, water, and related natural resources within the district;

4. To cooperate or enter into agreements with any agency or occupier of lands within the district in carrying out erosion control, flood prevention, drainage, watershed protection, and resource conservation and development projects or other works of improvements for the natural resources within the district;

5. To acquire, maintain, and sell property, real or personal, in carrying out the provisions of the law establishing the districts;

6. To make available to land occupiers within the district agricultural machinery, fertilizer, seeds, and other material as will assist such land occupiers in conservation projects upon their lands;

7. To construct and maintain structures as may be necessary under the law establishing the district;

8. To develop comprehensive plans for changes in land use, control and prevention of soil erosion, land drainage, and prevention of flood-water and sediment damages within the district; and

9. To take over by purchase, lease, or otherwise and administer any works of improvement for the conservation and development of soil, water, and related natural resources.

State of Maine

The organization in Maine which has jurisdiction on water pollution and water related sources is:

Maine Environmental Improvement Commission, an element of the Maine Department of Environmental Protection, under the following authority: State of Maine Legislative Document No. 1831, dated 11 June 1971

ENVIRONMENTAL PROTECTION

Chapter 425

There is created and established a Department of Environmental Protection, hereinafter called "the department", to protect and improve the quality of our natural environment and the resources which constitute it, and to improve the public's opportunity to enjoy and exist healthily in the environment, by controlling the man-made despoliation of our resources and directing growth and development along planned lines which will preserve for all time an ecologically sound and aesthetically pleasing balance of naturally occurring resources, to consist of a Commissioner of Environmental Protection appointed by the Governor with the advice and consent of the Council to serve at the pleasure of the Governor and Council, and the following as heretofore created and established: The Environmental Improvement Comission, the Board of Pesticides Control, the Wetlands Control Board, the Maine Mining Commission, the Maine Land-use Regulation Commission, the Pest Control Compact Adminstrator, the Board of Certification of Water Treatment Plant Operators, the New England Interstate Water Pollution Control Commission, and the Division of Sanitary Engineering of the Department of Health and Welfare.

Section 2. Organization. The Joint Select Special Committee of the Legislature on Governmental Reorganization, with the assistance of the commissioner, shall prepare a plan of organization of the department into such bureaus, divisions and sections as may be necessary to carry out effeciently the work of the department. The committee, with the assistance of the commissioner, shall prepare legislation to be presented to a special session of the 105th Legislature to amne, repeal and re-arrange statutes to reflect this department's powers, responsibilities and organization.

Directors of bureaus shall be appointed by the Governor, with the advice and consent of the Council, to serve at the pleasure of the Governor and Council.

The commissioner shall prepare a budget for the department in accordance with the Revised Statutes, Title 5, chapter 149.

The commissioner and the Joint Select Special Commitee of the Legislature on Governmental Reorganization may recomment the legislation for the transfer from or to another state deparment such functions as would appear to properly belong to the other department or to his departmant. The commissioner shall have no power or duties relative to the proposed department except those listed in this section.

Section 3. Effective date. This Act shall become effective 91 days after adjournment of the Legislature.

Note: The all Land Scheme No. 4, as described in Appendix III, proposes the use of certain land areas in Maine for irrigation and renovating waters from the Lowell-Lawrence-Haverhill area, therefore, the Maine Environmental Improvement Commission is listed above.

Cooperation and Coordination

a. The State of New Hampshire has a policy of close cooperation with the Federal Government in management of its water related land resources. The Water Resources Board maintains close contact with the U.S. Army, Corps of Engineers, U.S. Soil Conservation Service, and U.S. Geological Survey, Hydrologic Branch. The Water Supply and Pollution Control Commission coordinates with the Department of Health, Education, and Welfare, and such sub-agencies as the Federal Water Pollution Control Adminstration. Other State agencies maintain similar contacts on water resources matters. The Council of Resources and Development and the Office of Planning and Research maintain overall coordination among Federal and State efforts on water and related land resources matters in the best interests of the people of the State.

Further coordination is provided through the Office of the Governor, to whom the water resources agencies of the Federal Government submit requests for State approval for projects, and State cooperation in studies. The Governor, in turn, obtains the cooperation of the concerned State agencies for the projects.

The State also maintains contact with private industry and commercial enterprises which are involved in plans and projects for the State's waters and related lands.

Close coordination with these interests is especially necessary in the development of projects on our streams for private company hydroelectric installations and for major industries which use streams as coolants, to carry off wastes, or to generate power, for optimum use of this resource.

Coordination of the State of New Hampshire Water Resource Agency's

efforts with those in adjoining states is achieved both on an individual agency level and also through membership in several New England-wide organizations. These organizations include the New England Governor's Conference, the New England Regional Commission, the New England River Basins Commission, and interstate compact organizations that are cited in the Section on Administrative Structure.

b. In Massachusetts the enabling legislation creating the Water Resources Commission and the Division of Water Resources in 1956, placed heavy emphasis on the role of this agency in coordinating all the state and federal programs which have an impact on Water Resources. The commission remains the state's primary contact with the Corps of Engineers and U.S. Soil Conservation Service during all stages of the planning development and operation of their various water management programs.

The Water Resources Commission, through the Division of Water Pollution Control works cooperatively with the Federal Water Pollution Control Administration in the Department of the Interior to abate water pollution under the pertinent State and Federal Statutes.

The Massachusetts Department of Public Health cooperates with the U.S. Public Health Service in a program of water supply protection and the suppression of water-bourne diseases.

The Commonwealth by statute is pledged to a program of interstate cooperation. By virtue of special acts of the legislature, Massachusetts, through the Water Resources Commission, is represented on interstate river valley flood control commissions for the Thames, Connecticut, and Merrimack Rivers.

The New England Interstate Water Pollution Control Commission was

an active organization before the passage of strong federal pollution abatement legislation. This organization, which includes the New England states and New York, continues its cooperative program.

Interstate cooperation in studying water resource problems will undoubtedly grow as the New England River Basins Commission develops its planning program as authorized by the Water Resources Planning Act. Other Studies with Federal impetus that have fostered interstate cooperation include the Northeast Water Supply (NEWS), the North Atlantic Regional Water Resources Study (NAR), and the New England-New York Inter-Agency Committee (NENYIAC).

Listed below are some of the primary federal and applicable state laws on pollution abatement.

a. Federal

Public Health Service Drinking Water Standards

Water Pollution Control Act of 1956

Federal Water Quality Act of 1965 (PL 88-234)

Federal Clean Water Restoration Act of 1966

Executive Order 11507 dated February 4, 1970

Refuse Act of 1899

b. Commonwealth of Massachusetts

Massachusetts Clean Waters Act of 1966

Water Quality Standards (March 3, 1967)

c. State of New Hampshire

Senate Bill No. 83, dated 1967, providing for the classification of certain surface waters of the State.

Water Quality Act of 1965

House Bill Number 111

d. State of Maine

Legislative Document No 1831, dated June 11, 1971

L. CURRENT POLLUTION ABATEMENT OPERATIONS AND IMPLEMENTATION PROGRAMS:

The present status of the pollution abatement of discharges to the Merrimack River and certain tributaries in Massachusetts and New Hampshire is included in the following Tables 24 and 25 of this section.

Although some of the towns and industries are not within the areas of this feasibility study, the polluters and status outside the areas are being retained for information purposes only.

1. Massachusetts Implementations Schedule:

(Table No. 24)

TABLE NO. 24

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construct
Municipal Acton - Sanitary	Subsurface Disposal		N/A	N/A	N/A	N/A
Municipal Amesbury - Sanitary	None	Secondary	Completed 11/69	7/71	9/71	12/72
Amesbury Speciality Co. Amesbury -	Moved to Newburyport		N/A	N/A	N/A	N/A
Amesbury Metal Prod. Amesbury -	None	Moving to new location 12/70	N/A	N/A	N/A	N/A
E. G. and G. Formerly Startronics Amesbury -	None	Secondary	N/A	12/70	3/71	7/71
Micro Fab Amesbury -	None	Secondary	N/A	12/70	2/71	6/71
Brazonics Amesbury -	None	Secondary	N/A	11/70	1/71	8/71
Amesbury Tanning Co. Amesbury -	None	Secondary	N/A	Approved 5/70	Const. started 5/70	11/70
Bailey Co. Amesbury -	None	Subsurface Disposal	N/A	Approved 7/70	7/70	4/71

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construct
Municipal Andover - Sanitary	Part None Part Secondary	Part of GLSD	N/A	N/A	N/A	N/A
Reichold Chemical Andover -	Sanitary connected to munic. system Industrial secondary		N/A	Completed	Completed	Completed 10/70
Municipal Andover (Ballardville) - Sanitary	To Be Abandoned in 1975		N/A	N/A	N/A	N/A
Municipal Ayer - Sanitary	Secondary	Add Cl_2	N/A	Completed 10/69	Completed 5/70	1/71
Nyanza Chemical Ashland	Connected to Munic. System			Completed 7/68	Completed 8/68	Completed 1/69
Municipal Billerica - Sanitary	Secondary + Cl_2	Interceptor	Completed 9/68	Completed	Completed	Completed 5/70
Corenco Corp (Lowell Rendering) Billerica -	Grease Recovery	Secondary	N/A	3/71	5/71	5/72
No. Billerica Co. Billerica	None	Tie to Municipal	N/A	3/71	5/71	5/72
Treble Cove Shopping Center Billerica -	Inadequate Subsurface	Sub-surface disposal	N/A	Completed 5/70	3/71	5/71

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Constructic
RCA Burlington -	None	Tie to Municipal	N/A	12/70	1/71	5/71
Municipal Chelmsford - Sanitary	None	Secondary	Completed 9/68	Completed 9/70	3/71	3/73
Municipal Chelmsford Center - Sanitary	None	Secondary	3/72	3/73	9/73	4/75
Southwell Combing Chelmsford - Scouring	Grease Recovery	Pre-treat Tie to Munic. when available	N/A	2/69	4/69	4/70
Gilet Wool Scouring Chelmsford - Wool Scouring	None	" "	N/A	2/69	4/69	4/70
Municipal Clinton - Sanitary	Secondary	Add Cl_2	Awaiting opinion of AGO			
Municipal Concord - Sanitary	Secondary $+Cl_2$		N/A	N/A	N/A	Completed
Municipal Dracut - Sanitary	None	Secondary	4/71	6/72	9/72	11/74
J. P. Stevens Dracut -	None	Out of business February 1, 1971				
Municipal Fitchburg East Plant - Sanitary	Inadequate Secondary	Secondary	Completed 6/69	4/71	7/71	9/73

