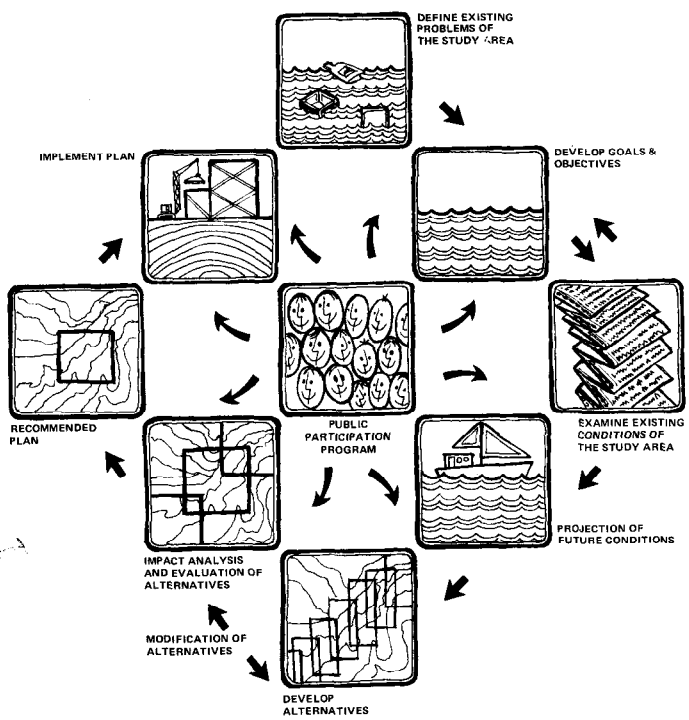
MERRIMACK WASTEWATER MANAGEMENT

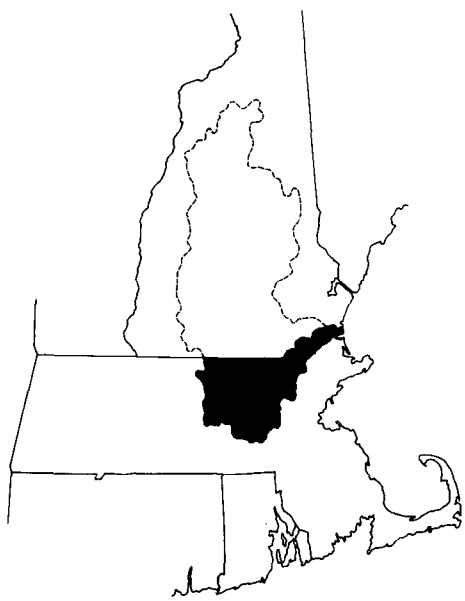
key to a clean river

PLANNING PROCESS



APPENDIX II

PLAN FORMULATION



NORTHEASTERN UNITED STATES WATER SUPPLY STUDY

NOVEMBER 1974

MERRIMACK WASTEWATER MANAGEMENT
INDEX TO REPORT VOLUMES

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MERRIMACK WASTEWATER MANAGEMENT

(KEY TO A CLEAN RIVER)

APPENDIX II

PLAN FORMULATION

November 1974

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A. INTRODUCTION AND SUMMARY OF PLAN FORMULATION

1. Introduction

Following a severe drought during the early to mid-sixties, Congress authorized the Northeastern United States Water Supply Study (NEWS) and requested the Corps of Engineers to function as the lead agency. After analyzing the area's water supply demand and water supply yield, a Corps study team resolved that the Merrimack River could offer a water supply source to the Boston Metropolitan area. The findings' major constraint was that the Merrimack was termed "grossly polluted;" public health and safety was a concern.

The Merrimack Wastewater Management Feasibility Study was authorized under the aegis of NEWS to determine the feasibility of river clean-up and resulting costs and benefits. The Merrimack: Designs for a Clean River resulted from that effort and developed costs and impacts associated with cleaning the river to "maximum feasible purity." The report recommended additional planning be undertaken, with greater emphasis on public and regional, state and local agency participation. State and Federal interest in the clean-up continued and led to the authorization of a survey-scope study, which is the subject of this report.

Following authorization from the Congress of the United States (received June 14, 1972), the Corps of Engineers and the Commonwealth of Massachusetts developed and co-signed an agreement on November 27, 1972 committing each to a joint study effort. This report's study area is the Merrimack River Basin in Massachusetts and the planning is wastewater management aiming toward thorough elimination of pollutants. The State/EPA Implementation Program for secondary treatment was incorporated and included as a baseline for all plans utilizing both basic and advanced wastewater treatment. River basin planning requirements of the Federal Environmental Protection Agency are basic to the study effort. The passage of the Federal Water Pollution Control Act Amendments (FWPCAA) of 1972 served to define that basis.

Federal, state and regional agencies joined to form the Merrimack Wastewater Management Study Team. This team determined the day-to-day decisions concerning overall technical and coordination efforts of plan formulation, impact assessment and public participation. Their primary action resulted in the Merrimack Wastewater Management Plan of Study. A result of six months intensive interagency effort, this plan of study outlined the scope of the study tasks. The agencies represented raised issues to be addressed by the study effort, provided

an inter-disciplinary frame of reference for decision making, insured the flow of existing and past information and verified inventory.

A fourth level of government was added to the study team after the plan of study's completion. Through the public participation program and a Citizen Advisory Group, local people added the fourth dimension. The public's involvement was designed to keep the planning open, to make the study responsive, and to provide another level of factual documentation and verification. Public issues and interests were provided through the open planning process.

Interagency coordination on a planning effort performed functions similar to citizen involvement, except with more professional planning and policy-making contacts. Interagency structure kept the study open and added expertise. It provided a framework for future implementation of the recommended solutions by making them more comprehensive and responsive to state, regional and local planning objectives.

Monthly meetings and daily contacts kept decisions open to reviews and recommendations by team members. The process was time-consuming; it provided early opportunity to catch errors and misguided planning strategies; it shifted priorities to more useful and implementable solutions. The process involved conflicts always inherent with having a large group with a highly varied expertise and range of interest.

Simulation exercises, commonly known as games, create a simplified model of reality in which roles can be structured and decisions made within the context of the game rules. In Amherst's University of Massachusetts Campus Center, more than sixty agency people congregated for three days and nights (28 February - 2 March 1973) and participated in a modified speeded-up planning exercise.

On the first day, the group was broken into four smaller groups. One had the function of designating plan actions or components of wastewater management alternatives for the Merrimack River Basin. A second group listed key impact categories for profiling a study area, and for assessing impact. This group gave units of measure to the quantifiable factors. A third group established policy issues inherent with wastewater management and assessed the institutional acceptability of a given solution. The final group generated preliminary decision paths of important organizations and agencies.

Using a University of Michigan computer to calculate the participant's voting pattern, each agency established its one role with its

own priority system of issues. Time was available for four full rounds of the exercise. Plan actions were discussed according to the highest number of votes given by the sum of the agency ballots. Impact categories and political feasibility were rated by each agency.

The simulation exercise united the interagency study team for the Plan of Study completion. It opened the doors of communication and cut down residual skepticism. Since every agency was given an equal number of votes in round one, regional agencies had as much power as state and Federal agencies. In fact, as there were five regional planning agencies, they had the greatest lobbying force if united. Although some noted that giving out equal votes to all did not simulate the real world, it did simulate the structure of the Merrimack Wastewater Management Study Team, and it prophesized the importance of the Regional Planning Agencies in this planning effort.

At the time of this simulation, Corps' priorities of zero discharge of pollutants, regionalization and resource recovery surfaced. Land use management and fiscal impacts leaped to the forefront as other agencies' priorities.

General agreement was reached that the overall goal of the study was to derive construction alternatives, costs and schedules required to meet target dates and criteria set forth in the Water Pollution Control Act Amendments of 1972 in keeping with the long-range goal of zero discharge of pollutants.

With the passage of Public Law 92-500, the Federal Water Pollution Control Act Amendments of 1972, the study objectives were clearly defined. The Act specified national goals and policies aiming at the elimination of the discharge of pollutants into navigable waters by 1985, and the interim goal of fishable-swimmable waters by 1983. The study team interpreted Sections 201 and 208 of the Act as recommending the most comprehensive planning process; they closely aligned philosophies toward achieving the planning efforts recommended by these sections.

One of the principal study goals was to design "regional wastewater systems that address the broader planning objectives of the people they serve." The first effort was to define those objectives. The FWPCAA of 1972 encourages public participation in the development, revision and enforcement of the plan. The study's extensive public participation program began with profiling residents' interests and local and regional issues as baseline data. Future land use plans were developed and compared to zoning trends. Categories such as

municipal finance and transportation, which together cover all aspects of a community profile, were called dominant factors. An information baseline was compiled for each town and dominant factor. Later in the study, these factors were rated in terms of their importance to a specific geographical area.

The Federal Water Pollution Control Act Amendments of 1972 encourages area-wide wastewater management. For operation, management and enforcement purposes, regional facilities are preferred by the Department of Public Health and the Division of Water Pollution Control in the Commonwealth of Massachusetts. But what is the scope of regional, the extent of area covered by the concept of area-wide? Does area-wide indicate a Standard Metropolitan Statistical Area--an inner city with its adjoining suburbs? Does it mean a regional planning agency's jurisdiction and include point sources of pollution not expected to tie into the municipal collection system? Non-point sources were addressed by non-structural strategies recommending improved institutional controls, conservation measures and implementation of effective land use plans. Land use management was recognized as a major mechanism for limiting non-point source pollution.

Since the Merrimack Feasibility Study, the team has accepted that "pollutants are resources out of place" and that they should be recovered and reused to the extent economically and technically feasible. During this survey study, one objective was to encourage wastewater management systems to include revenue producing facilities providing for the reuse and recycling of renovated wastewater and reclaimed wastewater constituents. For reuse of the renovated wastewater, (1) restoration of river quality; (2) flow augmentation; (3) groundwater recharge; (4) industrial water supply; (5) irrigation; (6) creation of recreational water bodies; and (7) municipal water supply were investigated. Certain reaches of the Merrimack have problems of low flow because of weekend diversion and storage into the industrially owned canal systems. Tributaries such as the Concord have notoriously low flow and resulting eutrophication. The study investigated treatment effluent being distributed to these problem areas. The land application technique of rapid infiltration was utilized along river fronts for flow augmentation purposes as well as in other areas for recharge of groundwater aquifers. Spray irrigation of secondary quality effluent as a means of returning nutrients to the soil was fully investigated and found to be somewhat less opportune in this region because of the shortage of available and suitable land. It has been, however, proposed for certain small towns having the desire to maintain their rural character and preserve open space. In pursuit of reuse of wastewater as industrial water supply, study efforts were the

least successful. The regional planning agencies looked for opportunities and discussion occurred with proponents of an oil refinery. However, their need for make-up process water was so much less than available quantities of effluent that it did not prove feasible. Other industries in the area benefited from this relatively water-rich region, by locating on the river fronts and the canals. The industries in the region presently pretreat their incoming water as is necessary to their process, and it is not felt that renovating wastewater would eliminate their need to insure proper quality through pretreatment. No direct pipe to faucet use of treatment plant effluent for municipal water supply is recommended by this study. There are sporadic operational failures and bypasses associated with all treatment facilities. Renovated wastewater for indirect reuse by municipal water supplies is addressed through river clean up as well as through groundwater aquifer recharge provided that the aquifers are adequately buffered from municipal well sites. No immediate opportunities were located for creation of new recreational water bodies; with the high premium on land in the region, this particular reuse appeared to have little potential especially as the rivers already offer recreation potential if cleaned.

Multiple use of the wastewater treatment facilities was another study objective embraced by the Merrimack Wastewater Management planning effort. Future land use plans for recreation and open space were used as one criteria for site location of spray irrigation - land application facilities. Spraying would take place at specific hours. The Commonwealth of Massachusetts has adopted a resource recovery approach to handling solid waste problems, and the study investigated technologies for the combined treatment and ultimate disposal of municipal refuse and wastewater sludges. In light of planning in the Minneapolis-St. Paul metropolitan area, it appears that economic potential exists in converting combined sludge and refuse to a char to be further generated into activated carbon. The activated carbon could be useful in advanced wastewater treatment processes or in water supply filtration facilities. Waste heat from the combustion process could be used to thermally influence sludges, or maintain temperatures in the biological treatment processes removing organics from wastewater.

An important study objective was to develop the means for implementing preferred solutions. Partly this was attempted through the development of a plan responsive to the local, regional and state interests. Interagency coordination and public participation throughout the study duration provided a mechanism of securing support for implementation as well as continuing the planning process where this study leaves off. Implementation mechanisms were also addressed

through modular, flexibly jointed engineering systems which could be designed and constructed in stages according to the variables occurring in projected conditions. Advanced treatment processes utilize currently planned units of primary and secondary treatment for the removal of phosphorus by chemical addition. Nitrogen removal, additional organics removal, and demineralization may be added as the needs are expressed.

2. Summary

a. Initial Formulation

Coordination with the wastewater management studies being conducted for the Nashua River Area and the Boston Harbor-Eastern Massachusetts Area permitted the Merrimack Study to concentrate its efforts in two of the five regional planning agencies within the Merrimack River Basin. The two regional planning agencies, the Northern Middlesex Area Commission (NMAC) and the Merrimack Valley Planning Commission (MVPC), are located along the mainstem of Merrimack River and encompass a total of twenty-four communities. Each RPA was engaged by the Corps of Engineers to profile their respective communities in terms of land use, employment, population, etc. They used information generated by the public participation process conducted during the course of this planning effort in addition to their past experience in their communities. A comprehensive list of impact categories and accompanying units of measurement was developed by the study team, and are listed at the end of this section.

From the list of impact categories, also called dominant factors, the interagency study team determined that population was the most important of the dominant factors. Accurate community profiles -- descriptive arrays of local characteristics -- depended on existing and future allocation of population. Population projections were developed from a "macro" to a "micro" scale. Figures for the Commonwealth of Massachusetts were assessed to the RPA's and the RPA's allocated them to their member communities according to how they thought the communities might develop. Their judgment was based on knowledge of the community zoning by-laws and community desires to remain rural versus desires for industrial expansion, etc. The community population projections were verified through the RPA commission members and the public participation process.

Land use was determined as the second most important impact category. Future land use plans were developed and modified by each RPA; after public exposure and verification, the plans were utilized as graphic presentations of regional growth and development

objectives. Much study team discussion went into the possibility of alternative land use plans, such as an environmental land use plan versus an economic land use plan, or alternative plans based on a specific set of objectives. The team agreed to have one future land use plan and one composite zoning plan (the zoning plan was based on present trends and existing conditions). Alternative land use plans could not be developed within the resources available to this study but are envisioned as an integral part of "area-wide" planning under Section 208 of PL 92-500.

The Department of Commerce and Development of the Commonwealth of Massachusetts provided invaluable assistance to the study through their compilation of economic data. Using the population projections already discussed, the Department of Commerce and Development (DCD) projected quantifiable measures of economic dominant factors. Their economic profiles for each of the communities in the study area were used in the development of regional profiles for each of the RPA's and include measures like employment rates, personal income, and labor force breakdown.

An extensive discussion of the existing and projected economic conditions throughout the study area to include a description of the basin's physical and natural resources can be found in Appendix I. This economic background information as well as the basic engineering data regarding existing and projected municipal, industrial and stormwater flows were utilized in the formulation of the wastewater management alternatives and the development of impact assessments.

Dominant factors that needed to be defined in order to have an accurate portrayal of the baseline and the projected conditions based on present trends were left to the individual impact assessment specialists. Examples of note include: water quality, aquatic and terrestrial species diversity, existing institutional structures, aesthetic visual diversity, and public health conditions throughout the study area with particular reference to non-point sources of pollution.

DOMINANT FACTORS

Population	Service Sector
Agriculture	Employment
Commercial Fisheries	Personal Income & Wealth
Manufacturing	

Housing	Land Use
Recreation	Municipal Services
Transportation	Municipal Finance

b. Engineering Systems

The previous discussion mentioned the national goals of zero discharge of pollutants by 1985 and fishable-swimmable waters by 1983. Relating these goals to plan formulation is a first step in developing engineering systems. The given goals and requirements of the Federal Water Pollution Control Act Amendments of 1972 required conversion into design criteria for the technical design of solutions.

For the design criteria of meeting the 1983 goal of best practicable wastewater treatment, EPA-issued effluent criteria was utilized. Federal guidelines on design criteria for the goal of zero discharge of pollutants were non-existent. Allowable limits of elements in surface waters utilized for drinking water were used as a starting point. These limits, combined with acceptable levels for aquatic organisms, gave a modified drinking water quality. This modified drinking water quality was used as the design effluent criteria for stage I of 1985 advanced wastewater treatment systems.

In order to go one step further toward effluent suggested by the zero discharge of pollutants, effluent criteria that would equal water found in "non-polluted" streams was generated. Sampling non-polluted tributaries in the Merrimack Basin provided approximate water quality background levels. This background water quality was used as the design effluent criteria for stage II of advanced wastewater treatment systems. Additional pollutant removals required for attaining background levels are principally in the area of total dissolved solids which include mineral salts and metals.

After development of design criteria, the ability of available technologies to attain these effluent levels were investigated. Technologies were compared on a cost and performance basis. A series of unit processes were developed. Advanced wastewater treatment facilities were planned as unit add-ons to existing or proposed secondary treatment facilities under the State-EPA implementation program. The advance process of phosphorus removal by chemical precipitation utilizes the primary and secondary treatment units present in existing facilities.