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
Municipal Fitchburg West Plant - Sanitary	None	Secondary	Completed 6/69	4/71	7/71	9/73
Fitchburg Gas and Light Fitchburg -	None	Connect to Munic. System when available		Approved 5/70	4/70	4/72
Berkey Photo Service Inc (Art Photo Service Inc.) Fitchburg -	None	Pretreat and connect to Munic. System	N/A	The company has received a demon. grant. 3/70	4/70	4/71
Great American Chemical Fitchburg	None	Secondary	N/A	10/70	12/70	4/71
Vogue Wall Cov. Fitchburg -	None	To Municipal System	Behind schedule due to consulting engineer. Final plans will be submitted 4/71. N/A	12/69	4/70	4/71
Simonds Saw and Steel Fitchburg -	None	To Municipal System	Report and plans have been completed. Co. will connect to the munic. system when available.			
Fitchburg Paper Co. Fitchburg - Paper	None	To Municipal System when available.	N/A	4/71	7/71	9/73
Falulah Paper Fitchburg - Paper	Out of Business		N/A	N/A	N/A	N/A
Iver Johnson Arms and Cycle Works Fitchburg -	None	No longer polluting 10/70	N/A	N/A	N/A	N/A

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
Jennison Co. Fitchburg -	None	To Municipal System	N/A	3/69	4/69	10/69
Independent Lock Co. Fitchburg -	None	Secondary	Report & plans under review by DWPC	2/70	4/70	6/71
Seth Thomas Fitchburg	None	Secondary	N/A	Completed 12/69	Completed 4/70	Completed 10/70
Weyerhauser Paper Co. Fitchburg - Paper	None	To Municipal System	N/A	Completed 3/68	7/71	9/73
Wachusett Potato Chip Fitchburg -	None	Secondary	N/A	12/70	12/70	3/71
Municipal Framingham - Sanitary	M.D.C.	Pumping Station	Completed 4/68	1/70	10/70	12/71
Municipal Framingham - Beaver Brook Interceptor	None	Connect to MDC		6/70	11/70	7/71
Roxbury Carpet Framingham -	None	Tie to Municipal	N/A	11/70	4/71	12/71
General Motors Framingham	None	Tie to Municipal	N/A	Completed 7/68	Completed 8/68	Completed 4/69

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
Municipal Greater Lawrence S D Project #1 - Sanitary	None	Secondary	6/70	3/72	9/72	3/75
Municipal Greater Lawrence S D Project #2 - Sanitary	None	Interceptors	6/70	3/72	3/74	3/76
Municipal Groveland - Sanitary	None	Tie to Haverhill	Completed 3/70	12/69	3/70	3/71
Groton Leather Board Groton -	None	Secondary	N/A	2/71	4/71	12/71
Hollingworth and Vose Groton -	Settling	Secondary	N/A	Completed 10/70	2/71	2/72
Municipal Haverhill Project #1 - Sanitary	None	Secondary	Completed 4/70	6/71	10/71	6/73
Municipal Haverhill Project #2 - Sanitary	None	Interceptor	Completed 3/70	6/72	10/72	10/73
L. Hamel Leather Co. Haverhill -	None	Secondary	N/A	12/71	3/72	12/72

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
Continental Can Co. Haverhill -	None	To Municipal System when available	N/A	3/69	7/69	7/70
Cowan and Shain Inc Haverhill -	None	To Municipal System when available	N/A	3/69	7/69	7/70
Gare Ceramics Haverhill -	None	To Municipal System when available	N/A	4/69	5/69	6/69
CF Jameson Haverhill -	None	To Municipal System when available	N/A	3/69	7/69	7/70
Hoyt and Worthern Tanning Co. Haverhill -	Grease and Oil Recovery	To Municipal System	N/A	12/70	3/71	4/71
Haverhill Plating Haverhill -	None	To Municipal System	N/A	Completed 3/69	Completed 7/69	Completed 7/70
Municipal Hopkinton - Sanitary	None	To prepare preliminary report and plans for agency approval by 12/71, Future dates will be established upon approval if necessary.				
Municipal Hudson - Sanitary	Secondary + Cl_2	Pumping Station	9/68	Completed 2/69	12/70	7/71
Atlantic Union College Lancaster - Sanitary	Part Primary Part Secondary	Secondary	Received permission to join the Lancaster Sewer District which was recently created by a legislative act.			

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth to Massachusetts

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
Municipal Lawrence - Sanitary Project #1	None	Part of GLSD	N/A	N/A	N/A	N/A
Municipal Lawrence - Sanitary Project #2	None	Part of GLSD	N/A	N/A	N/A	N/A
Merrimack Paper Co. Lawrence - Paper	None	Tie to Municipal	The following companies are dependant upon the GLSD. To date the district has completed a preliminary report and plan and have appropriated funds for final plans, and is moving ahead to the satisfaction of the Division. Industries adjacent to the sewer line will have interceptors constructed under phase I; those adjacent to phase II will have phase II dates.			
Mead Corp. Lawrence - Paper	None	Tie to Municipal				
Lawrence Wool Scouring Lawrence - Wool Scouring	Grease Recovery	Tie to Municipal				
Agawam Dye Works Lawrence - Dyeing	None	Tie to Municipal				
Oxford Paper Co. Lawrence - Paper	None	Tie to Municipal				
Municipal Leominster - Sanitary	Secondary	Secondary	In process of enlarging existing facilities with Cl_2 on a voluntary basis to accommodate the two industries Foster Grant and Borden Chemical.			
Foster Grant Leominster -	Lagoon	Secondary		Completed 11/68	Completed 3/69	Completed 12/69

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
Vertipile Inc. Lowell _	Centrifuges	To Municipal System when avail.	N/A	N/A	6/71	6/73
Suffolk Knitting Co. Lowell -	None	To Municipal System when avail.	N/A	N/A	6/71	6/73
Robinson Top and Yarn Dye Lowell -	None	To Municipal System when avail.	N/A	N/A	6/71	6/73
Pellon Corp. Lowell -	None	To Municipal System when avail.	N/A	N/A	6/71	6/73
Middlesex Worsted Spinning Co. Inc. Lowell -	None	To Municipal System when avail.	N/A	N/A	6/71	6/73
Jean Alan Products Lowell -	None	To Municipal System when avail.	N/A	N/A	6/71	6/73
Conant Houghton (United Elastic) Lowell -	None	To Municipal System when avail.	N/A	N/A	6/71	6/73
Vogue Silver Lowell -	None	Insignificant Waste	N/A	N/A	N/A	N/A
Lawrence Mfg. Co. Lowell -	None	To Municipal System when avail.	N/A	N/A	6/71	6/73

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
Borden Chemical Inc. Leominster -	Lagoons	Secondary		Completed 6/69	Completed 7/69	Completed 7/70
Paragon Plastics Leominster -	Has undertaken a sampling program and when this is completed, the Division will issue additional dates for completion of their pollution abatement program.					
Mass Metalizing Leominster -	Going out of business 12/70					
New England Apple Products Littleton -	Subsurface Disposal		N/A	Completed 6/69	Completed 10/69	Completed 3/70
Municipal Lowell - Sanitary Project #1	None	Secondary	Completed 7/69	1/71	4/71	4/73
Municipal Lowell - Sanitary Project #2		Interceptor	1/72	11/73	4/73	4/75
Commadore Foods Co. Lowell -	None	To Municipal System	N/A	N/A	6/71	6/73
Byfield Felting Lowell -	None	To Municipal System	N/A	N/A	6/71	6/73
Ames Textile Lowell - Textile	None	To Municipal System	N/A	N/A	6/71	6/73

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
Raytheon Lowell -	None	Secondary	N/A	11/70	4/71	9/71
Roger Bros. Lunenburg	None	To relocate in 1971	N/A	N/A	N/A	N/A
Municipal Marlborough - Sanitary East Section	Secondary + Cl_2	Phosphate Removal	Awaiting submission of pilot plant studies. Dates will be established when study has been received.			
Municipal Marlborough - Sanitary West Section	Secondary + Cl_2		Completed 2/68	Completed 7/68	Completed 9/68	Completed 10/69
Municipal Maynard - Sanitary	Inadequate Secondary	Secondary	Completed 3/69	2/70	4/70	4/71
Digital Equipment Co. Maynard -	Tied to Maynard	None	N/A	N/A	N/A	N/A
Municipal Merrimac - Sanitary	None	Secondary	Completed 2/70	1/72	4/72	1/74
Merrimac Metal Finishing Merrimac -	Orders to be issued.					
Municipal Methuen - Project #1	None	Part of GLSD	N/A	N/A	N/A	N/A

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
Municipal Methuen - Project #2	None	Part of GLSD	N/A	N/A	N/A	N/A
Essex Chrome Plating Co. Methuen -	None	Secondary	N/A	1/69	4/69	4/71
Municipal Newburyport - Sanitary	Primary + Cl_2	Secondary		2/71	4/71	4/72
Chase Shawmut Co. Newburyport -	Tied to Munic. System		N/A	Completed 2/69	Completed 11/69	Completed 5/70
Towle Silversmith Newburyport -	None	Secondary	N/A	2/71	4/71	7/71
Municipal North Andover - Sanitary	None	Part of GLSD	N/A	N/A	N/A	N/A
Western Electric Company North Andover - Sanitary & Plating	Neutralization Secondary		N/A	Completed 1/69	Completed 3/69	Completed 3/70
Wipex Inc. North Andover -	None	Out of business	N/A	N/A	N/A	N/A
Butcher Boy Steak House North Andover	Inadequate Subsurface	Subsurface or to Municipal System		Completed 6/70		10/69

Court action pending

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
Municipal Northborough - Sanitary	None	To Marlborough WPCF	Negotiating with the town of Marlborough.			
Machinery Electrification Northborough -	None	To Municipal System	N/A	3/73	5/73	5/74
Lawrence Candle Co. Northborough -	None	To Municipal System	N/A	3/73	5/73	5/74
Municipal Pepperell - Sanitary	None	Secondary	4/70	2/71	5/71	6/72
St. Regis Paper Pepperell - Paper	None	Secondary	N/A	12/70	3/71	11/71
Bemis Co. Inc. Pepperell -	None	Secondary Engaged engineer, have requested an extension for final plan submission.	N/A	3/70	5/70	5/71
Municipal Salisbury Salisbury Center - Sanitary	None	Secondary or Ocean Discharge	3/70	2/71	4/71	4/72
Salisbury Water Co. Salisbury -	None	To Municipal System when avail.				
Allen Drive Subdivision Salisbury -	Subsurface Disposal		N/A	Completed 6/69	Completed 8/69	Completed 10/69