The generation of population projections and the distribution of those populations were discussed previously. The engineers used the estimated population projections in conjunction with the future land use plans to determine the future municipal flow within each community. The industrial flows were determined from a survey of existing industries and their flows were projected in relation to projected industrial growth.

Treatment of industrial wastewater from the five major polluting industrial categories in the study area, i.e. paper, textiles, plastics, metal plating and leather tanning, was addressed as a special case. Treatment considerations include pretreatment at the industry, process water recycling at the industry, and treatment of the industrial wastewaters within the municipal system.

Treatment of stormwater from urban areas was based on the present and projected quantities and qualities of runoff. A computer-based modeling effort determined the amount of urban runoff. The model incorporated the study area's present and projected land use, climatology/hydrology, linear feet of curbing and the expected amount of dust and dirt in those curbed areas. Recommendations concerning the degree of treatment necessary to abate stormwater pollution were based on the above modeling effort's conclusions. Determinations were made concerning the costs of separating the already existing combined sanitary and stormwater sewers.

Pumped septage also received special attention in terms of treatment. It is a highly concentrated waste that can create upsets to a treatment plant's biological systems if it is added as a slug to that process. Recommendations for its handling include special holding facilities that allow bleeding the septage into the preliminary treatment facilities during periods of low flow and low organic loading.

Treatment system siting was based on the future land use plans as well as technical considerations. For example, areas of historical/cultural significance were considered; affiliation with possible "water reuse" industries was sought; spray irrigation treatment was seen as a means of preserving open space.

Various engineering systems were developed for sub-areas composed of two to several communities. Each sub-area received from two to six engineering solutions for wastewater management including both advanced water-oriented technologies and land treatment.

For the Merrimack Valley Planning Commission, there are six basic wastewater management alternatives. For the Northern Middlesex Area Commission, there are five alternatives. They range from decentralized alternatives with several small wastewater treatment plants to centralized alternatives with a few large facilities. The regionalized alternatives unite the NMAC planning area with the MVPC planning area.

The engineering systems were arrayed in the following fashion for presentation and comparison purposes, as well as to insure that all possible options had been included. The alternatives for Northern Middlesex Area Commission include:

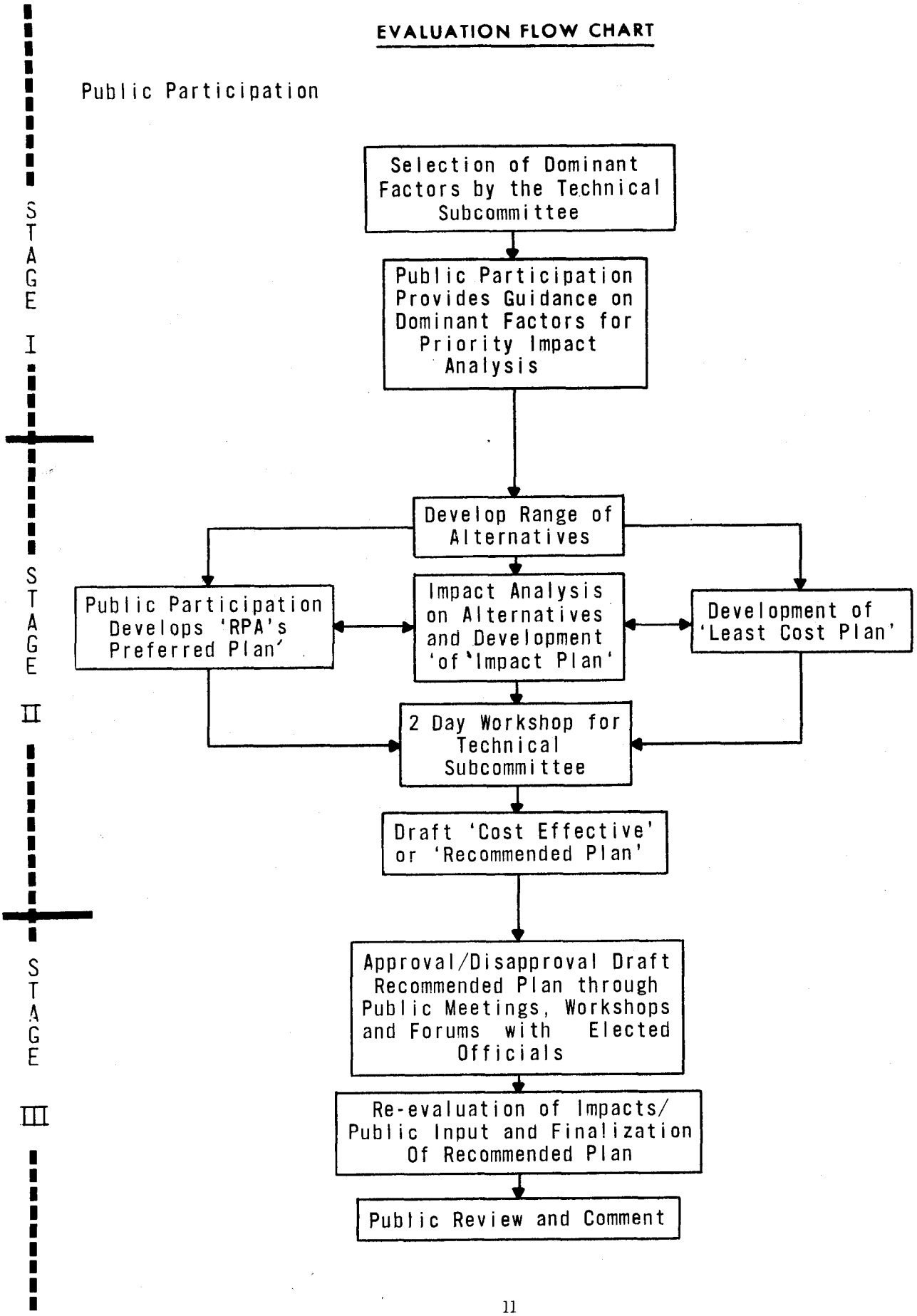
1. Water-oriented, decentralized
2. Water-oriented, partially decentralized
3. Water-oriented, centralized
4. Water-oriented, regional
5. Land-oriented, combination

The alternatives for the Merrimack Valley Planning Commission include:

1. Water-oriented, decentralized
2. Water-oriented, partially decentralized
3. Water-oriented, centralized
4. Water-oriented, regional
5. Land-oriented, decentralized
6. Land-oriented, centralized

The evaluation flow chart that follows gives an overall picture of the plan formulation methodology utilized in the Merrimack Wastewater Management Study. As can be seen in the schematic, the various impact assessments played a key role in the formulation and selection of the recommended plan.

EVALUATION FLOW CHART



c. Impact Analysis and Evaluation

Impact assessment provides a mechanism for making rational choices and decisions throughout the planning process. Impacts are forecasts of the future. They tell us what may be the probable changes both positive and adverse to our social, political, economic, biological, hygienic and aesthetic environment if plan "X" were to be implemented. Impact assessments hopefully provide the answers or at least some insight into choosing a course of action that would be "best" based on all the available facts.

In order to invest the time and money available for impact assessment in the most judicious manner, priority impact categories were established. The needed guidance on what issues were of most concern to the people of the Merrimack River Basin was obtained through the public participation program. A variety of groups and individuals expressed their views including local officials, citizens' groups, private citizens and agency representatives to the study team. Informal workshops, formal public meetings, interviews with local officials and citizens' groups, phone calls and letters to the Corps of Engineers were the major techniques utilized in the pulse taking effort and surfaced a variety of issues which oftentimes were dependent on the specific problems of a given town. The recurring theme, however, seemed to focus on the following major concerns:

(1) How would the technical alternatives be financed? What would it cost my town?

(2) Who would operate and maintain the regional treatment systems called for in the technical alternatives? Would small towns be forced to tie into big city systems and be gobbled up by big city politics?

(3) How would implementation of regional solutions affect existing land-use patterns? Would community growth and development policies have to be altered?

(4) What increased benefits could be gained from spending additional money and going beyond the existing program for secondary treatment? Is advanced treatment necessary?

(5) Should the problems of non-point sources, combined sewers and stormwater overflows be corrected before additional treatment of municipal wastes?

Logically, the impact categories of municipal finance, water quality and related recreation and land use were given the major consideration in the impact analysis. Less significant impacts were not overlooked or discarded but rather given a lesser degree of consideration. The institutional/political issue warranted detailed discussion in a separate appendix (Appendix V) which is part of this report. Since any discussion of recreational benefits is dependent on water quality considerations, close coordination was needed among the engineering, biological and socio-economic consultants. The anticipated water quality improvement as a result of implementing any of the alternatives is addressed in the biological report (Appendix IV-B).

Referring to the flow chart on page 11, it can be seen that the recommended plan is in reality the culmination of a series of planning steps. A range of engineering alternatives addressing various modes of treatment (land or water) and varying degrees of regionalization (centralized and decentralized) were detailed for each of the regional planning agencies within the study area. The impact consultants were requested to delineate the impacts for each of those alternatives. A summary of the impact assessment findings utilized in the screening of alternatives and the development of the recommended plan follows this discussion. The individual impact reports can be found in Appendices IV-A (Socio-Economic), IV-B (Biological), IV-C (Aesthetic), and IV-D (Hygienic).

Once the construction and operation and maintenance costs had been developed for each alternative, a hybrid "least cost" alternative was developed by the engineering consultants. The least cost alternative was developed from the component parts of the original eleven alternatives and reflected the lowest expenditure of public funds for the region.

The public participation program played a vital role in the evaluation and development of the recommended plan. The regional planning agencies presented the eleven alternatives and the preliminary findings of the impact assessment to their constituents through a series of meetings and workshops with commission members, elected officials and the local citizenry. The main objective of this series of meetings was to gain local preference for an alternative that the public would support. This interim public evaluation of the alternatives served an additional purpose since the public had the opportunity to check the planners to be sure that the issues surfaced during the initial phase of the study were in fact being considered in the development of the alternatives.

In the Merrimack Valley Regional Planning Commission area, the alternative that was preferred by the public consisted of component parts of alternatives 1, 2, 3, and 6 plus additional configurations not found in any of the alternatives. What they were in fact saying was that they did not like any one alternative in particular but did like pieces of number one, part of number six, some of their own design, etc. The preferred plan for the Northern Middlesex Area Commission closely resembled alternative number one. These public participation hybrids became known as the Regional Planning Agencies Draft Preferred Plans.

The consultants' impact reports became the basis of developing yet another alternative known as the "impact plan." The impact plan was also formulated from component parts of the original eleven alternatives and was based on maximizing socio-economic, biological, aesthetic and hygienic benefits without considerations as to monetary costs.

The Regional Planning Agencies Draft Preferred Plan (based on public evaluation of the alternatives), the Least Cost Plan (developed by the engineering consultant and based on minimizing the construction and operation and maintenance costs), the Impact Plan (developed to maximize socio-economic, biological, aesthetic, and hygienic benefits) and the impact reports on the original eleven alternatives then became the subject of a two-day workshop for the members of the study team.

The purpose of the two-day workshop was to evaluate all the plans that had been prepared together with the impact reports and the knowledge gained from the public and attempt to select or develop a preferred plan while focusing all significant issues for policy review that were associated with the selected plan. The plan developed at the two-day workshop became known as the "draft cost-effective plan" or the "draft recommended plan."

The "draft cost-effective plan" was presented to the public during the third set of public meetings. In all but a few communities, the draft plan met general acceptance. Elected officials and representatives of communities that had concerns over the cost-effective plan were asked to meet with the Technical Subcommittee to express their views. The knowledge gained by the members of the subcommittee during the forums with local elected officials necessitated a re-evaluation of the initial recommendations.

A major problem in the evaluation and the presentation of the final recommendations was that many of the issues on which value decisions and judgments had to be made were inextricably tied to other issues not directly affected by wastewater management. As an example, the subcommittee found itself evaluating the impacts of nonstructural (land management) strategies for rural communities and confronting the issues of land use based on wastewater management while other considerations such as economic growth policies, housing policies and open space or recreation issues might be the overriding factors on which the ultimate decisions concerning land use should be made.

A final word about the recommended plan itself. The "recommended plan" is a recommendation - an expression of what appears to be the best plan to implement to achieve the goals and requirements of the Federal Water Pollution Control Act Amendments of 1972 as they are now stated. The plan presented in this document has met general acceptance among the agencies that participated in this study, but has not as yet received any official recommendation.

SUMMARY OF IMPACTS

Geographical Area Lowell-Dracut-Tewksbury-Eastern Tyngsborough

-L - Adverse impact - long term*
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Aesthetic									
(+L) Flow augmentation of Merrimack River will improve visual quality during low flow periods.	x	x	x	x	x	x			
(-S) Transmission systems impact on natural environment.					x	x	x	x	
(+L) Potential recreational corridors along transmission lines. Supportive of regional land use plans and possible interface with Lowell Urban National Cultural Park.	x	x	x	x	x	x	x	x	
(+L) Improved visual quality of Merrimack River.	x								
(+L) Treatment plant design could accommodate need for river access point.	x	x	x	x	x	x	x	x	x
(-L) Reduction of instream flow between Lowell and Lawrence.								x	
(-L) Natural riverscape at Duck Island will be destroyed.	x	x	x	x	x	x	x	x	x
(-L) Rapid infiltration sites effect on landscape quality.									x
Biological									
(-L) Nutrients in Merrimack River may exceed acceptable limits.	x								
(-L) Potential residual chlorine toxicities to aquatic organisms.	x	x	x	x	x	x			
(+L) Flow augmentation will enhance aquatic life during low flow periods.		x	x	x	x	x			
(+L) Water quality improved to acceptable limits.		x	x	x	x	x	x	x	x
(-L) Impact on aquatic life between Lowell and Lawrence								x	

* In a number of cases, the designations of adverse or beneficial and long or short-term may be subject to question. The designations associated with the impacts are the best judgments of the authors.

SUMMARY OF IMPACTS

Geographical Area Lowell-Dracut-Tewksbury-Eastern Tyngsborough

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	
									Biological (cont'd)
								x	(+L) Due to buffering capabilities of land, discharge to land preferred over discharge to receiving stream.
								x	(+L) Recharge of groundwater aquifers.
									Engineering
		x			x	x	x		(+L) Large facility could realize improved operational efficiency.
x	x	x	x	x	x	x	x	x	(-L) Site expansion capabilities.
									Socio-Economic
x	x	x	x	x	x	x	x	x	(+L) Sewer service area would encourage development consistent with economic goals in Tewksbury and Lowell.
x									(-L) Excessive concentrations of nutrients in Merrimack River will limit recreational benefits.
	x	x	x	x	x	x	x	x	(+L) Advanced treatment may permit increased recreational pursuits.
	x	x	x	x	x	x	x	x	(-S) Local traffic patterns effected during construction of collection systems.
	x	x	x	x	x	x	x	x	(+L) Service sector associated with recreational pursuits will increase with improved water quality.