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
Municipal Shrewsbury -	Secondary + Cl_2		N/A	N/A	N/A	Completed
Municipal Sudbury -	Subsurface Disposal		N/A	N/A	N/A	N/A
State Hospital Tewksbury - Sanitary	Secondary + Cl_2		Adequate facilities			
Liquid Carbonics Tewksbury -	Subsurface Disposal		N/A	N/A	Completed 6/70	Completed 8/70
Coin Operated Laundry Tewksbury -	No longer polluting		N/A	N/A	N/A	N/A
Municipal Tyngsborough - Sanitary	None	Subsurface Disposal		12/70	4/71	4/72
Notre Dame Academy Tyngsborough -	Inadequate Secondary	Secondary	N/A	Completed	Completed	5/71
Advance Coating Inc. Westminster -	Secondary		N/A	Completed	Completed	Completed
Decotone Products Div. (Fitchburg Paper Co.) Westminster -	Subsurface Disposal Completed		N/A	Completed 12/69	Completed 4/70	Completed 10/70

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN MASSACHUSETTS
(As submitted by the Commonwealth of Massachusetts)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
Old Mill Restaurant Westminster -	None	Secondary	N/A	11/70	2/71	4/71
Municipal Westborough - Sanitary	Inadequate Secondary	Secondary	N/A	N/A	Completed 7/68	6/69
Nabnasset Laundry Westford -	No longer polluting		N/A	N/A	N/A	N/A

TABLE NO. 25

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN NEW HAMPSHIRE
(As submitted for the record by the State of New Hampshire)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construct
Municipal Boscawen - Sanitary	None	To No. Concord System	6/71	6/70	6/71	12/73
Municipal Concord North - Sanitary	None	Primary & Secondary	6/71	10/70	6/71	12/73
Municipal Concord South - Sanitary	None	Secondary	3/73	12/71	4/73	12/73
Penacook Fibre Co. Concord	None	To No. Concord System	N.A.	N.A.	9/73	12/73
Brezner Tanning Corp. Concord	Tied to Munic. System	Pre-treat.	N.A.	N.A.	9/73	12/73
Municipal Derry - Sanitary	Secondary	Study under way for additions and alterations, if any, for anticipated growth, report due 6/71.				
Municipal Franklin - Sanitary	None	Secondary	12/70	7/69	4/71	4/72
J.P. Stevens Co. Franklin	Not in operation.					
Municipal Hooksett - Sanitary	Secondary	--				Completed 7/70
General Electric Co. Hooksett	Subsurface & Equalization	Adequacy of facility is under study to consider need, if any, to connect to Hooksett, report due 11/71.				
French Bros. Beef Co. Hooksett	Tied to Munic. System	--				Completed 7/70

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN NEW HAMPSHIRE
(As submitted for the record by the State of New Hampshire)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Constructi
Municipal Hudson - Sanitary	None	To Nashua System	Study is being made to consider connection to Nashua secondary water pollution control facility, report due 7/71.			9/72
Franconia Paper Co. Lincoln - Paper	Copeland Process completed. Plant not in operation.					
Municipal Manchester - Sanitary	None	Primary	2/72	11/71	4/72	12/73
Municipal Manchester - Sanitary	None	Secondary	2/74	11/71	4/74	12/75
Municipal Manchester - Sanitary	None	Interceptors	2/73	12/72	4/73	12/75
Manchester State Industrial School Manchester	None	To Munic. System	N.A.	N.A.	9/75	12/75
Waumbec Mills Manchester	None	To Munic. System	N.A.	N.A.	9/75	12/75
Stevens Spin Co. Manchester	None	To Munic. System	N.A.	N.A.	9/75	12/75
Seal Tanning Co. Manchester	None	To Munic. System	N.A.	N.A.	9/75	12/75

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN NEW HAMPSHIRE
(As submitted for the record by the State of New Hampshire).

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construction
M. Schwer Realty Manchester	None	To Munic. System	N.A.	N.A.	9/75	12/75
M.K.M. Knitting Co. Manchester	None	To Munic. System	N.A.	N.A.	9/75	12/75
Granite State Packing Co. Manchester	None	To Munic. System	N.A.	N.A.	9/75	12/75
Foster Grant Co. Manchester	None	To Munic. System	N.A.	N.A.	9/75	12/75
Municipal Merrimack - Sanitary	Secondary	Interceptors	4/70	1/71	3/71	9/72
New England Pole Merrimack	No longer discharging.					
Anheuser Busch Merrimack	Tied to Munic. System					Completed
N.H. Plating Co. Merrimack	None	To Munic. System	N.A.	N.A.	7/72	10/72
Merrimack Leather Co. Merrimack	None	To Munic. System	N.A.	N.A.	7/72	10/72
Municipal Nashua - Sanitary	Part Primary	Primary & Interceptors	10/71	9/70	12/71	12/74
Municipal Nashua - Sanitary	Part Primary	Secondary	7/73	4/73	11/73	12/75

DISCHARGES TO THE MERRIMACK RIVER AND CERTAIN TRIBUTARIES IN NEW HAMPSHIRE
(As submitted for the record by the State of New Hampshire)

Municipality or Industry Location - Type of Waste	Present Treatment	Proposed Treatment	Appropriation of Funds	Completion of Plans	Start Construction	Finish Construct
Sanders Associates (Canal St. plant) Nashua	None	To Munic. System	N.A.	N.A.	9/74	12/74
Johns-Manville Nashua	Settling	To Munic. System	N.A.	N.A.	9/74	12/74
Ferrerflex Co. (Pine St. extension) Nashua	Moved to other plant which is connected to munic. system.		N.A.	N.A.	N.A.	N.A.
Brown Products, Inc. Nashua	None	To Munic. System	N.A.	N.A.	9/74	12/74
Granite State Tanning Corp. Nashua	Settling	To Munic. System	N.A.	N.A.	9/74	12/74
Sprague Electric Co. Nashua	None	To Munic. System	N.A.	N.A.	9/74	12/74
Hampshire Chemical Nashua	Domestic wastes connected to municipal system. Chemical wastes treated on site with no discharge.					
Municipal Plymouth - Sanitary	Primary	Secondary	4/71	5/71	6/71	12/72
Municipal Salem - Sanitary	Secondary & Cl_2					Completed

In addition, it is also noted that numerous watershed associations, private individuals and other quasi-official committees have assisted and implemented wastewater management practices in the areas of study.

Summary of State Policies regarding Methods of Pollution Abatement is as follows for New Hampshire and Massachusetts:

New Hampshire - Chapter 149 of Laws relating to Water Supply and Pollution Control read, in part:

"POLICIES. It is hereby declared as a matter of legislative intent, that the water supply and pollution control commission in the enforcement of this and other legislation dealing with classification of the surface waters of the state shall adhere to the following policies:

I. Insofar as practicable, the initial objective of the control program will be to obtain the installation of primary treatment (with adequate disinfection where sewage discharges are involved) for all discharges of sewage and industrial wastes.

II. The second objective will be to require the installation of secondary treatment whenever such additional treatment is necessary to protect the uses assigned to the particular stream classification.

III. The third objective, after all stream classification requirements throughout the state have been satisfied, will be to continue the program of pollution abatement by installing other forms of treatment desirable to maintain all surface waters of the state in as clean a condition as possible, consistent with available assistance, funds and technological developments.

IV.--------"

Massachusetts - Certain general policies of the Division of Water Pollution Control read, in part:

Par. 2. "All waste sources on fresh waters will be required to be treated to the secondary level regardless of the stream classification assigned. Secondary treatment will generally refer to biological treatment as applicable and/or its industrial wastes treatment equivalent all as determined by the Division of Water Pollution Control. Secondary treatment efficiencies shall range from 80-90% BOD removal with correspondingly similar removals on other waste parameters,-------.

Par. 3. Tertiary treatment may be required where the estimated increased beneficial water uses can be shown to be economically justifiable.-----.

Par. 8. Where serious water quality control problems are the result of low dependable flows consideration will be given to the need for and value of storage for waters to be used for low flow augmentation, contingent upon the requirements of Section 39, of Chapter 685 of the Massachusetts Acts of 1966."

(Note: Section 39 allows the water resource commission to construct reservoirs for water supply and for low flow augmentation from the proceeds of bond issues authorized for water pollution control.)

M. CITIES/TOWNS WHICH UTILIZE THE MERRIMACK RIVER FOR DOMESTIC USE

For many years many towns have been considering the use of the Merrimack River as a source of domestic water, however, the pollution problem and the availability of other sources, have deferred the use of the stream which could satisfy the consumption requirements.

The cities and towns which presently utilize the river for domestic use and the approximate quantities consumed are as follows:

City/Town	Capacity(MGD) 1965	Stream Source
Lowell, Mass.	10.5	Merrimack River
Lawrence, Mass.	8.8	Merrimack River
Methuen, Mass. (Through the Lawrence System)	2.5	Merrimack River
Total	21.8 MGD	

It is noted that there are no withdrawals taken from the Merrimack River in New Hampshire for domestic purposes.

N. NAVIGATION ON THE RIVERS

Merrimack River

Commerce on the Merrimack River to Newburyport and points upstream has been declining for a number of years. At the present time only minor tonnages of fish, sand and gravel are transported on the river. Pleasure boating is found throughout the basin with the greatest concentrations at the upstream lake areas and in the more densely populated areas downstream on the river.

In 1899, enactment of law, provided for a channel seven feet deep to be dredged and maintained from the Newburyport highway bridge to the railroad bridge in Haverhill, Massachusetts, a distance of about 16.5 miles. The project was completed in 1907, and the last dredging maintenance was accomplished in 1939 when the channel was restored following the 1936 flood.

Winnipesaukee River

In 1879, at Lake Winnipesaukee, a project was initiated to provide a channel 3,000 feet long, 50 feet wide, and not less than 5 feet deep at the lowest known stage of the lake. The completed project afforded

an outlet from the lake to Paugus Bay at The Weirs in the City of Laconia, New Hampshire. Commercial traffic from Lake Winnipesaukee to Paugus Bay consists of scheduled trips of a mail and passenger boat which operates from the middle of May to the latter part of November. Other portions of the river are utilized for recreational boating.

North Branch Nashua River

The river is not navigable for commercial navigation, although it is utilized for recreational boating.

O. HYDROELECTRIC POWER AND NEEDS IN THE MERRIMACK RIVER BASIN.

In 1967 there were approximately thirty-one existing hydroelectric plants in the Merrimack River Basin, with an average annual output of about 73,000 KW. This quantity and number of plants indicated does not include numerous small private industrial plants with capacities of 125 KW or less.

Demands for electric power will continue to grow in the basin and future load projection growths show that by 1980 and 2000, the demand will increase by 160 and 700 percnet respectively.

Corps of Engineers studies indicate that none of the proposed multi-purpose projects, proposed hydroelectric power projects, and enlargement of existing hydroelectric power projects would be economically favorable at this time.

Although approximately 297 megawatts of generating capacity from all types of plants is produced in the basin, the major portion of power utilized comes from plants outside of the basin.

Table No. 26 indicates some of the hydroelectric power dams located in the basin.

TABLE NO. 26

LIST OF DAMS ON THE RIVERS:

Dams on the Merrimack River

River Mile	Location	Use
28.99*	Essex Dam, Lawrence, Mass.	Ind.
40.60	Pawtucket Dam, Lowell, Mass.	Ind.
73.14	Amoskeag Dam, Manchester, N. H.	Elec. Gen.
81.05	Hooksett Dam, Hooksett N. H.	Elec. Gen.
86.80	Garvin Falls Dam, Manchester, N. H.	Elec. Gen
97.83	Sewells Falls Dam, Concord, N. H.	

Dams on the North Nashua River

98.0*	Wheelwright Paper Co. Dam, Leominster, Mass.	Ind.
98.5	Dam, Leominster, Mass.	Ind.
100.8	Bemis Dam, Fitchburg, Mass.	Ind.
101.1	Duck Mill Dam, Fitchburg, Mass.	Ind.
101.4	Arden Mill Dam Fitchburg, Mass.	Ind.
101.9	Fitchburg G&E Co. Dam " "	Ind.
102.9	Rollstone Dam, " "	Ind.
104.1	Cowee Mill Dam, " "	Ind.
104.4	Fitchburg Paper Co. Dam, " "	Ind.
104.8	Dam, " "	

Dams on the Winnipesaukee River

4.16	Lakeport Dam, Lakeport, N. H.	Public-Maint.
5.57	Avery Dam, Laconia, N.H.	Water levels
11.27	Lochmere Dam, Belmont, N. H.	in lakes
15.5	Dam destroyed	-
16.17	Tilton Leather Dam, Northfield, N. H.	Ind.
16.33	Dam destroyed, Tilton, H. H.	-
19.51	Harry's Dam	Ind.
19.64	Stevens Mill Dam, Franklin, N.H.	Ind.
19.78	Public Service Co. Dam, Franklin, N. H.	Ind.
20.53	Sulloway Mills Dam, Franklin, N. H.	Ind.

* From Newburyport Light

P. PARKS AND RECREATIONAL AREAS IN THE MERRIMACK RIVER BASIN

The basin, both in the States of Massachusetts and New Hampshire, is utilized extensively for recreation, and enjoyment for persons during the summer and winter as well. Winter sports, especially, in the northern regions of the basin, have become extremely popular and profitable.

Numerous historical, public forests, camp-grounds and points of interest dot the basin and are accessible over fine highways.

The pollution of streams, ponds and lakes, in many instances, has limited the use of such bodies of water for contact sports and fishing. This has caused crowded conditions at many other resort areas where the water quality is suitable for recreational purposes.

Q. FLOOD PLAIN MANAGEMENT IN THE MERRIMACK RIVER BASIN

New Hampshire

Delineation of the flood plain hazards in the State of New Hampshire due to stream overflows for the Merrimack River Basin are as follows:

River	Number of miles of flood hazard
Immediate need for corrective action	
Merrimack	45
Souhegan	16
Nashua	8
Pemigewasset	5
Baker	4
Beaver Brook	14
Spicket	6
Powwow	11
	109

Streams of lesser need:

Winnipesaukee	6
Merrimack	12
Soucook	11
Contoocook	13
Piscataquog	15
Cohas Brook	5
	61

Streams for tertiary consideration:

Suncook	9
Total (For Merrimack Basin)	179

The 179 miles out of the State's total of 16,000 miles or rivers represent a very small portion of streams subject to damages from floods. Based on 1966 price levels an estimated $393,000 is the average annual damage caused by floods in the basin.

Massachusetts

In Massachusetts, the length of the Merrimack River is about 49.8 miles, and the lower 22 miles are subject to tidal action. The mean range of tide at the mouth of the river is 7.9 feet and at Haverhill is 5.1 feet. However, the extreme ranges, due to the combined effect of wind and other causes are 11.7 feet at the mouth and 8.0 feet at Haverhill.

General Information

The Corps of Engineers and the Soil Conservation Service are the Federal Agencies which have primary control of flood plain management in New Hampshire. The Corps is responsible in the larger river basins, and the SCS has the responsibility in the smaller watershed protection projects.

The flood control projects of both agencies include dams and local protection such as dikes, retaining walls, channel improvements, etc.

In some cases it is not always desirable or economically sound to provide local protection for all flood hazard areas. These areas should not be discounted, as there are numerous compatible uses for which areas may be developed for wildlife refuges, agriculture, sports areas, etc.

Various Federal programs are available, and financial assistance may be furnished to the States to further Flood Hazard Delineation Programs. Some of these are:

a. Corps of Engineers (Flood Plain Information Studies)

b. U.S. Geological Surveys (Flood Inundation Maps)

c. Housing and Urban Development (701 Program)

d. Water Resources Planning Act (PL 89-80 enacted July 22, 1965)

Areas and/or treatment works for any of the proposed schemes for sewage disposal should be placed well above the flood plain elevations. Sewage pumping stations, and other facilities, if required to be located in the flood plain, should provide for flood protection. Before the location of sewage works are established, the Standard Flood Plain profiles for each locale should be thoroughly investigated.

Flood Plain Information studies are currently in progress on the mainstem of the Merrimack River in Lawrence and Methuen between river miles 22.8 and 36.0.

Current Status of Flood Plain Information Studies being accomplished by the Corps of Engineers in the Merrimack River Basin:

Completed

Massachusetts

Assabet River (in 9 towns)
Concord & Shawsheen Rivers (in Bedford, Mass.)

Authorized - Study in Progress

Massachusetts

Merrimack, Spicket and Shawsheen Rivers (are within Lawrence, Andover, North Andover and Methuen)

New Hampshire

Souhegan River (in Merrimack)
Merrimack River (in Litchfield)

Requested - Studies not Started

Massachusetts

Beaver Brook (in Littleton)

New Hampshire

Merrimack River (in Henniker)
Spicket River (in Salem)
Contoocook River (in Peterborough)

With respect to the Merrimack River Basin Wastewater Feasibility Study, it is not proposed to construct sewage treatment plants for Water Disposal Methods in the flood plains. However, it is anticipated that the effluent wastewater utilized in the Land Disposal Methods may be installed for irrigation purposes on existing farmlands which are in the flood plains. If a high flood should occur, the valves controlling the effluent to the specific fields being irrigated would be shut until the flood subsides. After flooding farmlands, it is often necessary to close down operations to clear fields of the normal debris and sedimentation associated with flooding. In view of the above, it is considered that spray-irrigating lands in the flood plains may be controlled and present no abnormal hazard.

Miscellaneous

In New Hampshire - There are no statutes specifically regulating development on flood plains. The Community Zoning Enabling Act, Chapter 31:60-89, R.S.A. 1955, empowers the legislative body of any city or town to regulate and restrict development of flood plains if it so desires through the zoning powers over ...the location and use of buildings, structures and land for trade, industry, residence or other purposes." In New Hampshire only the City of Keene has flood plain zoning provisions in effect.

Chapter 254, Laws of 1967, requires that a proposal for any fill operation in surface waters of the State, including streams, be submitted to the Water Supply and Pollution Control Commission for approval. While this regulation is directed to control possible water pollution from proposed projects, it insures that the State is informed of projects that will encroach on a stream channel.

Another regulation relating to encroachment of stream channels is R.S.A. Chapter 262-A which regulates the depositing of wastes and junk in streams and watercourses. This, too, is under the jurisdiction of the Water Supply and Pollution Control Commission.

In Massachusetts - The Division of Waterways of the Department of Public Works is authorized under Chapter 91 of the General Laws to construct works of improvement for flood control purposes. Projects constructed by this agency usually involve channel improvements, bank stabilization, stream clearance and, in some cases, the repair of flood-damaged dams. This agency processes approximately 20 projects a year, the number depending on requests and budgetary appropriations. This program

is local in scope, usually requiring fifty percent funding by the local community requesting the project.

Chapter 21, Sections 8-16 of the General Laws established the Water Resources Commission and designated it as the agency of the Commonwealth having supervisory responsibility over programs provided for by the Federal Watershed Protection and Flood Prevention Act. Since 1961, the Commission has contracted for the construction of 18 works of improvement on the sites it has purchased. The U.S. Soil Conservation Service has primary responsibilities in the design of structures and in the provision of resident engineering services during construction. Project plan review, contract administration and project maintenance are responsibilities of the Water Resources Commission.

The Commission is the state agency designated to review U.S. Corps of Engineers flood control project plans. In some instances the Commission has signed project assurances and in other cases, municipalities have done so. The Water Resources Commission makes recommendations to appropriate State agencies regarding the licensing of Corps of Engineers flood control reservoir storage basin areas.

The Division of Waterways has jurisdiction over the filling of public waters. The previously cited legislation regulating the filling of coastal and inland wetlands may also prevent channel encroachment.

By special act of the legislature, the Water Resources Commission was authorized to establish encroachment lines and flood plain zones on several streams in eastern Massachusetts.

The filling of flood plains along inland waters and areas subject to tidal flooding is regulated by legislation; Chapter 131, section 40, and Chapter 130, section 27A.

Other legislation allows the Commissioner of Natural Resources, after a public hearing to issue orders against the alteration of coastal wetlands, to promote public safety, health and welfare, and to protect public and private property, wildlife and marine fisheries (Chapter 130, section 105A). Private owners of land placed under such orders may petition the Superior Court that the order constitutes a taking without compensation. If the court holds this to be true, the Commissioner may take the fee, or any lesser interest in such land, by eminent domain. The actions authorized above may not restrict or impair the lawful powers and duties of the Department of Public Works, the State Reclamation Board or mosquito control projects.