SUMMARY OF IMPACTS

Geographical Area Lowell-Dracut-Tewksbury Eastern Tyngsborough

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Socio-Economic (cont'd)									
(-L) Sewer service areas compatability with regional and local land use plans.		x	x	x	x	x	x	x	x
(-L) 460 acres of land in Lancaster, 200 acres in Groton and 150 acres in Westford removed from tax roles.									x
Hygienic									
(-L) Transmission lines subject to leakage and pump failures.						x	x	x	x
(-L) Trace metals in fish flesh, which presently exceed safe standards for human consumption, will continue to biomagnify through the food chain.	x								
(-L) Ineffective virus removal with chlorination.	x	x	x	x	x	x	x	x	x
(+L) Advanced treatment will remove substances that can interfere with disinfection.			x	x	x				

SUMMARY OF IMPACTS

Geographical Area Chelmsford-Western Tyngsborough-Eastern Dunstable

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Aesthetic									
(-L) 435 acres of rapid infiltration sites effect landscape quality.									x
(-S) Transmission systems impact on natural environment.						x	x	x	
(+L) Potential recreational corridors along transmission lines.						x	x	x	
(+L) Rural character of Dunstable and West Tyngsborough maintained.	x			x	x				
(+L) 180-acre spray irrigation site in Chelmsford maintains open space.									x
Biological									
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.			x						x
(-L) Potential residual chlorine toxicities to aquatic organisms.				x	x	x			
(+L) Recharge of groundwater aquifers.			x						x
(-L) Flow of local feeder streams.						x	x	x	
(+L) Individual septic systems maintain flow of feeder streams in Western Tyngsborough and Eastern Dunstable.	x			x	x				
(-L) Nutrients in Merrimack River may exceed acceptable limits.	x								
(-L) Potential residual chlorine toxicities to aquatic organisms.				x	x	x			
(+L) Water quality improved to acceptable limits.			x	x	x	x	x	x	x

SUMMARY OF IMPACTS

Geographical Area Chelmsford-Western Tyngsborough-Eastern Dunstable

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Engineering									
(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.		x							x
(+L) Land systems more likely to consistently achieve design capability.		x							x
(-L) Operation and maintenance economies.					x				
Socio-Economic									
(-L) Treatment site compatability with future land use plans.		x							x
(-L) 210 acres removed from roles of taxable land in Tyngsborough.		x							x
(-L) 225 acres removed from roles of taxable land in Dunstable.									x
(-L) 180 acres removed from roles of taxable land in Chelmsford.									x
(-S) Transmission line construction effect on local traffic patterns.	x	x	x	x	x	x	x	x	x
(+L) Service sector associated with recreational pursuits will increase with improved water quality.		x	x	x	x	x	x	x	x

SUMMARY OF IMPACTS

Geographical Area Chelmsford-Western Tyngsborough-Eastern Dunstable

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Hygienic									
(-L) Transmission lines subject to leakage and pump failures.							x	x	x
(-L) Ineffective virus removal with chlorination.	x	x	x	x	x				x
(+L) Advanced treatment will remove substances that can interfere with disinfection.		x	x	x	x				

SUMMARY OF IMPACTS

Geographical Area Billerica

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Aesthetic									
(+L) Flow augmentation of Concord River during low flow periods.	x	x	x	x	x		x		
(-L) 340-acre rapid infiltration site effect on landscape quality.									x
(-S) Transmission systems impact on natural environment.							x	x	
(+L) Potential recreational corridors along transmission lines.		x	x	x	x	x	x	x	x
(+L) Treatment plant design could accommodate need for river access point.	x	x	x	x	x	x	x	x	x
Biological									
(-L) Treatment plant failure would have a substantial impact on aquatic life of Concord River.		x	x	x	x		x		
(-L) Residual chlorine, chloramines and ammonia may exceed acceptable limits.		x	x	x	x		x		
(-L) Nutrients in Concord River will exceed acceptable limits.	x								
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.									x
(+L) Recharge of groundwater aquifers in Concord-Carlisle area.									x
(+L) Flow augmentation will enhance aquatic life during low flow periods.		x	x	x	x		x		
(-L) Mercury concentrations effect on game fish species.	x								

SUMMARY OF IMPACTS

Geographical Area Billerica

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Engineering									
(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.									X
(+L) Land systems more likely to consistently achieve design capability.		X							X
Socio-Economic									
(+L) Sewer service areas compatible with regional land use plans.		X	X	X	X	X	X	X	X
(-L) Excessive concentrations of nutrients in Concord River will limit recreational benefits.	X								
(-L) 340 acres removed from roles of taxable land in Concord and Carlisle.									X
(-S) Local traffic patterns effected during construction of collection systems.	X	X	X	X	X	X	X	X	X
(+L) Service sector associated with recreational pursuits will increase with improved water quality.		X	X	X	X	X	X	X	X
(+L) Treatment site in proposed industrial development area would support goals for economic development.		X							X

SUMMARY OF IMPACTS

Geographical Area Billerica

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Hygienic									
(-L) Transmission lines subject to leakage and pump failures.							X	X	
(-L) Trace metals in fish flesh, which presently exceed safe standards for human consumption, will continue to biomagnify through the food chain.	X								
(-L) Effluent discharge above Billerica water supply intake.						X	X		
(-L) Ineffective virus removal with chlorination.	X	X	X	X	X	X	X	X	X
(+L) Advanced treatment will remove substances that can interfere with disinfectio		X	X	X	X	X	X		

SUMMARY OF IMPACTS

Geographical Area Westford

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Aesthetic									
(-L) 150-acre rapid infiltration system effect on landscape quality.									x
(-S) Transmission systems impact on natural environment.		x	x			x	x	x	
(+L) Potential recreational corridors along transmission lines.		x	x		x	x	x	x	x
(+L) 620-acre spray irrigation system maintains open space.									x
Biological									
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.									x
(+L) Recharge of groundwater aquifers.									x
(-L) Flow of local feeder streams.		x	x		x	x	x	x	
(+L) Nutrients in wastewater utilized by agricultural crops.									x
(+L) Individual septic systems maintain flow in local feeder streams.				x					
Engineering									
(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.									x
(-L) Operation and maintenance economies.									x

SUMMARY OF IMPACTS

Geographical Area Westford

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Socio-Economic									
(-L) Sewer service compatibility with planned industrial, commerical, and residential areas.	x	x	x	x	x	x	x	x	x
(+L) Economic return on crops harvested.									x
(-L) 770 acres removed from roles of taxable land.									x
(-S) Local traffic patterns effected during construction of collection systems.	x	x	x	x	x	x	x	x	x
(-L) Rapid infiltration site conflicts with future land use plans.									x
Hygienic									
(-L) Transmission lines subject to leakage and pump failure.			x	x		x	x	x	
(-L) Ineffective virus removal with chlorination.									x

SUMMARY OF IMPACTS

Geographical Area Pepperell-Western Dunstable

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Aesthetic									
(-L) 320-acre rapid infiltration system effect on landscape quality.		X			X				X
(-S) Transmission system impact on natural environment.		X	X		X	X	X	X	X
(+L) Potential recreational corridors along transmission lines.		X	X		X	X	X	X	X
(+L) Rural character of Dunstable maintained.	X		X		X				
Biological									
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.		X			X				X
(-L) Potential residual chlorine toxicities to aquatic organisms.						X			
(+L) Recharge of groundwater aquifers.		X			X				X
(+L) Individual septic systems maintain flow in feeder streams.					X				
Engineering									
(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.		X			X				X
(+L) Land systems more likely to consistently achieve design capability.		X			X				X

SUMMARY OF IMPACTS

Geographical Area Pepperell-Western Dunstable

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Socio-Economic									
(-L) Rapid infiltration site conflicts with land use plans.		x		x					x
(-L) 320-acres removed from roles of taxable land.		x		x					x
(-L) Sewer service in low density area might create development pressures.		x	x	x	x	x	x	x	x
Hygienic									
(-L) Transmission lines subject to leakage and pump failures.						x	x	x	
(-L) Ineffective virus removal with chlorination.	x	x	x	x	x				x
(+L) Advanced treatment plant will remove substances that interfere with disinfection.			x		x				

SUMMARY OF IMPACTS

Geographical Area Newburyport-Newbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Aesthetic										
(-S) Transmission systems impact on natural environment.							x	x	x	
(+L) Potential recreational corridors along transmission lines.							x	x	x	
(+L) Treatment plant design could accommodate need for river access point.	x	x	x	x	x	x	x	x	x	x
Biological										
(-L) Ammonia, residual chlorine or chloramines may exceed acceptable limits in the Merrimack estuary.	x	x			x		x	x	x	x
(+L) Levels of toxic materials reduced.			x	x		x	x	x		
(-L) Accumulation of toxic materials in shellfish would still be possible due to upstream discharges.	x	x	x	x	x	x	x	x	x	x
Engineering										
(+L) Operation and maintenance economies could be realized						x	x	x		

SUMMARY OF IMPACTS

Geographical Area Newburyport-Newbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Socio-Economic										
(-L) Sewer service in low density area might create development pressures in Newburyport.	x	x	x	x	x	x	x	x	x	x
(-S) Local traffic patterns affected during construction of collection systems.	x	x	x	x	x	x	x	x	x	x
(+L) Service sector associated with recreational pursuits will increase.			x	x		x	x	x	x	x
(+L) Clam flats may be able to open.			x	x		x	x	x		
Hygienic										
(-L) Transmission lines subject to leakage and pump failures.						x	x	x		
(-L) Treatment plant failure will cause health hazard in harvesting clams.	x	x		x	x		x	x	x	x
(-L) Ineffective virus removal with chlorination	x	x	x	x	x	x	x	x	x	x
(+L) Advanced waste treatment will remove substances that can interfere with disinfection				x			x	x		

SUMMARY OF IMPACTS

Geographical Area Georgetown

-L - Adverse impact - long term
-S - Adverse impact - short term
L - Beneficial impact - long term
S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Aesthetic										
(-L) 160-acre rapid infiltration system effect on landscape quality.									x	x
(-S) Transmission systems impact on natural environment.					x	x	x	x		
(+L) Potential recreational corridors along transmission lines.					x	x	x	x		
(+L) 460-acre spray irrigation system maintains open space.									x	x
(+L) Rural character of town maintained.			x	x						
(+L) Potential for recreational pursuits at spray irrigation sites.									x	x
Biological										
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.									x	x
(-L) Recharge of groundwater aquifers.					x	x	x	x		
(+L) Nutrients in wastewater utilized by agricultural crops.									x	x
(+L) Individual septic systems maintain flow in feeder streams.		x	x	x						

SUMMARY OF IMPACTS

Geographical Area Georgetown

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Engineering										
(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.									x	x
(-L) Operation and maintenance economies.									x	x
(+L) Land systems more likely to consistently achieve design capability.									x	x
Socio-Economic										
(-L) Treatment site compatibility with open space plans.									x	x
(+L) Sewer service areas supportive of regional land use plans.	x	x	x	x	x	x	x	x	x	x
(+L) Economic return on crops harvested.									x	x
(-L) 620 acres removed from roles of taxable land.									x	x
Hygienic										
(-L) Transmission lines subject to leakage and pump failures.					x	x	x	x		
(+L) Advanced waste treatment removes substances that can interfere with disinfection.					x	x	x	x		
(-L) Ineffective virus removal with chlorination.	x	x			x	x	x	x	x	x

SUMMARY OF IMPACTS

Geographical Area Rowley

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Aesthetic										
(+L) 320-acre spray irrigation system maintains open space.									x	x
(-S) Transmission systems impact on natural environment.							x	x		
(+L) Potential recreational corridors along transmission lines.							x	x		
(+L) Rural character of town maintained.		x	x	x						
Biological										
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.									x	x
(-L) Potential residual chlorine toxicities to aquatic organisms in Rowley River.					x					
(+L) Recharge of groundwater aquifers.									x	x
(-L) Flow of local feeder streams.							x	x		
(+L) Nutrients in wastewater utilized agricultural crops.									x	x
(+L) Individual septic systems maintain flow in feeder streams.		x	x	x						

SUMMARY OF IMPACTS

Geographical Area Rowley

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Engineering										
(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives									x	x
(+L) Land systems more likely to consistently achieve design capability.									x	x
(-L) Operation and maintenance economies.									x	x
Socio-Economic										
(+L) Economic return on crops harvested									x	x
(-L) 320 acres removed from roles of taxable land.									x	x
(-L) Treatment site compatibility with open space plans.					x				x	x
Hygienic										
(-L) Transmission lines subject to leakage and pump failures							x	x		
(-L) Effluent discharge to Rowley River.					x					
(-L) Ineffective virus removal with chlorination.					x				x	x

SUMMARY OF IMPACTS

Geographical Area West Newbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Aesthetic										
(-S) Transmission systems impact on natural environment.						X	X	X		
(+L) Potential recreational corridors along transmission lines.						X	X	X		
(+L) Spray irrigation systems maintain open space.									X	X
(+L) Rural character of town maintained.		X	X	X						
(+L) Potential for recreational pursuits at spray irrigation sites.									X	X
Biological										
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.									X	X
(+L) Recharge of groundwater aquifers.									X	X
(-L) Flow of local feeder streams.					X	X	X	X		
(+L) Nutrients in wastewater utilized by agricultural crops.									X	X
(+L) Individual septic systems maintain flow in feeder streams.		X	X	X						

SUMMARY OF IMPACTS

Geographical Area West Newbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Engineering										
(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.									x	x
(+L) Land systems more likely to consistently achieve design capability.									x	x
(-L) Operation and maintenance economies.									x	
Socio-Economic										
(+L) Spray irrigation sites would support open space goals.									x	x
(+L) Economic return on crops harvested.									x	x
(-L) 270 acres removed from roles of taxable land.									x	
(-L) 570 acres removed from roles of taxable land.										x
Hygienic										
(-L) Transmission lines subject to leakage and pump failures.						x	x	x		
(-L) Ineffective virus removal with chlorination.									x	

SUMMARY OF IMPACTS

Geographical Area Merrimac

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Aesthetic										
(+L) Spray irrigation system maintains open space.		x	x	x					x	
(-S) Transmission systems impact on natural environment.						x				
(+L) Potential recreational corridors along transmission lines.			x	x	x	x	x	x		x
(+L) Potential for recreational pursuits at spray irrigation sites.		x	x	x					x	
(+L) Protection of Lake Attitash water quality.			x	x						
Biological										
(-L) Nutrients in Merrimack River may exceed acceptable limits.	x									
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.		x	x	x					x	x
(+L) Recharge of groundwater aquifers.		x	x	x					x	x
(-L) Regional configurations impact on instream flow.					x	x	x	x		
(+L) Nutrients in wastewater utilized by agricultural crops.			x	x						

SUMMARY OF IMPACTS

Geographical Area Merrimac

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Engineering										
(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.									x	x
(+L) Land systems more likely to consistently achieve design capability.		x	x	x	x				x	x
(-L) Operation and maintenance economies.	x	x				x			x	x
Socio-Economic										
(-L) Treatment site compatibility with open space plans.		x			x				x	x
(+L) Sewer service area supports plans for medium and industrial development.	x	x	x	x	x	x	x	x	x	x
(-L) Excessive concentrations of nutrients in Merrimack River will limit recreational benefits.	x									
(+L) Preserves future water supply.			x	x						
(+L) Enhancement of recreation and industrial development.			x	x						
(+L) Economic return on crops harvested.			x	x					x	x
(-L) 380 acres removed from roles of taxable land.		x	x						x	x
(-L) 250 acres removed from roles of taxable land.				x						

SUMMARY OF IMPACTS

Geographical Area Merrimac

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Socio-Economic (Cont'd)										
(-S) Local traffic patterns effected during construction of collection systems.	X	X	X	X	X	X	X	X	X	X
(+L) Service sector associated with recreational pursuits will increase with improved water quality.		X	X	X	X	X	X	X	X	X
Hygienic										
(-L) Transmission lines subject to leakage and pump failures.						X				
(-L) Trace metals in fish flesh, which presently exceed safe standards for human consumption, will continue to biomagnify through the food chain.	X									
(-L) Ineffective virus removal with chlorination.	X	X			X				X	X

SUMMARY OF IMPACTS

Geographical Area Amesbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Aesthetic										
(+L) Flow augmentation of Powwow River during low flow periods.					X					
(-L) Rapid infiltration systems effect on landscape quality.		X	X	X					X	X
(-S) Transmission systems impact on natural environment.			X	X			X	X		
(+L) Potential recreational corridors along transmission lines.			X	X	X		X	X		
(+L) Spray irrigation system maintains open space.				X						
Biological										
(+L) Flow augmentation of Powwow River will increase dissolved oxygen levels during low flow periods.						X				
(+L) Removal of raw sewage discharges will significantly improve water quality of Powwow River.	X									
(-L) Nutrients in Merrimack River may exceed acceptable limits.	X									
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.		X	X	X					X	X
(-L) Potential residual chlorine toxicities to aquatic organisms.	X				X	X				
(+L) Recharge of groundwater aquifers.		X	X	X					X	X
(+L) Nutrients in wastewater utilized by agricultural crops.			X	X						

SUMMARY OF IMPACTS

Geographical Area Amesbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Engineering										
(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.									x	x
(+L) Land systems more likely to consistently achieve design capability.		x	x	x					x	x
Socio-Economic										
(-L) Treatment site compatibility with open space plans.		x	x	x					x	x
(-L) Sewer service in low density area might create pressure for development contrary to open space goals.	x	x	x	x	x	x	x	x	x	x
(-L) Excessive concentrations of nutrients in Merrimack River will limit recreational benefits.	x									
(+L) Advanced treatment systems may permit increased recreational pursuits.					x	x	x	x		
(+L) Preserves future water supply.			x	x						
(+L) Enhancement of recreation and industrial development.			x	x						
(+L) Economic return on crops harvested.			x	x						
(-L) 80 acres removed from roles of taxable land.		x	x						x	x
(-L) 370 acres removed from roles of taxable land.				x						

SUMMARY OF IMPACTS

Geographical Area Amesbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Socio-Economic (Cont'd)										
(-S) Local traffic patterns affected during construction of collection systems.	X	X	X	X	X	X	X	X	X	X
(+L) Service sector associated with recreational pursuits will increase with improved water quality.	X	X	X	X	X	X	X	X	X	X
Hygienic										
(-L) Transmission lines subject to leakage and pump failures.							X	X		
(-L) Trace metals in fish flesh, which presently exceed safe standards for human consumption, will continue to biomagnify through the food chain.	X									
(-L) Ineffective virus removal with chlorination.	X	X	X	X	X	X			X	X
(+L) Advanced treatment will remove substances that can interfere with disinfection.					X	X				

SUMMARY OF IMPACTS

Geographical Area Salisbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Aesthetic										
(-L) Rapid infiltration system effect on landscape quality.					x				x	x
(-L) Treatment plant and transmission systems' impact on wetlands.				x		x	x	x		
(+L) Spray irrigation of Amesbury flows in Salisbury maintains open space.					x					
Biological										
(-L) Ammonia, residual chlorine or chloramines may exceed acceptable limits in Merrimack estuary.	x	x				x		x	x	
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.					x				x	x
(+L) Levels of toxic materials reduced.					x	x	x	x	x	x
(-L) Soils marginally suitable for rapid infiltration.					x				x	x
(-L) Accumulation of toxic materials in shellfish would still be possible due to upstream discharges.	x	x	x		x	x	x	x	x	x