Similar legislation, Chapter 131, section 40A, was passed to promote public safety, health and welfare, and to protect public and private property, wildlife, fisheries, water resources, flood plain areas and agriculture on inland wetland areas. The Commissioner can issue orders on marshes or swamps bordering on inland waters, or that portion of any bank which touches any inland waters, or any marshes or swamps.

R. CITIES AND TOWNS IN THE STUDY AREAS WHICH HAVE EXISTING SEWAGE TREATMENT PLANTS

The towns and cities within each study area which have existing Sewage Treatment Plants are:

Study Area	City/Town	Type of Treatment	Present Design Capacity
Winnipesaukee River	Laconia	Primary	1.6 MGD
Concord-Manchester	Hooksett	Activated Sludge	0.5 MGD
Nashua	Merrimack	Activated Sludge	2.5 MGD
	Nashua	Part Primary	3.0 MGD
Fitchburg-Leominster	Fitchburg East Plant	Activated Sludge (Presently inadequate)	16.2 MGD
	Leominster New Plant	Activated Sludge	3.0 MGD
	Old Plant	Activated Sludge	2.0 MGD
Lowell- Lawrence-Haverhill	Billerica	Activated Sludge (extended Aeration) + Cl_2	1.5 MGD
	Andover	(A portion of the town has secondary treatment facilities.)	

APPENDIX I

BIBLIOGRAPHY & SOURCES OF DATA

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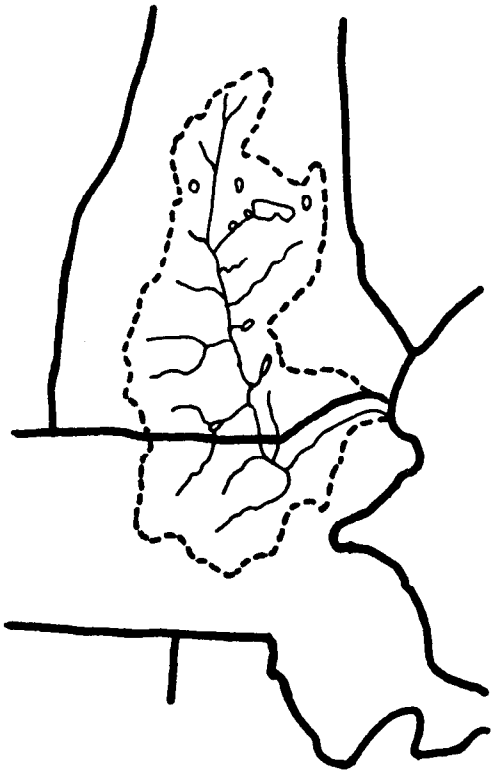
THE MERRIMACK:

DESIGNS FOR A CLEAN RIVER



THE STUDY AREA IN THE FUTURE (TO 2020)

APPENDIX II

AUGUST 1971

THE MERRIMACK: DESIGNS FOR A CLEAN RIVER

A
FEASIBILTY STUDY
FOR
WASTEWATER MANAGEMENT
IN THE
MERRIMACK RIVER BASIN

APPENDIX II

"THE STUDY AREA IN THE FUTURE"
(To 2020)

APPENDIX II

Study Area in the Future (to 2020)

A. POPULATION, ECONOMIC AND INDUSTRIAL PROJECTIONS II-A-1

B. ESTIMATED MUNICIPAL, INDUSTRIAL AND STORMWATER WASTE LOADS FOR EACH AREA IN THE STUDY II-B-1

C. REASONS FOR OBSERVING OTHER STRATEGIES FOR WASTEWATER MANAGEMENT II-C-1

D. ESTIMATE OF EFFECTS OF CONTINUING PRESENT WATER QUALITY MANAGEMENT II-D-2

E. ADDITIONAL SEWAGE OPERATIONS AND CONSTRUCTION THAT ARE ALMOST CERTAIN TO BE IMPLEMENTED WITHIN THE NEXT FIVE YEARS II-E-1

F. URBANIZATION TRENDS IN THE MERRIMACK RIVER BASIN II-F-1

G. ESTIMATED WATER REQUIREMENTS IN THE STUDY AREAS II-G-1

H. PERCENTAGE OF WASTEWATER TO THE 7 DAY-10 YEAR LOW FLOW II-H-1

I. BIBLIOGRAPHY AND SOURCES OF DATA II-I-1

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TABLE NO.		
1(a - w)	Estimated waste loads including their types for years 1990 and 2020.	II-B-3
2.	Projected Water Requirements and Deficiencies.	II-G-5
3.	Estimated Water Use on a Per Capita Day Basis.	II-G-7
		II-I-1
5.	Dilution Effects (Ratio of Wastewater/ 7 day-10 year Low Flow).	II-I-2

GENERAL

The Study Area in the future, up through the year 2020, will see great changes in population rates, shifting of urbanized areas, decay in certain sections, increase in land values and differences in land use and zoning.

If serious efforts to improve the water quality of the rivers and tributaries in the Merrimack Basin for "any use" are not instituted for effective zoning for residential and industrial relationships, and to take action to improve the environment in general, disastrous effects on future generations, including plant, aquatic and animal life may be the result.

It therefore behooves all concerned to consider the future projections and trends in the area up until 2020 so that proper planning and considerations may be proposed and assessed.

A. POPULATION, ECONOMIC AND INDUSTRIAL PROJECTIONS

Projections for these items are included in Table No. 2a-2g and in Table No. 3 of preceding Appendix I.

As may be noted from these tables and from Section G of Appendix I, farming or a full time occupation is on the downward trend even though there is a projected upswing in the population. The present rural areas are more or less the farming areas, but are rapidly urbanizing with residences and service type industries.

Some illustrations of this trend and the need for wastewater management in the study area are included in the following:

The Merrimack Basin

The economic outlook for the Merrimack River Basin as a whole will improve, especially in the services and manufacturing types of industry. Farming as an industry is on the continual decline. The number of operating farms are decreasing rapidly and becoming rural residences with their owners working in the cities and urbanized areas. It is predicted that population and the personal income will increase, the average annual employment growth rate will reduce considerably by the year 2020. Tables 2 and 2a through 2g in Appendix I illustrate the overall population and economic projections up to the year 2020 as well as reflecting comparisons with the Boston Metropolitan Area, New England and the United States. Also, affecting the future population and the economic projections for the basin, is the magnitude of pollution abatement practices which will have been placed in effect by that time.

The Fitchburg Area

With respect to the future economy of the area, the recent past of the North Branch Nashua River Basin has been one of steady and relatively prosperous economy. A study of the past and present trends in the economy of the area indicates a continuation of present trends and a continual growth in the lower portion of the basin and tributary areas.

Because of the physical size of the North Branch Nashua River, it is not reasonable to forecast expansion in manufacturing production to proceed at its past rate, however, considering an increase in productivity per worker and a moderate increase in plant facilities, the growth in manufacturing will rise.

As in other parts of the Merrimack River Basin it is expected that employment will increase in manufacuring and services types of business.

With expected flood control measures, river improvement and "filling-in" of the "in-between" areas, it is highly probable that land use will increase. Although the population of Fitchburg and Leominster are more stable, the land use and population of the towns of Lunenburg and Westminster will expand at a much higher rate.

Wastewater management and river improvement will certainly make the area more attractive, useable, and acceptable for industry as well as for the well-being of the inhabitants.

The anticipated waste loads and their sources, projected for the Fitchburg-Leominster Area for the years 1990 and 2020, are included in Table No. 1 of this Appendix I. Most of these are from the same type of industries as those currently in operation in the area.

The Lowell-Lawrence and Haverhill Areas

The cities of Lowell and Lawrence are expected to remain fairly stable with respect to population. It is anticipated that Haverhill may increase about 22 percent. It appears that by the year 2020 the population will increase from 387,800 in 1970 to 553,700. Most of the population increase in the overall study area will be in the surrounding towns where there is available land.

The above increase in population indicates an expansion in economic growth, particularly in the service industries. There will also be an increase in growth in textile production.

It is expected that considerable rehabilitation will take place in the three cities which will improve aesthetic values, and with emphasis on wastewater management and river improvement, the area could be revitalized tremendously.

Table No.1 indicates the projected waste loads for 1990 and 2020 to be respectively about 66 and 138% above the present municipal and industrial waste load 62 MGD.

As indicated in Table No. 2 of Appendix II the anticipated water shortages for the immediate vicinity, including those for some adjacent towns in New Hampshire which amounts to about 33.9 MGD in 1990 and 108.5 MGD in 2020, gives further evidence of the need of a clean Merrimack River as a source of water supply in the future.

The Nashua Area

This area, due to its close proximity to the Metropolitan

Boston Area and its open expanses, is expected to increase in population by almost three times that of its 1970 population. This increase will require the construction of residences and expand the services industries, business establishments, and other supporting elements.

It is expected that the waste loads will substantially increase because of this high rate of expansion, and cause additional burden on the municipalities.

The industrial waste load in 1990 will be about 5 MGD of which food processing is the largest with 3 MGD. However the greatest increase will be in municipal wastes which are expected to approximate 24 MGD in 1990, and 52 MGD by 2020. It is felt that with these quantities of wastes, plus additional wastes from upstream sources, further treatment of sewage beyond secondary is required to maintain proper river quality.

The Manchester Area

With the many groups working to improve conditions for industries already located in the city and to attract new businesses to the area, there is good reason to believe that Manchester's population and economy will continue to rise. From all indications the population of the area will increase from about 105,000 persons in 1970, to 168,700 in 1990, and to about 253,000 in 2020. This increase is quite large and several changes in the communities and the rural areas are bound to take place. In addition, new sources of water supply will be necessary and, with proper wastewater management practices, and construction of new adequate sewage facilities to improve the river quality and to control pollution, there is no reason why the Merrimack River could not serve as a local water source for the communities.

The Concord Area

Inasmuch as this is the political center of the State, the population of Concord is expected to continue increasing slowly and steadily through the next few decades.

The northern part of Concord is often called Penacook, and is the combination of the northern part of Concord and the southern part of Boscawen.

These surrounding communities have almost unanimously a greater rate of increase in population than the state average over the past ten years. In view of this, the community of Penacook is expected to increase in population over the next 4 to 5 decades. By 2020 the population of the area is expected to increase from about 41,700 persons to 123,000.

This increase in population will require increased services, shopping centers, etc., especially in the surrounding communities. With the increase in population the state governmental functions will rise also.