SUMMARY OF IMPACTS

Geographical Area Salisbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Engineering										
(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.				x					x	x
(+L) Land systems more likely to consistently achieve design capability.				x					x	x
(-L) Operation and maintenance economies.	x	x	x	x	x	x	x		x	x
Socio-Economic										
(-L) Treatment site compatibility with open space plans.	x	x	x		x	x	x			
(+L) Sewer service area supports plans for medium and industrial development.	x	x	x	x	x	x	x	x	x	x
(+L) Clam flats may be able to open.		x	x	x		x	x	x	x	x
(-L) 110 acres removed from roles of taxable land.									x	x
(-S) Local traffic patterns affected during construction of collection systems.	x	x	x	x	x	x	x	x	x	x
(-L) 360 acres removed from roles of taxable land.				x						
Hygienic										
(-L) Transmission lines subject to leakage and pump failures.			x			x	x	x		
(-L) Treatment plant failure will cause health hazard in harvesting clams.		x	x		x	x	x	x		
(-L) Ineffective virus removal with chlorination.	x	x	x	x	x	x			x	x

SUMMARY OF IMPACTS

Geographical Area Boxford

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Aesthetic										
(-L) 115-acre rapid infiltration system effect on landscape quality.									x	x
(-S) Transmission systems' impact on natural environment.							x	x		
(+L) Potential recreational corridors along transmission lines.		x			x	x	x	x	x	x
(+L) 450-acre spray irrigation system maintains open space.									x	x
(+L) Rural character of town maintained.			x	x						
(+L) Potential for recreational pursuits at spray irrigation sites.									x	x
Biological										
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.									x	x
(-L) Potential residual chlorine toxicities to aquatic organisms.					x					
(+L) Recharge of groundwater aquifers.									x	x
(-L) Flow of local feeder streams.		x				x	x	x		x
(+L) Nutrients in wastewater utilized by agricultural crops.									x	x
(+L) Individual septic systems maintain flow in feeder streams.			x	x						

SUMMARY OF IMPACTS

Geographical Area Boxford

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Engineering										
(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.									x	x
(+L) Land systems more likely to consistently achieve design capability.									x	x
(-L) Operation and maintenance economies.					x				x	
Socio-Economic										
(-L) Treatment site compatibility with open space plans.					x				x	
(+L) Economic return on crops harvested.									x	x
(-L) 580 acres removed from roles of taxable land.									x	x
Hygienic										
(-L) Transmission lines subject to leakage and pump failures.							x	x		
(-L) Ineffective virus removal with chlorination.					x				x	

SUMMARY OF IMPACTS

Geographical Area Haverhill-Groveland

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Aesthetic										
(+L) Flow augmentation of Merrimack River during low flow periods.				x				x	x	
(-L) 530-acre rapid infiltration system effect on landscape quality.			x							x x
(-S) Transmission systems impact on natural environment.				x			x x	x		
(+L) Potential recreational corridors along transmission lines.				x			x x	x		
(+L) Improved visual quality of Merrimack River.	x									
(+L) Treatment plant design could accommodate need for river access point.	x	x	x x	x x	x	x	x x	x	x x	
Biological										
(-L) Nutrients in Merrimack River may exceed acceptable limits.	x									
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.			x							x x
(-L) Potential residual chlorine toxicities to aquatic organisms.	x				x x	x	x			
(+L) Recharge of groundwater aquifers.			x							x x
(+L) Flow augmentation will enhance aquatic life during low flow periods especially in river reaches between Lawrence and Haverhill.				x				x	x	

SUMMARY OF IMPACTS

Geographical Area Haverhill-Groveland

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Biological (Cont'd)										
(-L) Soils marginally suitable for rapid infiltration in Groveland area.			x						x	x
(+L) Water quality improved to acceptable limits.			x	x	x	x	x	x	x	x
Engineering										
(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.			x						x	x
(+L) Land systems more likely to consistently achieve design capability.			x						x	x
Socio-Economic										
(-L) Sewer service in low density area might create pressure for development contrary to open space goals.			x	x	x	x	x	x	x	x
(-L) Excessive concentrations of nutrients in Merrimack River will limit recreational benefits.	x									
(+L) Advanced treatment may permit increased recreational pursuits.			x	x	x	x	x	x	x	x
(-L) 530 acres removed from roles of taxable land.			x						x	x

SUMMARY OF IMPACTS

Geographical Area Haverhill-Groveland

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

	STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
Socio-Economic (Cont'd)										
(-S) Local traffic patterns affected during construction of collection systems.	x	x	x	x	x	x	x	x	x	x
(+L) Service sector associated with recreational pursuits will increase with improved water quality.		x	x	x	x	x	x	x	x	x
(-L) Land treatment sites compatbility with future land use plans.		x							x	x
Hygienic										
(-L) Transmission lines subject to leakage and pump failures.							x	x	x	
(-L) Trace metals in fish flesh, which presently exceed safe standards for human consumption, will continue to biomagnify through the food chain.	x									
(-L) Ineffective virus removal with chlorination.	x	x	x	x	x	x	x	x	x	x
(+L) Advanced waste treatment will remove substances that can interfere with disinfection.				x	x	x				

SUMMARY OF IMPACTS

Geographical Area Greater Lawrence Sanitary District
(Andover, North Andover, Methuen, Lawrence)

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6		
											Aesthetic
	x	x	x	x	x	x	x	x	x	(+L)	Flow augmentation of Merrimack River during low flow periods.
							x			(-S)	Transmission system impact on natural environment.
							x			(+L)	Potential recreational corridors along transmission lines.
x										(+L)	Improved visual quality of Merrimack River.
x	x	x	x	x	x	x	x	x	x	(+L)	Treatment plant design could accommodate need for river access point.
											Biological
x										(-L)	Nutrients in Merrimack River may exceed acceptable limits.
x	x	x	x	x	x	x	x	x	x	(-L)	Potential residual chlorine toxicities to aquatic organisms.
	x	x	x	x	x	x	x	x	x	(+L)	Flow augmentation will enhance aquatic life during low flow periods.
	x	x	x	x	x	x	x	x	x	(+L)	Water quality improved to acceptable limits.
											Engineering
		x				x	x			(+L)	Large facility could realize improved operational efficiency.

SUMMARY OF IMPACTS

Geographical Area Greater Lawrence Sanitary District
(Andover, North Andover, Methuen, Lawrence)

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6		
											Socio-Economic
	x	x	x	x	x	x	x	x	x	(-L)	Sewer service in low density area might create development pressure in Andover, North Andover and Methuen.
x										(-L)	Excessive concentrations of nutrients in Merrimack River will limit recreational benefits.
	x	x	x	x	x	x	x	x	x	(+L)	Advanced treatment may permit increased recreational pursuits.
	x	x	x	x	x	x	x	x	x	(-S)	Local traffic patterns affected during construction of collection systems.
	x	x	x	x	x	x	x	x	x	(+L)	Service sector associated with recreational pursuits will increase with improved water quality.
											Hygienic
		x				x	x			(-L)	Transmission lines subject to leakage and pump failures.
x										(-L)	Trace metals in fish flesh, which presently exceed safe standards for human consumption, will continue to biomagnify through the food chain.
x	x	x	x	x	x	x	x	x	x	(-L)	Ineffective virus removal with chlorination.
	x	x	x	x	x	x	x	x	x	(+L)	Advanced waste treatment will remove substances that can interfere with disinfection.

B. FORMULATION OF ALTERNATIVES

1. Public Participation in Plan Formulation

Staff from each of the Federal, State and regional agencies that compose the technical subcommittee which directed the day-to-day work of the study contributed to the development of the public participation program and reviewed its progress at regular meetings. The Corps of Engineers and the regional planning agencies, especially the Merrimack Valley Planning Commission (MVPC) and Northern Middlesex Area Commission (NMAC), were responsible for encouraging public participation during the formulation of the alternative wastewater management systems.

Highlights of the public participation program include three sets of public meetings for a total of seven such meetings and 35 publicly announced workshops between the first and third sets of public meetings. The technical subcommittee met six times between the public meetings, and it has met seven times since the third set of public meetings. After the third set of public meetings, cities and towns which were dissatisfied with study findings were asked to meet with the technical subcommittee to resolve any and all differences. Eight communities accepted this invitation.

There were 67 miscellaneous meetings before the first public meetings, and these helped pave the way for the public participation program. In addition, numerous informal meetings have brought together people with a critical interest in wastewater management throughout the study and two People's Armadas (widely publicized canoe trips) along the river have helped generate widespread awareness of opportunities for public participation.

Study goals and objectives, planning assumptions and existing water quality conditions were presented at the early stage public meetings in October 1973. The data on which the wastewater management systems were to be based was also made available.

The regional planning agencies began holding workshops in November 1973 after the first wastewater management alternatives were prepared to learn preferences of residents of their member communities. MVPC held regional workshops with extra sessions for special interest groups while NMAC chose to hold two workshops in each of its communities with subsequent sessions in communities which were critical to the wastewater management systems.

Formal evaluation of the wastewater management alternatives began at the time of the mid-stage public meetings in April 1974 and at the workshops which followed. Preliminary cost estimates became available at this time and the draft assessments of the aesthetic, biological, hygienic and socio-economic impacts became available soon afterwards and were made public.

When the technical subcommittee met at the end of May 1974 to generate draft cost-effective wastewater management systems, they worked from three hybrid alternatives which combined systems from the 11 alternatives which the study had developed. The first was the least cost alternative, the second was the minimal impact alternative, and the third was an alternative which contained systems delineated by both MVPC and NMAC staff based upon their understanding of the preferences of the communities which they serve.

The draft cost-effective systems were presented at late-stage public meetings in June 1974, and communities which asked to see changes in their composition were asked to meet with the technical subcommittee. Eight of the 24 cities and towns affected by the draft systems requested such a meeting.

When difficulties created by the draft cost-effective systems were resolved, the Division Engineer of the New England Division and policy-making officials of the Commonwealth were to be asked to concur with the recommendations of the technical subcommittee. A final report was then prepared for the signatures of the Division Engineer and the Governor of Massachusetts. The communities affected by the report were given a review period before the report was forwarded to the Office of the Chief of Engineers for submittal to the Secretary of the Army and the Congress.

2. Reuse Potentials and Considerations

a. Introduction

The Massachusetts communities in the Merrimack River Basin draw their water supply from three different sources: the Merrimack River and its tributaries, local lakes and reservoirs, and from wells drilled into unconsolidated sands and gravels of glacial origin. The origin of the water in all three cases is precipitation falling on or adjacent to the river, lake or well field and not, as certain popular myths would have it, from some far distant source such as the White Mountains via a "vein" or underground river. It is of paramount importance for those concerned about questions of water and water supply to make this distinction between local and "exotic" origins of the water.

A discussion of the role of precipitation in water supply follows with the intent that the interested reader will more easily understand how wastewater discharge can be used to complement precipitation as a water resource. The average annual precipitation in the Lawrence-Lowell-Haverhill area is approximately 42-43 inches. The precipitation is distributed rather evenly over the year. Of this yearly amount, approximately 21-22 inches is returned almost immediately to the atmosphere by evaporation and transpiration (transpiration by vegetation). Of the remaining 21-22 inches, a portion runs off the land directly into surface bodies of water such as streams and lakes and the rest infiltrates through the soil to become groundwater. Groundwater is that water occupying the voids in the soil and rock underlying the surface. Not all of the void space in the soil and rock is saturated with water. The surface of boundary between the saturated zone and overlying zone (unsaturated) is called the water table. Precipitation must infiltrate through the unsaturated zone to reach the groundwater reservoir.

Groundwater is an abundant resource. An appreciation of the importance of the groundwater reservoir to water supply can be gained from the fact that there is about thirty-five times as much available freshwater stored in the ground as there is in all the lakes and rivers in the world.

The water in the ground is by no means stationary but rather is constantly in motion (rather slow motion) so that it discharges to the surface at rivers, lakes and swamps. It is groundwater which allows wells to produce, rivers to flow, and lakes to remain relatively full even after prolonged periods of little or no rainfall. In short, the

continuity of water supply, whether it be from wells, rivers or reservoirs, is afforded not by precipitation directly but rather by the groundwater resources of an area. The primary source of the water flowing from household taps is precipitation. If it were not for the existence of a large volume of water stored in the ground which continually feed rivers, lakes and wells, however, the water faucets would function sporadically, only during and immediately after periods of rainfall. When precipitation recharges the groundwater reservoir, it is making an absolutely necessary contribution to our water supplies.

With the above hydrogeological summary as background, it is possible to address the question of how wastewater can be used to augment water resource supplies. The answer lies in substituting the term treated wastewater for precipitation in the foregoing discussion. Wastewater can adequately and safely perform all the functions of precipitation providing it has been properly treated. It can be fed directly into rivers and streams or it can be applied on the ground where it will infiltrate to the groundwater reservoir, and from there to recharge wells and surface water supplies such as reservoirs and rivers.

The study considered properly treated wastewater as a resource. The water resources quantity of any geographical area, including the Merrimack River Basin, are essentially fixed. This concept that the total available water resources are finite does not imply that the system is static. On the contrary, the water balance within a specified area is in the state of dynamic equilibrium. The natural outflows via stream flows, evaporation, groundwater movement must be balanced with natural replenishment from precipitation. Similarly, outflows via pumped water supply can be balanced by replenishment from wastewater renovation facilities.

b. Water Reuse Constraints

Essentially, three engineering considerations constrain the use of any given water:

(1) Water Quantity

(2) Temporal Distribution

(3) Water Quality

Water quantity is not the major limitation in New England, a comparatively water-rich area with a mean annual rainfall in excess of 42 inches. However, temporal distribution places some limitation

on the use of water in the Merrimack Basin. Water quality is the major limiting factor on the use of water resources in the Merrimack Basin.

When any one of the three constraints is excessively limiting, it makes the entire water supply unsuitable for use. In the case of the Merrimack River and its major tributaries, typical water quality constraints include:

(1) Water too high in pathogens, such as bacteria and viruses, nitrates, and refractory organics to be suitable for a municipal water supply.

(2) Water too highly colored for use in the paper and textile industries.

(3) Water too high in dissolved solids for use as industrial process water, such as boiler feed water.

(4) Water too low in dissolved oxygen to be suitable for propagation of indigenous fish species.

(5) Water too high in pathogens to be suitable for agriculture irrigation.

(6) Water too highly colored and high in pathogens to be suitable for water-contact sports.

c. Wastewater Renovation and Reuse

Two separate categories of technologies can be employed to insure that wastewater is renovated to meet the most stringent water quality tests and thus be able to serve as a water resource. The categories are:

(1) Water-oriented technology whereby wastewater undergoes a series of primary, secondary and tertiary treatment components.

(2) Land-oriented technology whereby secondary treatment effluent can be sprayed upon vegetative tracts of land, or flooded over sand beds, and collected for reuse by underground drainage collection systems.

Current technology can technically renovate wastewater to any level of purity from industrial cooling water to drinking water. The level of treatment selected may be based upon the designated reuse of the treated wastewater. Reuse potentials for renovated wastewater are:

(1) Restoration of river quality
(2) Flow augmentation
(3) Groundwater recharge
(4) Industrial water supply
(5) Irrigation
(6) Creation of recreational water bodies
(7) Municipal water supply
(8) Aquaculture

d. Restoration of River Quality

Addition of nutrient limited renovated wastewater to the river can increase the growth of algae and other aquatic plants. A well balanced diverse community of aquatic organisms is necessary for a healthy aquatic ecosystem, however, excessive growths of algae may deplete the water's supply of life-sustaining dissolved oxygen.

Wastewater can be renovated to be virtually free of suspended solids. Addition of this renovated wastewater to the river should minimize turbidity, which curtails photosynthesis by prohibiting sunlight penetration into the water. Reduction of the river's suspended solids would also greatly enhance the aesthetic quality of the river by improving its clarity.

Wastewater treatment can deactivate virtually all disease producing bacteria, virus and protozoa. Addition of pathogen-free renovated wastewater to the river, would restore the river quality for swimming and bathing. Shellfish harvesting could once again be a hygienically safe and enjoyable recreation as well as provide commercial revenues.

Sustaining various species of fishlife requires specific water quality levels of temperature, pH, dissolved oxygen, turbidity, carbon dioxide, nutrients, salinity, heavy metals and pathogenic organisms. Water quality criteria is usually more stringent for the natural propagation of various fish species. The degree of river restoration desirable may be based on the type of sport fish and/or indigenous fish desirable to sustain and/or propagate. Generally speaking, water suitable for fish and other aquatic organisms will be suitable for wildlife.

e. Flow Augmentation

Renovated wastewater could also be used to augment flow during dry seasons such as the late summer months. A regulated steady stream flow would enhance the aesthetics of the river as well as help maintain a proper temperature and dissolved oxygen level for sustaining fishlife. Low flows result in less turbulence and less reaeration, and thereby a reduction in aquatic life-sustaining dissolved oxygen. Low flows during late summer months are also subject to higher temperatures and higher concentrations of pollutants from point and non-point sources. The rivers' capability to assimilate waste loads is severely decreased during low flows. In addition to environmental reasons, segments of the river, such as the canals in Lowell, require a minimum flow for industrial purposes. Recycling of reclaimed water through selected sections of the river would reduce low-flow segments.

f. Groundwater Recharge

Increasing groundwater withdrawals without adequate replenishment, leads to gradual lowering of the groundwater table. Highly treated wastewater can recharge groundwater in the same manner as precipitation. As it filters down through the soil, further treatment occurs as an insurance for public health and safety.

The groundwater aquifer can be recharged by the following methods:

(1) deep well injection of treated wastewater
(2) land application of treated effluent by rapid infiltration

g. Industrial Water Supply

It is unlikely that substantial direct savings to industrial users would result from clean water in the Merrimack Basin. The problem is quite fundamental. The standards for adequacy of water are quite different for human and industrial uses. Bacterial contamination is rather unimportant from the viewpoint of industry, while certain chemical properties acceptable for human use such as dissolved solids and hardness have undesirable affects on equipment such as boilers, or even in some cases cooling units.

Industrial users usually perform appropriate chemical treatment of intake water to ready it for their special purposes. It is unlikely that they would dispense with this treatment even if the water were clean enough for human consumption. Boston Edison, for example, spends as much as 40 cents per 1,000 gallons for treatment of water taken from the Boston municipal supply. Most of this treatment requirement would remain even with the wastewater management programs proposed by the Merrimack Study.

The removal of dissolved solids from the water -- which most likely would remain in the case of water taken from the Merrimack even after treatment -- is relatively costless in view of the substantial expense required to treat water for purposes of chemical adequacy. Thus, the filtering of solids is usually easily incorporated into the design for chemical pretreatment facilities without additional cost.

h. Irrigation

For purposes of land application, the effluent should be of secondary treatment quality. Using the land as a treatment system may be an effective way of preserving open space. Irrigation systems, similar in concept to everyday lawn sprinklers, could spray the effluent in the evening or early morning hours. This could avail the land to daytime recreation or agricultural production.

Secondary effluent is virtually colorless and odorless. Disinfection can render it pathogen free and hygienically safe for human contact. Only the unseen refractory organics, trace metals, and nutrients remain in any substantial quantities. By land application, these could be removed by the soil and plants before being recycled to the groundwater or collected by underground drainage for various reuses.

The literature suggests that irrigation with treated wastewater should be restricted to regularly harvested crops. Non-harvested crops return nutrients to the land as they die and decompose. For this reason, irrigation of forest land is contingent on regular harvesting. Most of the nutrients consumed by trees find their way into the tree leaves. Therefore, as the leaves annually fall to the ground and decompose, they return the nutrients to the soil. Eventually nutrients begin to leach into the groundwater table.

In dry regions, irrigation has proven to result in greater water loss than water storage. This is because water tends to evaporate sooner when spread on soils than it does from a reservoir. However,

in New England where the water supply problems are those of quality more than quantity and where evaporation rates are relatively low, this is not construed as a constraint.

i. Creation of Recreational Water Bodies

Swimming and other water contact sports are becoming increasingly popular. As the population increases and people acquire more leisure time, the popularity of such sports multiplies.

Unfortunately, while the demand for water based recreation has increased, the quality of the rivers has decreased. In the urban areas where most of the country's taxpayers reside, the demand for recreation is the greatest and the water quality is the worst. Enhancing recreation will not only improve a region's economy by enhancing tourism, but will save money for those people no longer forced to travel to recreate.

Wastewater being reused for recreation must be hygienically safe and have a pH level that is non-irritating to eyes and skin. In addition, it must be relatively free of solids, for unless it is aesthetically pleasing, recreation will not be the outcome of treatment. Public acceptance is mostly based on aesthetic quality of clarity and odor.

j. Municipal Water Supply

The concept of water use is not so much one of "consuming" as it is one of "borrowing". Most of the water we use remains a part of the continuous hydrologic cycle. In the Merrimack Basin, the same gallon of water may scour wool in Lowell and quench a thirst in Lawrence.

Assimilate capacity is the term used to explain a river's natural capability to help renovate wastewater. However, this capacity is limited, and increased wastewater volumes require additional renovation by man-made technology. New industrial production results in structurally complex synthetic compounds, trace metals, and refractory organics which are not naturally removed and, therefore, not able to be assimilated by the rivers. Technology is available for removing these materials from the used water and renovating this wastewater for reuse.

The first question concerning reuse is one of need. Is there a water supply problem in Massachusetts? According to water supply projections done by the Northeastern United States Water Supply Study (NEWS), there is a need and the problem is of special magnitude for the Boston Metropolitan Area. According to Boston's Metropolitan

District Commission "We have so little water that we can no longer guarantee the public water supply for 1984." Not only is population increasing, but the per capita consumption is increasing.

Despite all of this, the problem is more one of quality than quantity. For Eastern Metropolitan Massachusetts, there appears to be two likely engineering water supply alternatives:

(1) interbasin transfer from western or northern river basins
(2) reuse of renovated wastewater

Concerning interbasin transfer, the rivers offering the greatest potential are very polluted. The Merrimack River, which already supplies drinking water to its major urban communities is severely polluted. Because of the heavy pollution of the river, the water removed for domestic use receives purification at water treatment facilities. Treatment normally consists of filtration through media such as sand and carbon and of disinfection with chlorine; some treatment plants include the addition of chemicals which coagulate solids so they will settle out of solution.

Why is treated river water more publically acceptable than highly treated wastewater? Before treatment, both contain the same pollutants only the concentrations vary. There is one argument that would favor using river water for future water supply. If the nation realizes the goal set forth by Congress in the Federal Water Pollution Control Act Amendments of 1972, "that the discharge of pollutants into navigable waters be eliminated by 1985," the rivers should revitalize to become more suitable for water supply.

Concerning the use of renovated wastewater for potable supply, several important items must be explored. Firstly, existing drinking water standards are inadequate in testing the hygienic safety of complex household and industrial pollutants being introduced with each new chemical product. Not only does the list of pollutants increase as laboratory inventions continue, but the effect of these chemicals in humans is generally unknown.

A second concern is that automatic "fail-safe" treatment systems have not yet been developed. The quality of treated effluent varies according to operational difficulties, and the quantity and quality of incoming raw wastewater.

Third, fast and reliable analytical techniques and monitoring devices have yet to be developed. Once adequate drinking water quality standards are developed, continuous monitoring of treated wastewater is necessary to insure compliance with those standards. At the moment, tests for virus require three days to complete. Because of the time necessary to complete water quality monitoring, renovated wastewater would have to be stored before release for reuse. Storage costs would be very expensive, and the volume of land required could be extensive.

Before proposing direct potable water supply reuse of renovated wastewater, short and long term studies should be carried out on population already exposed to reuse. For instance, what were the effects of wastewater reuse in 1956 and 1957 when Chanute, Kansas used treated wastewater to augment their municipal supply. In the Rhine River Basin, millions of people consume river water that may contain as much as 40 per cent wastewater during low flow periods. Aside from well known water-borne diseases, evaluations must include long term effects of carcinogenicity, mutagenicity, and various physiological effects.

Although this study does not propose direct reuse of renovated wastewater drinking water, it does not foreclose the potential for other municipal uses. Treated wastewater can be used for laundry, fire protection, lawn sprinkling, car washes, etc. It may prove feasible to install dual water supply systems, particularly in those communities which currently have no systems. Problems of pipeline hookups being confused could be remedied, especially if a much higher user fee were charged for the potable supply over the renovated wastewater supply. Not only would the cost of treating wastewater be offset by its value for municipal supply, but the demand for water of drinking water quality would be greatly decreased.

k. Aquaculture

Over half a century ago, in Germany, domestic settled sewage effluent was mixed with freshwater for aquaculture. The sewage added nutrients and organics to the freshwater. Carp and ducks were propagated in and on ponds of diluted sewage effluent. Both were grown for sale on the food market.

Today, in experiments at Woods Hole, Massachusetts, scientists are feeding domestic sludge pellets to fishlife.

In other areas, shrimp is being propagated in industrial cooling water effluent diluted with sea water.

1. Recovery and Reuse of Wastewater Solids

"Sludge" is the solids and accompanying liquids removed from wastewater during treatment. Sewage sludge is high in organic matter, and contains wastewater constituents such as pathogens, nutrients, and heavy metals. Aside from wastewater's removed constituents, sludges from advanced treatment facilities contain chemicals, such as lime and alum, used during the treatment process. A major problem which evolves from wastewater treatment is how to handle the sludges.

Sludge can be treated as a resource, in the same way as renovated wastewater is a resource.

Treatment of sludges can destroy the pathogens, and special handling can control the transport of heavy metals. Reuse potentials for sludge include:

(1) Pyrolysis (destructive distillation) of sludge mixed with municipal refuse to a fuel oil.
(2) Compost of sludges mixed with garbage for fertilizer production.
(3) Direct land application of treated (digested) sludge for fertilization.
(4) Reclamation of barren land, such as strip mines, with sludge acting as an organic soil container.
(5) Steam for power generation from incineration of sludges mixed with municipal refuse.

m. Salt Water Infiltration

Salt water contamination of private wells is becoming an increasing problem as more demands are being made upon coastal groundwater supplies. In addition, concern has been expressed over the possibility of salt water infiltration to subsurface sewer and stormwater pipelines. Water with a high chloride concentration cannot be used for land application because of potential salt damage to soils, crops, grasses and other vegetation. Secondary sewage treatment processes cannot remove sodium chloride from the wastewater. Salt water infiltration would thus effective negate the use of secondary effluent for land application.

Tests of effluent discharging from sewage treatment plants have shown chloride concentrations ranging from 70-350 ppm, and specific conductance readings in the range of 1700. Although this data is not conclusive, it has, together with the general concern over salt water infiltration, prompted an effort to delineate a "safe line", inland of which salt water infiltration to buried pipes would be highly improbable.

The location of the fresh/salt water interface is determined in great part by (a) the distance inland from the shoreline; and (b) the elevation of the freshwater table. Because of its lighter density, freshwater will float in sea water (very similar to an ice cube floating in water). Quantitatively the density relationships imply that for every foot of freshwater floating above sea water there will be approximately 35-40 feet of freshwater below sea level. These natural phenomena result in near shore salt water occurring as a wedge underneath a lens of freshwater. Figure 1 is a schematic diagram illustrating this occurrence.

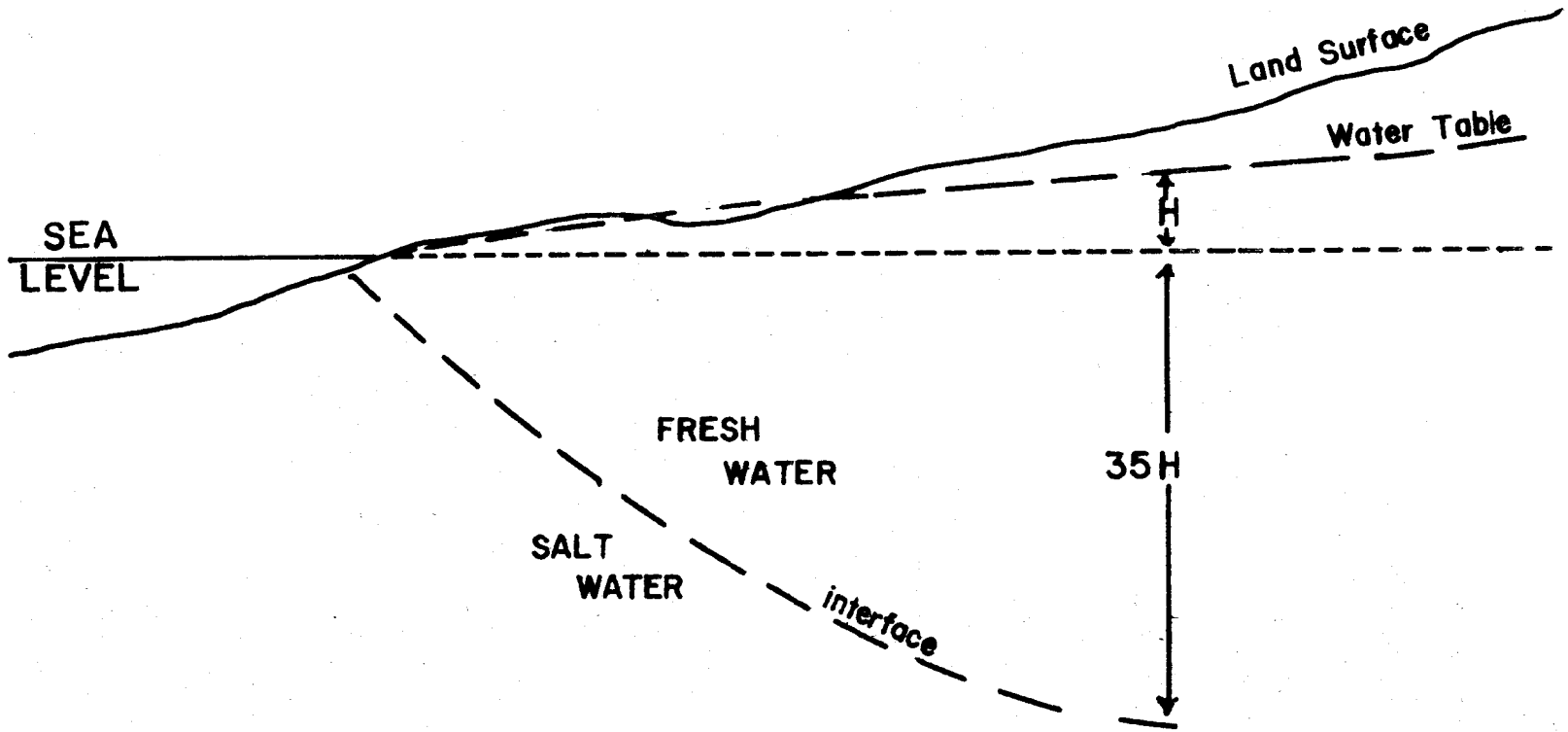
Note that:

a. As the height of the water table above sea level increases, so does the thickness of the freshwater lens below sea level, and

b. The depth below sea level of the fresh/salt water interface increases with increasing distance inland from the shoreline.

In areas of thick permeable unconsolidated sediments, such as are found on parts of Cape Cod, actual salt/fresh water conditions often approach the theoretical model (determined from the Ghyben-Herzberg concept) described above. Where this ideal situation occurs, it is a simple matter to plot the depth of the freshwater lens from known and inferred elevations of the water table. For example, if the elevation of the water table is 4 feet above sea level, then the depth below sea level of the fresh/salt water interface would be from 35 to 40 times that figure, or approximately 140 to 160 feet below sea level.

In most areas of New England, however, and specifically the lower Merrimack Basin and estuary, the lithology of the subsurface is composed of bedrock and impermeable tills and clays as well as permeable unconsolidated sediments. Under these conditions the simple application of the Ghyben-Herzberg principle does not apply. Bedrock and other rock material of low permeability inhibit and prohibit the free flow of both salt and freshwater and prevent the formation



SCHEMATIC DIAGRAM

GHYBEN-HERZBERG PRINCIPLE

FIGURE 1

of the simple wedge and lens relationship illustrated above. Given such lithologic relationships, it is difficult to accurately predict the depth of the fresh/salt water interface without more specific information such as well logs of the immediate area.

It is possible, however, to use the Ghyben-Herzberg principle as a guideline for predicting depth to salt water in heterogeneous lithologies of varying permeability. A water table elevation of 20 feet above sea level would theoretically signify a depth to salt water of 700-800 feet below sea level. This theoretical prediction is not valid when applied to the mixed and varied rock and soil types found in the Merrimack estuary. The lithology of this area strongly suggests the implementation of a more conservative estimate. This report assumes that in this area freshwater elevation of 20 feet above sea level implies a depth to salt water of at least 60 feet below sea level providing there are no extraordinary circumstances. This assumption implies a minimum depth of 80 feet to salt water (20 feet above plus 60 feet below sea level) and any ground above the water table would be additional to the 80 feet.

It is proposed here, therefore, that the 20 foot water table contour serve as a "safe" boundary line. Inland from this line, salt water should be found deeper than 60 feet below sea level (at least 80 feet below ground level). The margin of safety increases further inland because the depth of salt water increases with distance from shore.

Reasonable caution should be employed when applying the 20 foot contour rule. Factors which could obviate, modify, or reduce in effectiveness the rule include:

a. local outcrops of bedrock in areas where depth to bedrock is very shallow;

b. indicators of "perched" water table;

c. a zone of diffusion between salt and freshwater;

d. occurrence of drawn down pump fields;

e. a marked local or regional rise or fall of the water table due to natural or man-made causes.

Judicious application of the 20 foot water table contour "safe line" concept should delineate the boundary inland of which no salt water infiltration of sewer pipes would occur. The concept is conservative but necessary considering the potential risk to the alternative of land application.

Figure 2, following is a map of the Merrimack Valley Planning Commission on which the 20 foot water table contour line is drawn. This line was determined by plotting water table elevations gained from records of well logs, topographic maps and other sources of information. A contour map of the water table surface was drawn from these plotted points and the 20 foot contour line was transferred to the map accompanying this report. Inland from this line no salt water should be found at a depth less than 80 feet providing no extraordinary circumstances are encountered.