With the anticipated expansion in population and industry, the pollution problem will increase if plans and their implementation of them are not placed in effect.

The Winnipesaukee River Area

By the year 2020 it is expected that the present permanent population will practically double to about 49,600 persons, thus stimulating and creating new service businesses to accomodate the populace. In addition, since the area offers tremendous opportunities for winter sports, vacationists are not only summertime visitors but become winter visitors as well.

Though industry in the area is relatively small the number of motels,

restaurants etc. are anticipated to increase.

Since this area is one of New England's most popular vacation resorts, it is most imperative that the quality of the Winnepesaukee River, Winnisquam Lake, Paugus Bay, Opeechee Bay and Silver Lake, as well as the Winnipesaukee River itself, be improved.

One of the possible methods of providing improved bodies of water in the area is to increase circulation by diverting renovated water by one of the proposed water disposal schemes discussed in Appendix No. III under Solutions.

B. ESTIMATED MUNICIPAL, INDUSTRIAL AND STORMWATER WASTE LOADS FOR EACH AREA IN THE STUDY

Projections for these future loads are included in Table No. 1 and 1a-1w in Appendix II.

The loads are based on the same municipalities in the specific study areas in the Merrimack River Basin considered in Appendix I.

TABLE NO. 1

ESTIMATED WASTE LOADS INCLUDING THEIR TYPES
FOR YEARS 1990 AND 2020

Type of Pollution	1990	2020
Fitchburg-Leominster Area		
Municipal	21.27 MGD	26.93 MGD
Industrial		
Plastics	1.14	2.89
Metal Plating	.51	1.04
Food Processing	.11	.19
Pulp & Paper	15.70	17.00
Miscellaneous	.97	1.60
subtotal	18.43 MGD	22.72 MGD
Total M & I	39.70 MGD	49.9 MGD
Stormwater Runoff (Annual)	5284 MG/yr.	5812 MG/yr.
Lowell-Lawrence-Haverhill Area		
Municipal	81.09 MGD	146.6 MGD
Industrial		
Dairy	0.10	.10
Textiles	1.30	2.19
Food Processing	.24	.28
Pulp & Paper	11.26	12.12
Metal Plating	90 gpd	90 gpd
Rendering	.12	.15
Wool Scouring	1.32	2.17
Tannery	.17	.17
	14.51 MGD *	17.18
*Part of the Municipal load		
Total M & I (Combined Sewers)	95.6 MGD	146.6 MGD
Stormwater Runoff (Annual)	9855 MG/yr	10840 MG/yr

TABLE NO. 1 (CONT'D)

Type of Pollution	1990	2020
Nashua Area		
Municipal	23.87 MGD	52.1 MGD
Industrial (Included in Municipal)		
Food Processing (Including brewery)	3.	5.0
Pulp & Paper	.3	.3
Tannery	1.0	1.0
Metal Plating	.33	.50
Miscellaneous	.4	1.0
Subtotal	5.03 MGD	7.80 MGD
Total M & I	28.9 MGD	59.9 MGD
Stormwater Runoff (Annual)	4094 MG/yr	4505 MG/yr
Concord Area		
Municipal	11.94 MGD	12.77 MGD
Industrial (Part of the Municipal Load)		
Tannery	1.20	1.2
Paper	.46	.49
	1.66 MGD	1.69 MGD
Total M & I	13.60	
Stormwater Runoff (Annual)	3439 MG/yr	3783 MG/yr
Manchester		
Municipal	30.54	81.10
Industrial (Part of the Industrial Load)		
Textiles	1.75	2.22
Food Processing	.67	1.14
Plastics	.38	.96
Tannery	.60	.60
Wool Scouring	.16	.20
Subtotal	3.56 MGD	5.12 MGD
Total M & I	34.1	
Stormwater Runoff (Annual)	3988 MG/yr	4387 MG/yr

TABLE NO. 1 (CONT'D)

Type of Pollution	1990	2020
	Winnipesaukee River Area	
Municipal	11.66 MGD	14.0 MGD
Industrial Tanning	.04 MGD	.04 MGD
Total M&I	11.70	14.04
Stormwater (Annual)	5791 MG/yr.	6429 MG/yr.

Notes:

1. The Stormwater Flows include the 5 year-6 hour storm (Appr. 2.7")

2. Initial design elements in this feasibility study and the various solutions for wastewater management are based on the year of 1990.

3. The Concord-Manchester Area was originally considered as one area, however, during the course of the Study, it was determined that it was better to divide the area into two parts, namely: Concord and Manchester.

Table 1a

LOWELL-LAWRENCE-HAVERHILL
STUDY AREA
SUMMARY
MUNICIPAL WASTEWATER CONCENTRATIONS

		1990	2020
Influent *	Flow		
	mgd	98.3	146.6
	BOD		
	mg/l	143	155
	lb/day	116,800	188,900
	SS		
	mg/l	178	183
	lb/day	145,800	223,500
Effluent **	Flow		
	mgd	98.3	146.6
	BOD		
	mg/l	27.4	18
	lb/day	21,600	24,200
	SS		
	mg/l	23.5	14
	lb/day	19,280	17,400

Note: Municipal wastewater includes industrial wastes.

* Prior to treatment.
** After treatment.

Table 1b
MERRIMACK RIVER BASIN
WASTE WATER MANAGEMENT STUDY

MUNICIPAL WASTES
FITCHBURG-LEOMINSTER AREA

Municipalities Served	Population	Population Served	Average Sewage Flows (mgd)	Waste Concentrations			
				Influent		Effluent	
				BOD mg/l	Sus.Solids mg/l	BOD mg/l	Sus.Solids mg/l
Fitchburg							
1990	48,000	48,000	8.4	328	328	33	33
2020	54,000	54,000	11.4	284	284	28	28
Leominster							
1990	40,000	36,000	6.85	233	233	23	23
2020	51,500	48,900	10.5	218	218	22	22
Lunenberg							
1990	12,500	14,300	1.86	185	185	18	18
2020	19,000	21,900	5.03	160	160	16	16
Westminster							
1990	8,000	Combined with Lunenberg above					
2020	12,000						

Table 1c
MERRIMACK RIVER BASIN
WASTE WATER MANAGEMENT STUDY

MUNICIPAL WASTES
NASHUA AREA

Municipalities Served	Population	Population Served	Average Sewage Flows (mgd)	Waste Concentrations Influent BOD mg/l	Influent Sus.Solids mg/l	Effluent BOD mg/l	Effluent Sus.Solids mg/l
Merrimack							
1990	25,000	15,500	6.1	890	355	53	21
2020	58,000	20,000	8.0	1,000	400	60	24
Hudson							
1990	26,000	22,000	4.4	150	240	30	36
2020	43,000	38,700	11.6	140	180	28	27
Nashua							
1990	81,750	81,000	20.0	146	208	28	20
2020	110,000	110,000	32.5	142	183	28	27

Table 1d
MERRIMACK RIVER BASIN
WASTE WATER MANAGEMENT STUDY

MUNICIPAL WASTES
CONCORD-MANCHESTER AREA

Municipalities Served	Population	Population Served	Average Sewage Flows (mgd)	Waste Concentrations Influent BOD mg/l	Influent Sus.Solids mg/l	Effluent BOD mg/l	Effluent Sus.Solids mg/l
Concord							
1990	43,000	34,000	9.81	189	251	38	38
2020	74,000	39,000	12.77	185	241	37	36
Pembroke							
1990	6,800	5,100	0.8	150	240	30	36
2020	17,000	6,450	1.3	155	245	31	49
Hooksett							
1990	19,500	16,600	3.0	133	180	27	27
2020	32,000	28,800	8.0	130	180	36	20
Goffstown							
1990	28,000	14,000	3.9	150	172	30	26
2020	58,000	35,000	11.0	134	172	27	26
Manchester							
1990	118,500	115,000	30.0	161	207	24	32
2020	147,500	143,000	48.0	125	161	19	24
Bedford							
1990	22,200	19,000	4.6	140	174	28	26
2020	47,500	42,800	12.8	134	179	27	28

Table 1e
MERRIMACK RIVER BASIN
WASTE WATER MANAGEMENT STUDY

MUNICIPAL WASTES
WINNIPESAUKEE AREA

Municipalities Se ved	Population	Population Served	Average Sewage Flows (mgd)	Waste Concentrations Influent BOD mg/l	Influent Sus.Solids mg/l	Effluent BOD mg/l	Effluent Sus.Solids mg/l
Belmont							
1990	3,800	3,000	0.31	263	313		
2020	6,000	4,800	0.50	244	286		
Winnisquam							
1990		4,000	0.49	166	166		
2020				196	196		
Franklin							
1990	8,600	8,000	5.23	93	60		
2020	14,500	10,800	6.46	92	68		
Laconia							
1990	30,000	30,000	3.0	240	288		
2020	40,000	40,000	5.0	163	192		
Northfield Tilton							
1990	5,400	5,500	0.57	377	231		
2020	12,200	6,800	0.84	370	194		
Sanbornton							
1990	1,300	1,200	0.12	221	260		
2020	2,000	1,800	0.38	107	126		

Table 1f
LOWELL-LAWRENCE-HAVERHILL
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
1990

	Flow	BOD		S. S.		TDS	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Dairy	0.055	2,955	1,360	663	305		
Cotton Textile	0.78	408	2,655	191	1,245	588	3,825
Synthetic Textile	1.28	548	5,856	439	4,689	2,130	22,743
Food Processing	0.24	2,115	4,231	893	1,786		
Pulp and Paper	11.26	376	35,380	535	50,190		
Metal Plating	90 gal/day						
Rendering	0.12	400	400				
Tannery	0.165	1,110	1,530	3,152	4,350	4,580	6,320
Wool Scouring	1.32	660	7,330				
Miscellaneous	0.0005	1,250	5	71,250	285		
Total	15.22	462	58,747	495	62,850		

Table 1g
LOWELL-LAWRENCE-HAVERHILL
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
2020

	Flow	BOD		S. S.		TDS	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Dairy	0.094	2,950	2,300	660	515		
Cotton Textile	0.99	386	3,185	180	1,490	552	4,560
Synthetic Textile	1.63	547	7,432	438	5,952	2,125	28,891
Food Processing	0.40	2,000	6,685	904	3,020		
Pulp and Paper	12.15	377	38,240	535	54,260		
Metal Plating	90 gal/day						
Rendering	0.15	384	480				
Tannery	0.165	1,110	1,530	3,152	4,350	4,580	6,320
Wool Scouring	1.66	672	9,310				
Miscellaneous	0.0005	1,250	5	71,250	285		
Total	17.24	481	69,170	486	69,870		

Table 1h
FITCHBURG-LEOMINSTER
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
1990

	Flow	BOD		S. S.		COD		TDS	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/da
Food Processing	0.11	1,467	1,345	277	254	1,866	1,711	1,023	938
Pulp and Paper	15.7	32	4,210	33	4,317				
Metal Plating	0.51	17	72	36	153	251	1,067		
Plastics	1.14	252	2,392						
Miscellaneous	0.97	13	102	0.3	24	259	2,095		

Table 1i
FITCHBURG-LEOMINSTER
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
2020

	Flow	BOD		S. S.		COD		TDS	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/da
Food Processing	0.19	1,443	2,280	272	430	1,835	2,900	1,006	1,590
Pulp and Pape-	17.0	33	4,613	33	4,685				
Metal Plating	1,04	19	165	29	249	202	1,752		
Plastics	2.89	251	6,060						
Miscellaneous	1.6	13	170	0.3	3.8	248	ɔ,309		

Table 1j
NASHUA
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
1990

	Flow	BOD		S. S.		COD	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Food Processing Anheuser-Busch	2.95	25	615	20	495		
Pulp and Paper	0.274	260	595	260	595		
Metal Plating	0.33	230	620	265	730	640	1,740
Tannery	1.0	690	5,750	1,735	14,500		
Miscellaneous	0.41			1,000	3,380		

Table 1k
NASHUA
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
2020

	Flow	BOD		S. S.		COD	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Food Processing Anheuser-Busch	5.0	25	1,040	20	835		
Pulp and Paper	0.296	260	640	260	640		
Metal Plating	0.51	230	975	270	1,150	640	2,750
Tannery	1.0	690	5,750	1,735	14,500		
Miscellaneous	1.05			1,000	8,550		

Table 1L
CONCORD-MANCHESTER
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
1990

	Flow	BOD		S. S.		TDS	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Textile	1.75	471	6,880	216	3,160	639	9,325
Food Processing	0.67	1,319	7,360	1,458	8,135		
Pulp and Paper	0.46	26	99	26	99		
Tannery	1.8	1,361	20,430	1,765	26,490		
Wool Scouring	0.16	735	977	111	147		
Polystrene	0.38	1,435	4,550	10	33		

Table 1m

CONCORD-MANCHESTER
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
2020

	Flow	BOD		S. S.		TDS	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Textile	2.22	472	8,730	217	4,010	640	11,855
Food Processing	1.14	1,311	12,470	1,445	13,750		
Pulp and Paper	0.49	27	110	27	110		
Tannery	1.8	1,361	20,430	1,765	26,490		
Wool Scouring	0.20	743	1,240	114	190		
Polystrene	0.96	1,436	11,500	11	85		

Table 1n
WINNIPESAUKEE
STUDY AREA
SUMMARY
INDUSTRIAL WASTEWATER LOADINGS
1990 - 2020

	Flow	BOD		S. S.		TDS	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Tannery	0.04	1,040	350	2,950	990	4,350	1,450
Total	0.04	1,040	350	2,950	990	4,350	1,450

Note: No real growth projected for the tanning industry in 1990 and 2020.

Table 1o

LOWELL-LAWRENCE-HAVERHILL
STUDY AREA
SUMMARY
MUNICIPAL WASTEWATER CONCENTRATIONS

		1990	2020
Influent *	Flow		
	mgd	98.3	146.6
	BOD		
	mg/l	143	155
	lb/day	116,800	188,900
	SS		
	mg/l	178	183
	lb/day	145,800	223,500
Effluent **	Flow		
	mgd	98.3	146.6
	BOD		
	mg/l	27.4	18
	lb/day	21,600	24,200
	SS		
	mg/l	23.5	14
	lb/day	19,280	17,400

Note: Municipal wastewater includes industrial wastes.

* Prior to treatment.
** After treatment.

Table 1p

FITCHBURG-LEOMINSTER
STUDY AREA
SUMMARY
MUNICIPAL WASTEWATER CONCENTRATIONS

		1990	2020
Influent *	Flow		
	mgd	17.11	26.93
	BOD		
	mg/l	274	235
	lb/day	39,160	52,800
	SS		
	mg/l	274	235
	lb/day	39,160	52,800
Effluent **	Flow		
	mgd	17.11	26.93
	BOD		
	mg/l	27	24
	lb/day	3,916	5,280
	SS		
	mg/l	27	24
	lb/day	3,916	5,280

Note: Municipal wastewater includes industrial wastes.

* Prior to treatment.
** After treatment.

Table 1q

NASHUA
STUDY AREA
SUMMARY
MUNICIPAL WASTEWATER CONCENTRATIONS

		1990	2020
Influent *	Flow		
	mgd	30.5	52.1
	BOD		
	mg/l	294	273
	lb/day	74,800	118,600
	SS		
	mg/l	242	215
	lb/day	61,600	93,600
Effluent **	Flow		
	mgd	30.5	52.1
	BOD		
	mg/l	34	33
	lb/day	8,700	14,400
	SS		
	mg/l	22	27
	lb/day	5,600	11,600

Note: Municipal wastewater includes industrial wastes.

* Prior to treatment.
** After treatment.

Table 1r

CONCORD-MANCHESTER
STUDY AREA
SUMMARY
MUNICIPAL WASTEWATER CONCENTRATIONS

		1990	2020
Influent *	Flow		
	mgd	52.11	93.87
	BOD		
	mg/l	162	135
	lb/day	70,420	105,380
	SS		
	mg/l	209	176
	lb/day	90,800	137,600
Effluent **	Flow		
	mgd	52.11	93.87
	BOD		
	mg/l	28	25
	lb/day	12,150	19,280
	SS		
	mg/l	32	26
	lb/day	13,880	20,430

Note: Municipal wastewater includes industrial wastes.

* Prior to treatment.
** After treatment.

Table 1s

WINNIPESAUKEE
STUDY AREA
SUMMARY
MUNICIPAL WASTEWATER CONCENTRATIONS

		1990	2020
Influent *	Flow		
	mgd	9.7	13.7
	BOD		
	mg/l	156	144
	lb/day	12,600	16,400
	SS		
	mg/l	158	136
	lb/day	12,800	15,500
Effluent **	Flow		
	mgd	9.7	13.7
	BOD		
	mg/l	15.6	14.4
	lb/day	1,260	1,640
	SS		
	mg/l	8	7
	lb/day	640	780

Note: Municipal wastewater includes industrial wastes.

* Prior to treatment.
** After treatment.

Table 1t
LOWELL-LAWRENCE-HAVERHILL
STUDY AREA
SUMMARY
STORMWATER CONCENTRATIONS

	1990	2020
Flow		
mgd	48.8	53.7
BOD		
mg/l	100	100
lb/day	40,699	44,786
SS		
mg/l	250	250
lb/day	101,748	111,965

Table 1u

FITCHBURG-LEOMINSTER
STUDY AREA
SUMMARY
STORMWATER CONCENTRATIONS

	1990	2020
Flow		
mgd	24.0	26.4
BOD		
mg/l	70	70
lb/day	14,011	15,412
SS		
mg/l	221	222
lb/day	44,235	48,879
Organic N lb (KJEIDAHL)	1,820	1,970
Coliform		
MPN/100 ml	72,000	72,000

Table lv

NASHUA
STUDY AREA
SUMMARY
STORMWATER CONCENTRATIONS

	1990	2020
Flow		
mgd	20.7	22.8
BOD		
mg/l	66	65
lb/day	11,394	12,360
Organic N lb (KJELDAHL)	737	819

Table 1w
CONCORD-MANCHESTER
STUDY AREA
SUMMARY
STORMWATER CONCENTRATIONS

	1990	2020
Flow		
mgd	34.8	38.3
BOD		
mg/l	126	126
lb/day	36,568	40,246
SS		
mg/l	209	209
lb/day	60,660	66,761
Organic N lb (KJELDAHL)	2,380	2,650
Coliform		
MPN/100 ml	167,000	167,000

Table lx
WINNIPESAUKEE
STUDY AREA
SUMMARY
STORMWATER CONCENTRATIONS

	1990	2020
Flow		
mgd	21.7	23.9
BOD		
mg/l	86.8	86.8
lb/day	15,709	17,301
SS		
mg/l	211	211
lb/day	38,183	42,057

C. REASONS FOR OBSERVING OTHER STRATEGIES FOR WASTEWATER MANAGMENT

The present cognizance of the pollution problem in the rivers and the enforcement and implementation program, even though making for delays in schedules, deserves thorough appreciation of the problems involved.

However, the present "secondary" methods of sewage treatment which are being installed, are not deemed fully sufficient to render in most cases the desired quality of water for discharge back into the streams or for industrial and domestic re-use.

Appreciable values, not necessarily connected with a monetary value, can be realized by a geographic area, a river basin, a community and especially by the inhabitants themselves.

Some of the reasons for looking at other than present day wastewater management practices, and for furthering the degree of sewage treatment, are to:

a. Prevent further decay in various blighted city and urban areas.

b. Permit a reclaiming of these decaying areas for new housing, industry and recreation.

c. Improve the aesthetics of present areas which will induce new investments and sense of pride in their environment for the inhabitants.

d. Improve the well being and health of the area and its population.

e. Afford these new and additional areas for water contact recreation, and for fishing, which are becoming scarce because of the current rates of pollution and the increasing rate of population projections.

f. Help to return the streams to the high asset value and esteem for which they previously held.

g. Render the streams as a source of water supply which will be of higher quality and require less expensive treatment for domestic consumption.

h. To review and update existing primary plants and some of the overtaxed secondary plants in the areas in which poor quality of effluent is produced.

i. To meet new "clean water" legislation by both the Federal and State Governments.

j. To adequately provide for future population and industrial growth and expansion.

k. To provide an overall basin wastewater management system.