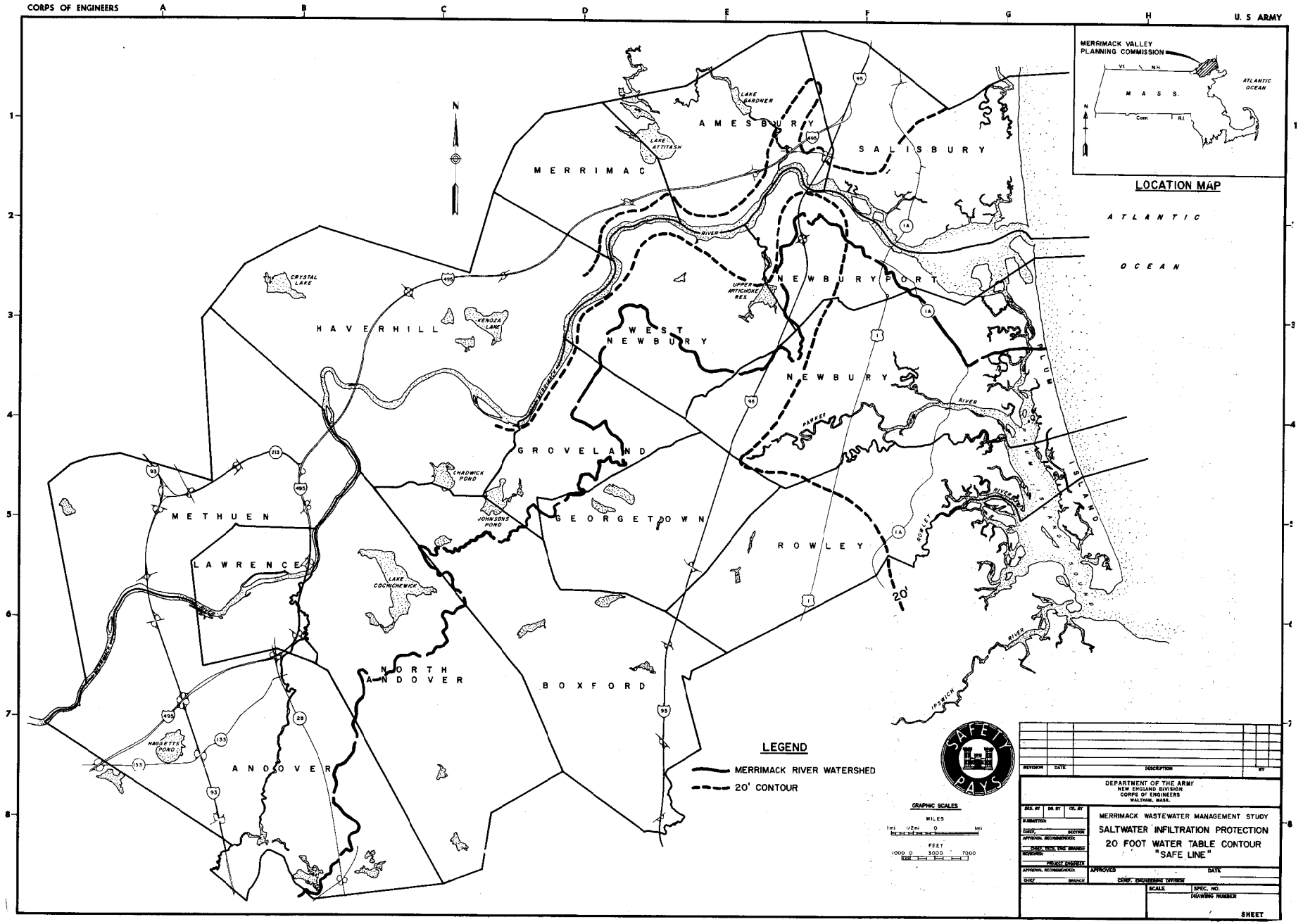

CORPS OF ENGINEERS
U. S ARMY
MERRIMACK VALLEY PLANNING COMMISSION
VT.
N.H.
MASS.
CONN.
R.I.
ATLANTIC OCEAN
LOCATION MAP
ATLANTIC OCEAN
N
MERRIMAC
AMESBURY
SALISBURY
HAVERHILL
WEST NEWBURY
NEWBURYPORT
NEWBURY
GROVELAND
GEORGETOWN
ROWLEY
METHUEN
LAWRENCE
NORTH ANDOVER
BOXFORD
ANDOVER
PLUM ISLAND
LAKE GARDNER
LAKE ATTITASH
CRYSTAL LAKE
KENOZA LAKE
UPPER ARTICHOKE RES.
CHADWICK POND
JOHNSONS POND
LAKE COCHICHEWICK
HAGGETTS POND
MERRIMACK RIVER
PARKER RIVER
ROWLEY RIVER
IPSWICH RIVER
20'
LEGEND
MERRIMACK RIVER WATERSHED
20' CONTOUR
GRAPHIC SCALES
MILES
FEET
SAFETY PAYS
REVISION
DATE
DESCRIPTION
BY
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
MERRIMACK WASTEWATER MANAGEMENT STUDY
SALTWATER INFILTRATION PROTECTION
20 FOOT WATER TABLE CONTOUR
"SAFE LINE"
APPROVED
DATE
CHIEF, ENGINEERING DIVISION
SCALE
SPEC. NO.
DRAWING NUMBER
SHEET

FIGURE 2

3. Plan Formulation Methodology

a. General

The Merrimack Wastewater Management Study placed special emphasis on the two regional planning agencies along the mainstem of the Merrimack River commencing at the Massachusetts-New Hampshire state line and extending easterly to the Atlantic Ocean. These two regional agencies, the Northern Middlesex Area Commission and the Merrimack Valley Planning Commission, contain some of the major urban and industrialized areas in the Massachusetts portion of the river basin. They contribute large amounts of municipal, industrial and combined sewage pollution to the Merrimack River.

The Plan Formulation for the Nashua River Basin, a sub-basin to the Merrimack River Basin is included in a separate report being prepared with Federal funds by the Nashua River Program under the jurisdiction of the New England Interstate Water Pollution Control Commission.

The Plan Formulation for the Sudbury, Assabet and Concord River Basins (SUASCO) which are also sub-basins to the Merrimack River are included in the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study. This separate report is being prepared jointly between the Commonwealth of Massachusetts (Metropolitan District Commission) and the Corps of Engineers, New England Division.

The aforementioned studies for the Nashua River and SUASCO basins of the Merrimack River Basin are addressing the 1977 and 1983 requirements of PL 92-500 in the formulation of wastewater management alternatives. Waters from these two sub-basins discharge into the Merrimack River mainstem in and upstream of the Merrimack Wastewater Management Study area.

In formulating alternative plans for the study regions of the Northern Middlesex Area and the Merrimack Valley Planning Commissions for the Merrimack Wastewater Management Study, the following items were considered:

- Location of existing and future population and industrial centers.

- Location, quantities and types of wastewater loads from the region.

- Existing wastewater treatment facilities, including: collection systems, combined sewer locations and overflows, and treatment plants and their capacities.
- The on-going Environmental Protection Agency - Commonwealth of Massachusetts implementation program for abatement of water pollution.
- Future land use planning, population growth and other alternative futures deemed important in the regions.
- Availability of suitable soils for alternative wastewater treatment methods.
- Feasibility of continuing with private on-lot individual private wastewater disposal systems and non-structural solutions.
- Institutional impacts.
- Public Participation and results of Open Planning.

At the outset of the study it was considered that wastewater management alternatives would be arrayed for consideration and implementation by others at a later date and after this study was completed. However, during the course of the study it appeared sensible to the joint study team that a "most favorable" or "preferred plan" should be developed based on considerations which would be more implementable from engineering, cost, impact assessment, and institutional aspects. It was decided by the study team that arriving at a most favorable plan during this study period would benefit others after the study was completed and make implementation for future planning easier as the "preferred plan" would also have been publicly tested through the open planning process

It is noted that all wastewater plans herein have been presented to the public and then elected officials through the Public Participation Program conducted for the Merrimack Wastewater Management Study

The formulation of the preferred plan for each regional planning area was an iterative process which began by setting on paper any wastewater option possible for each town in the study area without judging its merit, feasibility or compatibility with existing or proposed wastewater facilities or plans. The purpose of this approach was to give the public an opportunity to react to the options at the same time that the options were undergoing the technical screening process.

The plan formulation for the region commenced in the Fall of 1973 with as many as 20 possible wastewater alternatives for some towns. These alternatives were studies from all aspects and with public participation were reduced to about 12 alternatives for many communities. A further and more detailed review and screening process continued until about 5-6 final alternatives passed the rigourous technical, public, institutional and impact assessments. Conceptual plans and cost estimates were prepared for these "final" alternatives and detailed impact assessments were prepared on each of the remaining alternatives. A "least cost" alternative was also developed which was the cheapest from a monetary point of view only. This also was arrayed and assessed along with the other alternatives. After presenting these alternatives to the public, the people and officials were requested to provide reaction and input so that a "most preferable" or "cost effective" plan could be arrived at. The "cost effective" plan would be that plan which considering all elements such as engineering; environmental, hygienic, and aesthetic impacts; costs; institutional views; and public desires would be the one which the public and officials desired

More detailed discussion on plan formulation of wastewater management systems for the Merrimack Valley Planning Commission and the Northern Middlesex Area Commission follows:

b. Northern Middlesex Area Commission

This regional planning agency consists of the following 9 cities and towns.

Billerica	Pepperell
Chelmsford	Tewksbury
Dracut	Tyngsborough
Dunstable	Westford
Lowell	

The only existing sewage treatment facility in the commission area is at Billerica which has secondary treatment. All other cities and towns use on-lot septic systems and/or discharge raw wastewater directly into the Merrimack River or small feeder streams.

The Commonwealth of Massachusetts and the Environmental Protection Agency have an on-going implementation program to abate water pollution with Secondary Treatment plants scheduled for Pepperell and Lowell. The Lowell Sewage Treatment Plant

will also take the wastewaters from a portion of Chelmsford, Dracut, Tewksbury and Tyngsborough.

c. Merrimack Valley Planning Commission

This regional planning agency consists of the following 15 cities and towns:

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

The only sewage treatment plant presently in operation in the MVPC regional planning area is a primary treatment plant in the City of Newburyport All of the other cities and towns use on-lot septic systems and/or discharge raw wastewaters directly into the Merrimack River or small feeder streams.

The Commonwealth of Massachusetts and the Environmental Protection Agency have an on-going implementation program to abate water pollution with secondary treatment plants scheduled in the very near future for Amesbury, Groveland-Haverhill, Newburyport and the Greater Lawrence Sanitary District consisting of Andover, Lawrence, Methuen and North Andover.

d. Formulation

The technical objective of this study is to determine the most cost-effective means of collecting, treating and discharging wastewater to comply with the interim 1977 and 1983 requirements proposed by EPA, and the 1985 zero discharge goal mandated by Congress in PL 92-500. To complete this study, since these ultimate limitations have not yet been clearly defined, several levels of treatment technology have been proposed to meet the national goal of "zero-discharge".

Meeting the "zero-discharge" level is however, only one aspect of the project. An integral input to the decision making process is public opinion and reaction to the various options proposed under different wastewater management schemes.

The study area is composed of the twenty-four towns along the main stem of the Merrimack River in Massachusetts, whose present wastewater treatment facilities range from individual on-lot systems to a secondary treatment plant which is near completion. At the outset of this study, in order to determine the extent of sewerage options under decentralized and centralized schemes, each town was examined on an individual basis. The purpose of this exercise was to array for screening all possible options. In addition to decentralized and centralized options, all water and all land oriented wastewater schemes were also investigated.

e. Screening

The initial list of options was very long and it became obvious that within the stringent time limitations of this study, it would not be possible to have the public provide meaningful input to such an extensive number of alternatives. Consequently, the list was screened first using best engineering judgement and then, the Regional Planning Agencies were asked for their evaluation of the remaining options (First Iteration). Finally, combining input from the RPA's, previous engineering reports for the study area towns, and utilizing engineering experience and judgement as to which alternatives were technically feasible, a set of plans was produced arraying the remaining possible options for each town to be presented to the public for comments and feedback (Second Iteration). The alternatives were then revised to incorporate any constructive input received from any of the above study participants (Third Iteration).

To arrive at a workable number of options, the necessity of determining a standard set of screening criteria became obvious. These criteria were developed for collection of raw wastewater, treatment plant orientation, and final discharge of the effluent. Initial screening of the list of options eliminated those in which the cost was obviously prohibitive - one regional advanced wastewater treatment plant in the estuary area to treat the entire flow of the contributing communities. In land oriented schemes, it was determined that wastewater would only require secondary treatment (plus polishing) before land application and that there will be no splitting of effluent streams from multiple reuses. Treatment plants have been located as near the source of the waste, urban centers, and the discharge points of the effluent as possible. Options which provided long detention times for raw sewage in pipelines were eliminated as septic conditions could develop. Wherever feasible, existing plants were upgraded and enlarged, however, alternatives

that situated plants in adjacent communities were abandoned in favor of transporting the waste from the upstream town to the downstream one; no one criteria is valid for all schemes. In screening the alternatives on the centralized schemes, long pipelines and frequent pumping of wastewater were considered only when they could be justified by savings in capital and operating costs; reliability and flexibility of performance; and operational controls which are more easily possible with large regional facilities.

The elimination of options for collection and treatment plant orientation were generally similar. Upon review of engineering reports it becomes obvious that there are towns within the study area that, at the present time, do not need wastewater collection or treatment as evidenced by a lack of a sewage study and the absence of a water pollution abatement order by the Commonwealth of Massachusetts, Division of Water Pollution Control. The towns that are not under orders are Dunstable, Westford, Georgetown, Boxford, Rowley, West Newbury and Newbury. It is not the intent of this study to recommend that every town be required to collect and treat its wastewater. Rather it is recommended that not only the towns that are currently using private sub-surface disposal continue to do so as long as possible, but the unsewered areas of towns already partially sewered also continue to use on-lot systems, except where sewers are forecast in past municipal engineering reports. For example, only the northern part of North Andover is shown to be sewered. It is recommended that the remainder of North Andover (the southern portion) implement effective land use controls to prevent the need for sewers. Westford, on the other hand, is an exception. Although not under implementation orders, Westford has had an engineering report prepared which suggested a small extended aeration treatment plant for the Nabnasset Pond area and stabilization ponds for the Forge Village part of town. In this study, Westford takes on added importance as it is the eastern boundary of the "undeveloped" portion of the Northern Middlesex Area and the town closest to Fort Devens - the prime land application site for the NMAC. Consequently, treatment facilities and sewers have in some schemes been proposed for Westford although it remains to be verified to what extent they are required at this time. In order to complete the requirements of the study and provide a workable basin plan for community development in the future, it was necessary to anticipate the need for sewers. Consequently for the communities listed above, options for sewage collection and treatment have been developed and a cost for these options determined although implementation of these options will not be recommended until the

need for sewerage is demonstrated. In conjunction with this recommendation is the assumption that those towns not currently subject to the implementation schedule will not, even by 1977, have a pressing need for sewers and consequently sewage treatment. Therefore by the time they do install sewers, if ever, the wastewater based on the interim requirements, will have to be treated at an advanced wastewater treatment plant. As a result, the options proposed reflect this assumption.

In locating treatment plants, the state implementation schedule was adhered to, in that plants were located where they have been proposed in previous engineering reports, are under construction or as they exist. However, all proposed sites were examined for suitability for enlargement and it was determined that all sites could be utilized in some manner with only a few exceptions: It appears that the site of the existing primary treatment plant in Newburyport is too small to recommend as the site of a regional advanced wastewater treatment plant, consequently, under centralized schemes, it is proposed that the Newburyport plant be relocated away from the waterfront. In Lowell, the site of the secondary plant could be expanded to allow advanced treatment for 1990 flows from initial contributing communities, but the site is not large enough to treat future flows from additional communities. In this case, under centralized schemes, it is proposed that the secondary effluent be treated to an advanced state at some other site (i.e., Billerica).

Basically, the implementation schedule sets target deadlines for communities polluting the state's waterways, to effect a remedy for the pollution problems. In the study area all the towns except those previously mentioned are under order to abate pollution of the Merrimack River or its tributaries. To date, the only significant existing treatment plants are in Billerica and Newburyport although there are plants under construction in Haverhill, Amesbury and North Andover. Regional treatment facilities are planned in Lowell. The Lowell plant will serve, as presently proposed, Lowell, Dracut, Tewksbury, and part of Chelmsford and Tyngsborough. The North Andover plant will serve the Greater Lawrence Sanitary District - Andover, Methuen, Lawrence and North Andover and the proposed plant in Haverhill will serve Haverhill and Groveland. In addition there are municipal plants proposed for Pepperell, Merrimac, and Salisbury. Because the Division of Water Pollution Control has established and is administering an effective program for pollution abatement, it is recommended to accept the proposed construction schedule presently being undertaken. However, since most plants are designed for 1990 or 1995 and are designed only for secondary

treatment, it has become necessary to supplement the implementation programs to meet the 1983 goal of best practicable treatment. In this study, no additional secondary treatment plants - as they are presently known - are being proposed under water oriented schemes; they will all be some form of advanced wastewater treatment although the initial construction program may propose construction of a secondary facility with later upgrading to advanced. In order to achieve post 1977 water quality levels, secondary treatment facilities will only be adequate when used in conjunction with some form of land application of a polished secondary effluent. It is expected that in order to achieve the goal of "zero-discharge" without incurring costs that put the concept out of reach financially, the boundaries of existing sanitary districts may have to be modified to take advantage of the economy of scale available in regional treatment plants. That is to say that secondary effluent from the Lowell area may receive advanced treatment in the Greater Lawrence Sanitary District. In addition, the proposed sanitary districts raise problems which seem to make some of the schemes somewhat impractical such as: Pepperell which is included in both the Nashua River Program Study and this Merrimack Wastewater Management Study. Consequently, wastewater management considerations for Pepperell are addressed differently in each report as the result of differing data being available at the time of plan formulation. Another case in point is Tewksbury which is, by implementation scheduling, aligned with Lowell and Dracut when upon examination of projected population distribution, land use and sewered areas, a large portion of the Tewksbury flow could perhaps more readily be treated at an expanded and upgraded Billerica plant. This situation becomes even more critical under the centralized schemes in which it is proposed that an advanced wastewater treatment plant be located in Billerica to serve the needs of the eastern portion of the Northern Middlesex Planning Area. Under the given orientation, Tewksbury's wastewater would be transported to Lowell for secondary treatment then back to Billerica for advanced treatment almost completing a circle. The other aspect of this unusual situation is the town of Tyngsborough which has been ordered by the State to abate pollution in the Mascuppic Lake area. It is presently planned that this area will be fed into the Dracut System. However, neither the proposed Dracut system nor the Lowell treatment plant is being designed for future flows from the remainder of Tyngsborough. As a result, the rest of the town will have to transport its sewage elsewhere for treatment. Considering the alternative available it would seem more realistic at some point in the future, to convey Tyngsborough's flow to

Lowell and Tewksbury's flow to Billerica maintaining the design flow of the Lowell plant but shortening the length of pipelines required.

It is noted that during the course of this study, construction of proposed secondary treatment facilities under the State-EPA Implementation Program for Lowell, Lawrence and Haverhill has commenced.

In the Merrimack Valley Planning Commission, a problem exists with the Towns of Boxford and Rowley. Both towns lie outside the boundaries of the Merrimack River Basin but are still within the study planning area. Neither town is highly developed at present and no municipal engineering report on sewerage has been performed for either town. Consequently it is difficult to determine alternatives. It is recommended that these towns continue to use on-lot sewage disposal systems until the demand for sewers is demonstrated. Their locations outside of the river basin suggests that the most feasible alternatives are municipal treatment, either individual or joint, or connection to facilities in the MDC study area. Although both of these options are suggested, determining a cost for connection into the MDC study and their engineer's proposals for this area are unavailable and therefore, transmission of flow from these two towns to the MDC study area cannot be fully evaluated at this time.

f. Effluent Limitations

Once a treatment plant has been sited and the wastewater collected and conveyed to the plant, the effluent must be disposed of or utilized in some manner. As previously mentioned, all treatment plants proposed in this study will be advanced facilities with the degree of treatment being dependent upon the final disposition of the effluent i.e. effluent to be applied to the land or discharges to the ocean will receive a lower degree of treatment than that which is discharged to a river. In the initial array of discharge options such choices as flow augmentation, water-supply augmentation, industrial reuse and groundwater recharge were considered, however, these alternatives (except augmentation to the Concord River) were eventually eliminated as being unfeasible. The reasons will be more fully discussed on the following pages. In the land-oriented schemes, many of the original sites for rapid infiltration and spray irrigation had to be eliminated after closer inspection of the sites showed them to be unacceptable due to factors such as high groundwater table, depth to bedrock,

steeply sloped hills and impervious soils. In the Northern Middlesex Area Commission only a small piece of land in Pepperell along the Nashua River was considered acceptable for land application (rapid infiltration). Consequently in order to have an all land alternative in the NMAC, the effluent from the area must be taken to the rapid infiltration site at Fort Devens. In the Merrimack Valley Planning Commission, the situation is not quite as critical as there appears to be several acceptable large rapid infiltration and several spray irrigation sites large enough to treat the effluent from a local municipal plant. All effluent discharge whether land or water oriented is, however, restricted to Massachusetts due to restriction imposed on the study. It is quite likely that there are sites in New Hampshire that may be close enough to warrant consideration as final disposal sites. The possibility may exist that the border towns in New Hampshire would welcome advanced wastewater treatment plant effluent to augment water supplies.

The remainder of this section deals with a detailed discussion of the step-by-step iterative process of generating the final set of wastewater alternatives which are presented in the next section of this appendix.

g. Wastewater Alternatives

(1) Initial Listing

Without consideration to existing or presently proposed sewerage collection, transmission, or treatment facilities, a listing was prepared of the basic options available to each community in the study area for wastewater management In this listing, no attempt was made to define the type or degree of treatment required, the practical or technical feasibility of the options, the discharge medium (land or water), or any treated wastewater reuse opportunities.

The initial listing is presented on the following pages.

INITIAL LISTING OF WASTEWATER ALTERNATIVES

NORTHERN MIDDLESEX AREA COMMISSION

Pepperell

1. on site treatment
2. local treatment with discharge to Nissitissit or Nashua Rivers
3. pump flow easterly on Lowell Road (Pleasant St., Rte. 113) to Dunstable
4. local treatment w/land disposal (800+ acres available)
5. pump flow to Groton which in the Curran Assoc. report for the Montachusetts Region will have a regional plant serving Ashby-Townsend-Ayer-Groton-Shirley

Dunstable

1. small town w/no industry, possible that on-lot systems would suffice
2. if Pepperell pumps toward the Merrimack, then Dunstable could tie in
3. local municipal treatment
4. pump to Groton
5. gravity interceptor w/Pepperell to N. Chelmsford
6. pump to Tyngsboro (which could go to an interceptor along Rte. 3A or the B&M ROW)

STP = Sewage Treatment Plant
AWT = Advanced Wastewater Treatment (Plant)

Tyngsborough

1. being this far east, it is now unfeasible to connect to any other drainage area other than the Merrimack

2. hilly area so extensive use of on-lot systems probably not feasible

3. local treatment probably not feasible

4. construct an interceptor parallel to Rte. 3A or the B&M ROW into N. Chelmsford and connect to existing system

Westford

1. local treatment

2. on-lot disposal - probably feasible as there are close to 2,000 acres available for land disposal

3. connect in Groton's regional STP

4. connect into interceptor from Tyngsborough at N. Chelmsford

5. build a regional STP in Westford serving Pepperell, Dunstable, Tyngsborough, Westford, and part of Chelmsford and Lowell

Chelmsford

1. minimal on-lot treatment

2. possible local treatment plant serving also Pepperell, Dunstable, and Tyngsborough

3. possible regional treatment plant in Chelmsford

4. part of flow to regional STP in Westford

5. part of flow to Lowell STP under construction

6. all flow to a regional plant in either Westford or Lowell

Lowell

1. presently Lowell is building a STP on Duck Island which is probably not a large enough piece of land to build a regional plant. The plant is supposed to take flows from Lowell, part of Dracut, part of Chelmsford, and part of Tewksbury

2. build a second plant in Lowell that would be a regional plant and serve Lowell, Billerica, and part of Chelmsford and Tewksbury. This would entail expanding the plant under construction to be upgraded to an AWT plant and take all flow from Dracut

3. regional plant in North Andover to serve Lowell, Lawrence, Haverhill, Andover, Groveland, Methuen, North Andover, Billerica, Chelmsford, Dracut and Tewksbury

Billerica

1. local treatment w/either water or land disposal

2. partial on-lot disposal

3. connect to a regional plant in Lowell or Tewksbury

4. connect into the Metropolitan Area (MDC)

Dracut

1. local treatment w/either land or water disposal. There are about 2,000 acres of land in Dracut suitable for ground disposal

2. Dracut could be the site for ground disposal for a regional treatment plant in Lowell, Tewksbury, or Chelmsford

3. probably not a good place for a regional plant because contributing towns would be across the river

4. joint STP with Methuen

Tewksbury

1. very wet area according to USGS maps and no land available for ground disposal

2. on-lot systems probably not feasible

3. regional treatment plant probably not feasible because of land suitability and availability

4. local treatment possible with water discharge only

5. probably should go into a regional system with Lowell or into the Metropolitan District

MERRIMACK VALLEY PLANNING COMMISSION

Andover

1. lot of land available for ground disposal - possibly good place for a regional STP serving Andover, North Andover, Lawrence, and Methuen

2. local treatment

3. on-lot disposal outside urban area

4. go to a regional plant in Lowell

North Andover

1. local treatment with some land available for ground disposal

2. on-lot systems out of the urban area

3. connect to a regional plant in Andover, E. Methuen, or Lowell

Lawrence

1. too small and densely populated for any land disposal

2. water oriented local treatment

3. possible land disposal of local waste in Methuen

4. connect to a Regional plant in Andover, E. Methuen, or Lowell

Methuen

1. municipal treatment, some land available for ground disposal

2. on-lot treatment for much of the area

3. joint treatment w/Lawrence

4. regional treatment in Andover, E. Methuen, or Lowell

Haverhill

1. local treatment - some areas for land disposal, but probably not enough for future needs

2. probably good place for regional plant - south of Kenoza Lake which would serve part of N. Andover, part of Boxford, Groveland, part of W. Newbury, Haverhill, and maybe Georgetown

3. go to a regional plant in Lowell

Boxford

1. north Boxford has much land available for ground disposal plus land is available in S. Haverhill, consequently local treatment in Boxford is a possibility

2. S. Boxford could go into the Metropolitan Area

3. N. Boxford could tie in with N. Andover or Groveland

4. S. Boxford could do nothing for a while

Groveland

1. local treatment

2. on-lot treatment

3. tie into a regional plant in Haverhill or Lowell

4. tie into a joint plant in Boxford

5. building a joint or regional plant in Groveland for any combination of Boxford, Haverhill, Groveland, part of W. Newbury, and possibly Georgetown

Georgetown

1. on-lot treatment
2. connect into a regional plant in Groveland
3. connect in with Rowley and go into the Metropolitan District
4. local treatment

Rowley

1. on-lot treatment
2. local treatment
3. go into the Metropolitan District
4. connect to possible Newburyport or Groveland regional plant

Merrimac

1. local treatment - land available in N. Merrimac for land disposal
2. connect with Amesbury or Haverhill for regional treatment
3. joint treatment w/West Newbury
4. on-lot treatment

W. Newbury

1. local treatment, lots of land for land disposal
2. joint treatment w/Merrimac
3. connect to a regional plant in Amesbury or Newburyport
4. on-lot treatment

Newbury

1. on-lot treatment

2. connect to Rowley and go into Metropolitan District

3. local treatment

4. connect to a regional plant in Newburyport

Amesbury

1. presently constructing a secondary treatment plant, possibly enlarge it and make it a regional plant w/Merrimac and Salisbury

2. local treatment

3. abandon plant and go into a regional plant in Newburyport

Newburyport (existing primary plant)

1. upgrade for local treatment (Investigate deep ocean vs estuary outfall)

2. expand and upgrade to regional plant for W. Newbury, Newbury, and Newburyport (or include Amesbury and Salisbury)

3. joint treatment w/Salisbury either in Salisbury or Newbury

Salisbury

1. individual treatment (already proposed)

2. joint treatment w/Amesbury

3. joint treatment w/Newburyport

4. tie into a regional plant in Newburyport

(2) First Iteration

As mentioned in the paragraph preceding the Initial Listing of Wastewater Alternatives, a listing of what seemed to be any and all possible alternatives for wastewater treatment on a town by town basis were noted regardless of whether they had initial merit or not. Wall maps showing these numerous alternatives for each town were prepared, presented to and discussed by representatives of local, regional, state and Federal representatives as well as public interest personnel. As discussion progressed at two early meetings, some of the initial listing were added to, modified, expanded, and in some cases deleted from further consideration.

Later a "first iteration" of the wastewater alternatives was made which related to and is based on group comments made on the initial listing of alternatives previously described

The initial listing of option was reviewed with the study objectives in mind and a comprehensive "laundry list" of alternatives was prepared which set down all of the options available to each community in the study area for handling its wastewater. It was felt that the best way to avoid missing available options was to incorporate every one into such a master listing. It was left to subsequent screening to ascertain the technical and practical feasibility of the options presented.

In the development of this initial layout of sewerage options, the following general guidelines were used:

1. The study objective of "zero discharge" would require treatment beyond the secondary level. Land treatment would achieve this goal.

2. Discharges to the Nissitissit and Shawsheen Rivers would not be permitted by the Commonwealth of Massachusetts, Division of Water Pollution Control.

The resultant "First Iteration of Wastewater Alternatives" are presented on the following pages.

FIRST ITERATION OF WASTEWATER ALTERNATIVES

NORTHERN MIDDLESEX AREA COMMISSION

Pepperell

1. Build nothing.

   a. Raw waste to a. Groton

   b. Raw waste to b. Nashua Area

   c. Raw waste to c. Fitchburg Area

   d. Raw waste to d. NMAC Regional Plant

2. Build proposed secondary plant--leaving most of town on septic tanks. Not enough suitable land in Pepperell for spray irrigation. Could use part of effluent for recharge. Therefore, effluent will have to go elsewhere.

   a. To regional STP in Groton

   b. To possible regional STP/land application in Nashua area

   c. To possible regional STP/land application in Fitchburg area

   d. To regional STP/land disposal elsewhere in the basin

3. Build AWT plant in Pepperell

   a. Can discharge effluent to Nashua

   b. Can return to local industries for re-use

   c. Use for flow augmentation where necessary

Dunstable

East side of Massapoag Pond drains toward the Merrimack River and the west side toward the Nashua River.

1. Build nothing.

   a. Extensive use of on-lot systems

   b. If necessary, build local sewers and pump to either Pepperell or Tyngsborough.

2. Build secondary plant.

   a. Effluent to AWT plant in Pepperell

   b. Effluent to AWT plant elsewhere in basin

   c. Effluent for land disposal in Westford

   d. Effluent to regional plant in Groton

3. Build AWT plant.

   a. Treat flow from Pepperell and possibly west portion of Tyngsboro-Discharge to Massapoag Pond.

   b. Re-use for Pepperell industry.

Tyngsborough

1. Do nothing.

    a. Raw waste from west portion to Dunstable

    b. Raw waste from west portion to Westford

    c. Pump some to Nashua (including Dunstable's flow)

    d. Pump some to Dracut (including Dunstable's flow)

    e. Pump some to Chelmsford

    f. Pump to Dracut only

    g. Pump to Nashua only

    h. All flow to Westford

    i. Far west part of town to Groton

Westford

1. Do nothing

   a. extensive use of on-lot systems

   b. raw waste to Groton STP

   c. pump to Chelmsford

2. Build secondary plant
   a. local treatment only - effluent to a_1 land or a_2 regional plant in Groton or elsewhere a_3

   b. collect all or part of Pepperell, Dunstable, Tyngsborough (west of the River), Westford and west part of Chelmsford - effluent to land disposal or regional plant in Groton or elsewhere.

3. Build AWT plant

   a. local treatment only - effluent to land application or flow augmentation to local pond

   b. regional plant for towns in item 2b - effluent to land application or flow augmentation of local ponds and Merrimack River

   c. reuse for Lowell industries

Chelmsford

1. Build nothing

   a. Flow from west part of town to Westford

   b. Flow from west part of town to east side

   c. Raw waste to Lowell

   d. Raw waste to Billerica

2. Build secondary plant

   a. local treatment only, discharge to land application in Westford

   b. local treatment only, discharge to land application in Billerica

   c. joint treatment with Westford discharge to

      c_1 land in Westford

      c_2 land in Billerica

      c_3 AWT plant in Billerica

Dracut

1. Build nothing

   a. all raw waste to Lowell

   b. on lot systems where applicable

   c. E. Dracut to Methuen

Lowell

1. Build secondary plant

   1. Serving Lowell and Dracut

   2. Serving Lowell, Dracut and east Tyngsborough

   3. Serving Lowell, Dracut, east Tyngsborough and Chelmsford

   4. Above plus N. Tewksbury

   Effluent to

   a. part to land disposal in Dracut, part to land disposal in Andover and part to land disposal in Billerica

   b. to regional AWT plant in Billerica

   c. to regional AWT plant in Westford

   d. reuse in low water quality industries

2. Build AWT serving any combination of above

   Effluent to

   a. Merrimack River

   b. reuse in industry

   c. canals for city park plan

Tewksbury

1. Build nothing

   a. NW part of town to Lowell, SE to Billerica

   b. all of town to Lowell

   c. all of town to Billerica

   d. NW part of town to Lowell, SE to Wilmington

2. Build a secondary plant

   a. local treatment-effluent to land in Andover

   b. local treatment-effluent to AWT plant in Lowell

   c. local treatment-effluent to AWT plant in Billerica

   d. local treatment-effluent to land in Dracut

3. Build AWT plant

   Serving contributors to Lowell and/or Billerica

   Effluent to

   a. the Merrimack River

   b. the Concord River

   c. land in Dracut

   d. industry in Lowell

   e. canals in Lowell

Billerica - existing secondary plant

1. Abandon existing plant

   a. whole town to Lowell

   b. whole town to Westford

   c. whole town to Tewksbury

   d. north part of town to Lowell, south to MDC study area

2. Expand secondary plant to take flows from neighboring towns
   Effluent to

   a. Land in Dracut

   b. Land in Andover

   c. Land in Billerica

   d. Land in Westford

   e. AWT plant in Lowell

   f. AWT plant in Tewksbury

   g. AWT plant in Westford

3. Upgrade to AWT plant

   Effluent to

   a. Merrimack River

   b. Concord River

   c. industrial reuse in Billerica and Lowell

   d. canals in Lowell

Basin

- construct parallel interceptor along the Merrimack River to collect all raw wastewater. Take it to

  1. secondary plant) in Lowell, Tewksbury or Andover
  2. AWT plant)

- if secondary plant
  - effluent to land wherever available
    a. land wherever available

- if AWT plant
  - effluent to
    a. Merrimack River
    b. flow augmentation wherever needed
    c. industrial reuse

OR - construct same interceptors, collect flow in Tewksbury and pump back to Tyngsborough or Pepperell for treatment.