D. ESTIMATE OF EFFECTS OF CONTINUING PRESENT WATER QUALITY MANAGEMENT STRATEGIES

Efforts initiated under present legislation by the Environmental Protection Agency, the States, and others are steps in the right direction for the abatement of pollution. It is considered that these steps will not be fully adequate for producing water quality in streams which can be improved for "any" water use. The achievement of this goal is extremely expensive and time consuming in coordination and planning as well as in construction. It is essential that all concerned maintain a positive attitude toward the problem and cooperate to the fullest extent in its resolution. Unless this is accomplished the future generations may find:

a. That the upgrading of stream classifications to anything less than "any use" is not sufficient.

b. There will be a lack of recreational water bodies, especially as the population increases. The water bodies which may be acceptable for recreation in the future may be of such distance that their use is limited.

c. The water bodies and streams as they become further polluted by nutrients, etc. may reduce the aesthetic value of the vicinity and blighted areas may appear.

d. That the cost and effort to improve the situation will become more expensive and difficult to cope with as additional pollution sets in.

e. Without fully considering the treatment of stormwater to rid the flows of contaminants, pathogens and viruses only partial treatment of the pollution problem is being accomplished and the health of the populace may be seriously affected.

E. ADDITIONAL SEWAGE OPERATIONS AND CONSTRUCTION THAT ARE ALMOST CERTAIN TO BE IMPLEMENTED WITHIN THE NEXT FIVE YEARS

Enumerated in Tables 24 and 25 of Appendix I are the projects which are almost certain to be constructed within the next five years. The dates included in the implementation schedule are those based on the most recent available data obtainable from the Environmental Protection Agency, The State of New Hampshire, and the Commonwealth of Massachusetts. Often, even during the planning stages, towns and regions alter their plans up until the time of actual construction. This condition is often caused by political situations, monetary financing, advanced technology and changing trends in the population and industries. In some cases, litigation proceedings affect the implementation schedule until the problems are resolved.

In many instances the sewage planning processes in many cities and regions is a continuing project wherein extensions to the existing systems are planned and programmed.

However, a summary of the anticipated Sewage Treatment Facilities in Cities and Towns within the Study Areas which are almost certain to be constructed within the next five years include:

Area	City/Town	Type of Treatment
Lowell-Lawrence-Haverhill	Lowell*	Activated Sludge
	Dracut	(will connect to
	Tewksbury	Lowell system)
	Lawrence*	Activated Sludge
	Methuen	(will connect to
	Andover	Lawrence System)
	North Andover	" "
	Haverhill*	Activated Sludge
	Groveland	(will connect to Haverhill system)

* Regional Sewer Districts

Areas	City/Town	Type of Treatment
Fitchburg-Leominster	Fitchburg	
	East Plant	Activated Sludge
	West Plant	Activated Sludge**
	Westminster	(to connect to the Fitchburg West Plant)
	Lunenburg	(to connect to Fitchburg East Plant)
Nashua-Manchester	Nashua	Activated Sludge (2 plants)
	Hudson	(to connect into Nashua system)
	Concord	Activated Sludge (2 plants)
	Bow	(Portion of Bow to connect into Concord)
	Manchester	Secondary (Probably A.S.)
Winnipesaukee River Area	Franklin	Secondary (Probably A.S.)

**The Fitchburg West Plant may be a Physical-Chemical Treatment due to industry.

F. URBANIZATION TRENDS IN THE MERRIMACK RIVER BASIN

a. Population of the Merrimack River Basin

(1) General Statement

(a) The population centers of the basin, for the most part, are located along the Merrimack River. The approximate 1970 population within the Merrimack River Basin is estimated to be 1,250,000 of which 850,000 persons are in Massachusetts and 400,000 are in New Hampshire. The population increase over the 1960 census in the basin is about 16%. The localities with populations over 25,000 comprise 44% of the total basin population.

Whereas the present ratio of urban to rural populace is about 3:1, the ratio by 1990 will be about 4:1. The population on the Massachusetts portion on the basin is expected to continue to exceed the New Hampshire total, and consequently its dependence on the water and related land resources of the basin will be much greater. Urbanization of the New Hampshire portion of the basin will increase, but at a slower rate than that of Massachusetts.

(b) New Hampshire's population growth is not now, and probably never will be, evenly distributed across the state. The bulk of the population (about 2/3) will probably be concentrated in the three southeastern counties in the year 2020. The populous counties are Rockingham, Hillsborough and Merrimack; about 75% of the population in these counties will live in the Merrimack River Basin.

G. ESTIMATED WATER REQUIREMENTS IN THE STUDY AREAS

An estimate of the Water Requirements for the Study Areas has been made and data is included in the following Tables:

a. Table No. 2 - Projected Water Requirements and Deficiencies

b. Table No. 3 - Estimated Water Use on a per Capita Per Day Basis

As noted in Section I of this Appendix the estimated future water deficits for the Study Areas involved, excluding other New England Areas such as the Southeastern portion of New Hampshire, necessitate use of the Merrimack River for domestic water supply in the future.

With reference to Municipal flows of sewage from the various study areas, it is noted that the difference between the higher municipal flows and the lower projected water use consumption is due to much infiltration into the sewer collector system. The main reasons for this infiltration, is that most of the sewer systems in existence in the study area are older and are subject to higher ground water conditions.

TABLE NO. 2

PROJECTED WATER REQUIREMENTS AND DEFICIENCIES

Area	Estimated Water Requirements (MGD)			Estimated Water Deficits (MGD)	
	1966	1990	2020	1990	2020
Winnipesaukee River:					
Franklin	.6	1.2	2.6	---	0.6
Northfield	---	.4	2.9	.4	3.0
Tilton	.3	.4	.4	.1	---
Sanbornton	---	.1	.4	.1	.4
Belmont	.1	.6	1.8	.2	1.5
Laconia	1.3	1.9	2.8	---	---
Totals	2.3	4.6	10.9	.8	5.5
Concord-Manchester:					
Goffstown	1.0	4.6	12.0	3.6	11.0
Bedford	.6	3.5	11.5	3.0	10.9
Manchester	13.5	14.5	16.0	.3	1.8
Boscowan	.5	.8	1.5	.3	1.0
Bow	---	.3	2.4	.3	2.4
Concord	3.8	6.7	13.2	2.9	9.4
Pembroke	.5	1.0	3.4	.5	2.9
Hooksett	.2	2.7	6.8	2.3	5.6
Totals	20.1	34.1	66.8	13.2	45.0
Nashua:					
Merrimack	.8	4.4	12.0	2.3	10.3
Hudson	.5	2.8	8.5	2.2	7.2
Nashua	6.8	10.2	13.0	1.2	4.2
Totals	8.1	17.2	33.5	5.7	21.7
Lowell-Lawrence-Haverhill :					
Sector No.1 of Essex County	27.1	46.2	82.8	13.7	56.8
Sector No.3 of Middlesex Co.	19.0	37.6	57.3	15.1	36.7
Sub-Totals	46.1	83.8	140.1	28.8	93.5
Fitchburg -Leominster:					
Sector No.2 of Worcecster Co.	18.5	34.6	63.8	13.3	29.7
Totals	18.5	34.6	63.8	13.3	29.7

Remarks:

1. Future water requirements for New Hampshire cities/towns are based on Anderson-Nichols & Co., Inc. Report dtd May 1969, for the state of New Hampshire.
2. Future water requirements for Massachusetts cities/towns and counties from the NEWS study.
3. Deficiencies are based on present water yields.

TABLE NO. 3

ESTIMATED WATER USE ON A PER CAPITA PER DAY BASIS

Area	1960	1966	1970	1990	2020
Winnipesaukee River	73	87	87	125	180
Nashua	133	137	134	157	198
Concord-Manchester	136	143	154	169	208
Fitchburg-Leom.	222	239	233	275	358
Lowell-Lawrence & Haverhill	93	-	104	136	162

I. PERCENTAGE OF WASTEWATER TO THE 7 day-10 year LOW FLOW:

Table Number 4 indicates the Dilution Effects(Ratio of Wastewater to the 7 day- 10 year Low Flow) for the projected year of 1990.

The relatively high percentages in each river causes obnoxious and deleterious conditions especially in the summer when the depletion of oxygen proceeds more rapidly.than in winter.

This situation confirms the need for wastewater management and clean-up of the river systems in the basin. These problems can be rectified by the various alternatives described in Appendix III hereinafter.

Table No. 4

Dilution Effects (Ratio of Wastewater/7 Day-10 Year Low Flow)

Area	1990 Wastewater (M&I) Flow (MGD)*** Flow	Cumulative Flow	Streamflow (7 day - 10 yr. low) MGD		Ratio of Cumulative Wastewater to 7 Day-10 Yr. Low Flow
Merrimack River					
Franklin *	11.72 MGD	11.72 MGD	390 MGD	(589 cfs)	3.0%
Concord	13.61	25.33	415 **	(620 cfs)	6.2%
Manchester	*34.10	59.43	440	(663 cfs)	13.5%
Nashua	28.90	88.33	580 **	(870 cfs)	15.2%
Lowell *	31.00	119.33	650	(980 cfs)	18.3%
Lawrence	43.00	162.33	670 **	(1000 cfs)	24.2%
Haverhill	21.61	183.94	690	(1020 cfs)	26.5%
Winnipesaukee River					
Lakeport *	-	-	0	(0 cfs)	0
Tilton *	6.49	6.49	28 MGD	(48 cfs)	23.2%
Franklin ****	0	6.49	30 MGD **	(49 cfs)	21.7%

Notes: a. 7-day - 10 year low flow does not really apply due to restorations on Lake Winnipesaukee.

b. The present safe water discharge from Lake Winnipesaukee at Lakeport should not exceed 2,600 cfs (Appr. 1,733 MGD). This is not a 10 year - 7 day low flow.

North Branch Nashua River

		MGD	MGD		
Fitchburg	27.7	27.7	12 **	18 cfs	21.3%
Leominster	12.0	39.7	20 **	30 cfs	19.5%
Leominster *	0	39.7	21	32 cfs	18.9%

* = Gaging Station
** = Estimated
*** = Excludes contribution on Pemigewasset River above Franklin.
**** = Proposed Franklin Sewer Treatment Plant (5.23 MGD) will actually discharge into the Merrimack River.

The above wastewater figures do not include stormwater quantities but do include infiltration into the sewer system.

APPENDIX II

BIBLIOGRAPHY AND SOURCES OF DATA

1. Public Water Supply Study, Phase One Report, May 1969, New Hampshire Department of Resources and Economic Development.

2. Report on the Development of a Mathematical Model for Minimizing Construction Costs in Water Pollution Control, June 1969, Prepared for the United States General Accounting Office by Camp, Dresser, and McKee.

3. Draft of "Feasibility Report on Alternative Regional Water Supply Plans for Southeastern New England," 15 September 1969, prepared by the Corps of Engineers.

4. Report No. 10, Land-Water Recreation, prepared by the New Hampshire Planning Project.

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6. Investigations by Anderson-Nichols & Co., Inc.

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