MERRIMACK VALLEY PLANNING COMMISSION

Andover

1. Build nothing.
    a. Flow to Lawrence w/on - lot disposal systems
    b. Pump to regional plant in Tewksbury
    c. Pump to regional plant in Lowell
    d. Pump to regional plant in Billerica
    e. Flow to regional plant in North Andover
    f. Flow to Methuen
2. Build secondary plant
    a. Local treatment w/land disposal
    b. Joint treatment with West Methuen - w/land application
3. Build AWT plant
    a. Serves Billerica, Tewksbury, Lowell, Methuen and Lawrence w/land disposal in Andover or New Hampshire
    b. Same w/flow augmentation to local ponds
    c. Discharge to the Merrimack River
    d. Reuse in Lawrence industry.

Methuen

1. Build nothing.

   a. West Methuen to Andover, East to Lawrence

   b. All to Andover

   c. All Lawrence

   d. Pump to Dracut (then to Lowell)

   e. Pump to Haverhill

2. Build two secondary plants

   Serving Andover, East Dracut, Lawrence, North Andover, Haverhill

   Effluent to

   a. Land in Methuen & N. H.
   b. Land in Andover
   c. Land in Dracut
   d. AWT plant in Tewksbury
   e. AWT plant in Lowell
   f. AWT plant in North Andover

   a. Land in Methuen or N. H.
   b. AWT plant in North Andover
   c. AWT plant in Haverhill
   d. Land in Boxford
   e. Land In Haverhill

3. Build AWT plant

   Serves same as above

   Effluent to

   a. The Merrimack

Methuen (continued)

b. New Hampshire

c. Reuse in Lawrence

Lawrence

1. Build nothing.

    a. Pump to Andover

    b. Pump to Methuen

    c. Flow to North Andover

    d. Flow to Haverhill

2. - 3. No room to build any type of plant

North Andover

1. Build nothing

   a. Pump to Methuen

   b. On-lot treatment where feasible

   c. South North Andover to MDC study area

   d. Flow to Haverhill

   e. South North Andover to Boxford

2. Build secondary plant

   Serve Lawrence, North Boxford, West Methuen, Andover and Haverhill

   Effluent to

   a. Regional AWT plant in Haverhill

   b. Land disposal in Boxford

   c. Land disposal in Haverhill

3. Build AWT plant

   Serves same as above

   Effluent to

   a. Reuse in Lawrence industry

   b. Flow augmentation or land application in New Hampshire

   c. The Merrimack River

   d. Flow augmentation to Lake Cochichewick

Haverhill

1. Build nothing

   a. Raw waste to Methuen

   b. Raw waste to North Andover

   c. Raw waste to West Newbury

2. Build one secondary plant

   Serving North Andover, Methuen, Lawrence, Groveland, North Boxford

   Effluent to

   a. Land in Boxford

   b. Land in Haverhill

   c. Land in New Hampshire and Methuen

   d. AWT plant in North Andover

   e. AWT plant in Haverhill

3. Build AWT plant

   Serving same as above

   Effluent to

   a. The Merrimack River

   b. New Hampshire

   c. Local augmentation

   d. Industrial reuse

Boxford

1. Build nothing.

   a. North Boxford to Haverhill, South to MDC study area

   b. North Boxford to North Andover, South to MDC study area

   c. Whole town to Haverhill or North Andover

   d. North Boxford to Haverhill or North Andover, South to Georgetown

   e. On-lot systems where feasible

2. Build secondary plant

   Serving Boxford; Georgetown, Groveland, West Rowley and South North Andover

   Effluent to

   a. Land in Boxford

   b. AWT plant in Haverhill

   c. AWT plant in North Andover

   d. AWT plant in Rowley

Groveland

1. Do nothing

   a. Waste to Haverhill

   b. Waste to Georgetown

   c. Waste to Boxford

   d. Waste to Newbury

2. Build secondary plant

   Serving Boxford and Georgetown

   Effluent to

   a. Land in Boxford and Haverhill

   b. Land in West Newbury

   c. AWT plant in Newbury

   d. AWT plant in Rowley

   e. AWT plant in Haverhill

Georgetown

1. Build nothing.

   a. Waste to Groveland

   b. Waste to Newbury

   c. Waste to Boxford

   d. Waste to Rowley

   e. On-lot systems where feasible

2. Build secondary plant

   Serving Georgetown, Groveland, East Rowley and South Boxford

   Effluent to

   a. Land in Boxford

   b. Land in Haverhill

   c. Land in West Newbury

   d. AWT plant in Newbury

   e. AWT plant in Rowley

Rowley

1. Build nothing

   a. Waste to MDC study area

   b. Waste to Boxford

   c. Waste to Georgetown (then to Groveland)

   d. Waste to Newbury

   e. On-lot systems

2. Build secondary plant

   Serving Georgetown, Boxford, Rowley and Newbury

   Effluent to

   a. Land in West Newbury

   b. Land in MDC area

   c. Plum Island Sound

   d. AWT plant in Newbury

3. Build AWT plant

   Serving the above

   Effluent to

   a. Plum Island Sound

   b. Rowley River

   c. Parker River

   d. Artichoke Reservoir

   e. MDC area

Merrimac

1. Build nothing

   a. Flow to Amesbury

   b. Pump to Haverhill

   c. Pump to West Newbury

   d. Pump to New Hampshire

   e. On-lot treatment where feasible

2. Build secondary plant

   Local treatment only

   Effluent to

   a. Land in Merrimac

   b. Land in West Newbury

   c. AWT plant in West Newbury

   d. AWT plant in Newbury

   e. AWT plant in Haverhill

3. Build AWT plant

   Serving Merrimac, Amesbury, W. Newbury, Newbury Salisbury

   Effluent to

   a. The Merrimack River

   b. Artichoke Reservoir

Merrimac (continued)

c. Lake Attitash

d. New Hampshire

e. Haverhill Industries

Amesbury - existing secondary plant

1. Abandon existing plant

   a. Flow to Salisbury

   b. Flow to Newburyport

   c. Flow to Merrimac

   d. Flow to West Newbury

   e. On-lot treatment

2. Keep existing plant as is (local treatment only) or enlarge to

   Serve Merrimac, Amesbury, Salisbury, West Newbury,

   Newbury, or Newburyport

   a. Effluent to land in West Newbury

   b. Land treatment in Amesbury and Merrimac

   c. Land treatment in Newburyport

   d. Land treatment or AWT plant in New Hampshire

   e. AWT plant in Merrimac

   f. AWT plant in West Newbury

   g. AWT plant in Salisbury

   h. AWT plant in Newburyport

3. Build AWT plant

   Serving Merrimac, Amesbury, Salisbury, West Newbury

Amesbury (continued)

Newbury or Newburyport

Effluent to

a. The Merrimack River

b. Artichoke Reservoir

c. Lakes Gardner and Attitash

d. Local industrial reuse

e. New Hampshire

Salisbury

1. Build nothing

   a. Waste to Amesbury

   b. Waste to Newburyport

   c. Waste to Newbury

   d. Waste to West Newbury

   e. On-lot systems

2. Build secondary plant

   Serving Merrimac, Amesbury, Newbury, West Newbury, Newburyport, or Salisbury

   Effluent to

   a. Land in West Newbury

   b. Land in Newburyport

   c. AWT plant in Newburyport

   d. AWT plant in Amesbury

   e. AWT plant in Newbury

   f. Deep ocean outfall

   g. Land in Amesbury-Salisbury

3. Build AWT plant

   Serving same as above

   Effluent to

   a. The Merrimack River

Salisbury (continued)

b. The estuary

c. Deep ocean outfall

d. Land in West Newbury

e. Land in Newburyport

f. Reuse in local industry

g. Artichoke Reservoir

Newburyport - existing primary plant

1. Abandon existing plant

   a. Waste to Salisbury

   b. Waste to Amesbury

   c. Waste to Newbury

   d. Waste to West Newbury

2. Retain existing plant serving only Newburyport

   Effluent to

   a. Land in Newburyport and West Newbury

   b. Deep ocean outfall

   c. AWT plant in Salisbury

   d. AWT plant in Amesbury

   e. AWT plant in Newbury

   f. AWT plant in West Newbury

3. Upgrade to secondary serving only Newburyport

   Effluent to same as above a through f

4. Build AWT plant in Newburyport

   Serving Merrimac, Amesbury, Salisbury, Newbury, West Newbury and Newburyport

   Effluent to

   a. The Merrimack River

Newburyport (continued)

b. Parker River

c. The estuary

d. Artichoke Reservoir

e. Industrial reuse

f. Deep ocean outfall

g. Ground water recharge of Plum Island

Newbury

1. Build nothing.

   a. Waste to Newburyport

   b. Waste to Newbury

   c. Waste to Salisbury

   d. Waste to West Newbury (to Merrimac)

   e. On-Lot disposal where feasible

2. Build secondary plant

   Serving Merrimac, Amesbury, Salisbury, Newburyport, West Newbury

   Effluent to

   a. Land in Newbury and West Newbury

   b. AWT plant in West Newbury

   c. AWT plant in Newburyport

   d. AWT plant in Merrimac

   e. AWT plant in Amesbury

   f. AWT plantin Salisbury

   g. Deep ocean outfall

   h. Estuary

3. Build AWT plant serving same as above plus Groveland Georgetown and Rowley

Newbury (continued)

Effluent to

a. Parker River

b. The Merrimack River

c. Plum Island Sound

d. Deep ocean outfall

e. The estuary

f. Plum Island groundwater recharge

g. Artichoke Reservoir

h. Industrial reuse

Basin

Continue the proposed dual intercepting system for the NMAC along the Merrimack to a regional or basin-wide AWT plant in Newburyport or Salisbury.

The treated water could then be distributed throughout the basin as necessary.

(3) Second Iteration

In late September and early October of 1973, study team members consisting of representatives of the Commonwealth of Massachusetts, Division of Water Pollution Control, the Merrimack Valley Planning Commission, the Northern Middlesex Area Commission, and the Corps of Engineers held a series of four conferences to discuss the array of possible alternatives developed in the first iteration. Data generated at these meetings were augmented by information gained from the two early stage Public Hearings held in the MVPC and NMAC areas in the second week of October. The following considerations and data evolved from this series of conferences and hearings:

1. Specific information on towns' objectives, desires, growth trends, problem areas, etc.

2. Areas of potential low flow augmentation (i.e. headwaters of the Concord River; Merrimack River in the Lawrence area; etc.).

3. Areas of needed water supply augmentation (i.e. Newbury, Amesbury, Newburyport, southern New Hampshire).

4. Potential suitable and available land application sites.

5. Desirable wastewater treatment plant locations.

6. Opportunities for treated wastewater reuse (i.e. industries, potential power plant in Salisbury, potential oil refinery in Dracut; etc.).

7. Opportunities for regional wastewater management and a potential area for an environmental resource recovery center (a joint regional solid waste - wastewater treatment facility in Billerica).

8. Expressed desires to retain treated wastewater within the Merrimack River Basin.

From this information, seven basic alternatives were developed for each community in the two regional planning areas. Each of the alternatives contained as many as seven possible technical options for each community. Each of the options for every town was depicted on a set of maps. A sample of one of these maps was presented as Plate No. 1.

Each step in planning for wastewater management in the Merrimack River Basin must continuously incorporate the viewpoints of governmental agencies and the general public, as well as provide a method for keeping open future options for those who will be responsible for implementing the study recommendations. Planning in this study incorporates a dual formulation process - one which provides for the display and screening of alternative solutions, and the other for a display of a range of technological choices responsive to the land application and water-oriented treatment technologies of advanced wastewater treatment.

In order to determine the range of sewerage options, each town was examined on an individual basis, and the list for all the options for each town, developed in the first iteration was refined. Briefly, this entailed one or more of the following:

a. on-lot disposal

b. piping raw sewage elsewhere

c. build a secondary facility

    1. local, joint, or regional

    2. effluent to land application or advanced wastewater treatment

d. build an advanced wastewater treatment (AWT) plant

    1. joint or regional

    2. effluent to flow augmentation, water supply, industrial reuse, land application, etc.

The purpose of this exercise was to array all of the options in a set of organized wastewater alternatives. While accompanying plans and listings have shown wastewater collection, treatment, and discharge alternatives for every town in the Merrimack Valley Planning Commission and the Northern Middlesex Area Commission, it is not presupposed that every town must take action on one of these alternatives. It may very well be that communities such as Dunstable, Rowley, and Boxford may not require sewers within the time frame of this study (to the year 2020). In such cases, the alternative plans for those communities will not need to be implemented.

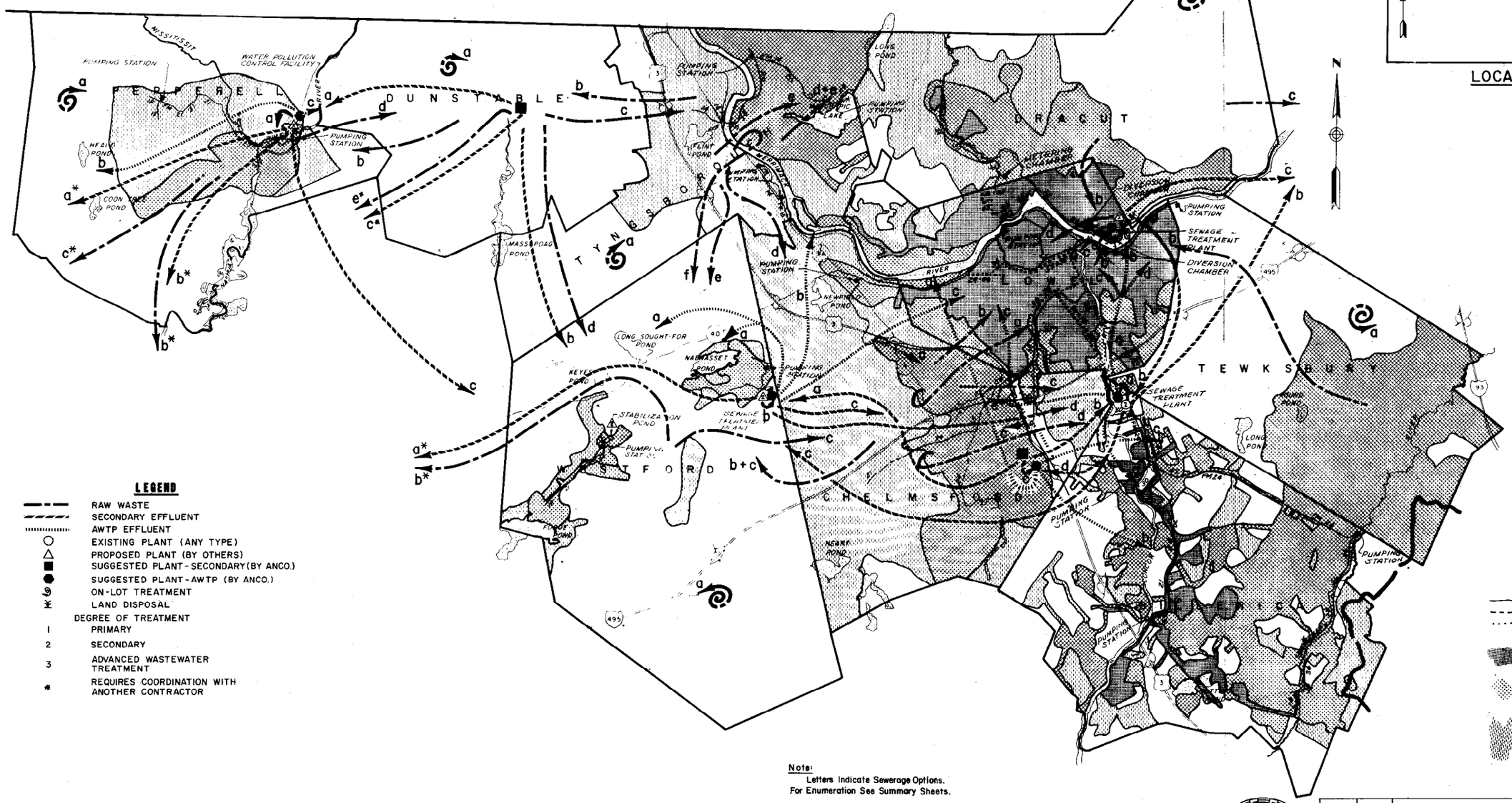
It is further assumed that the present plans and work underway to upgrade existing facilities will continue, and every effort will be made to incorporate these facilities, where feasible, into the ultimate schemes to be developed as part of this study. This does not preclude the option to phase out or abandon these facilities.

After the first interation of possible options was completed, an initial screening was performed to eliminate alternatives that were contrary to existing conditions. The Lowell area grouping and the Greater Lawrence Sanitary District were held intact, but some additions were suggested.

In refining the initial list, all options of transportation of any kind to New Hampshire were eliminated as such conditions have been ruled out of the study scope. Except in special cases, it was considered unfeasible to convey flow, other than existing systems, through the population centers in Lowell, Lawrence, and Haverhill in a direction contrary to existing grades. Options that had extremely long pipelines (in one alternative versus another) were discarded based on anticipated cost, and those which combined raw waste and secondary effluent were dropped. Recommendations made in other engineering reports usually were retained (e.g., Lowell's plant is to serve Dracut and Tewksbury; consequently, no plant was proposed for either town).

If one examines the area closely, one discovers that it can be readily divided into six sub-areas: the Nashua River sub-area, the Chelmsford sub-area, and Lowell sub-area, and the Lawrence, Georgetown and the Newburypot sub-areas. Once these were established, possible treatment plant locations were indicated and plans were produced for the following effluent discharges:

CORPS OF ENGINEERS — U. S ARMY



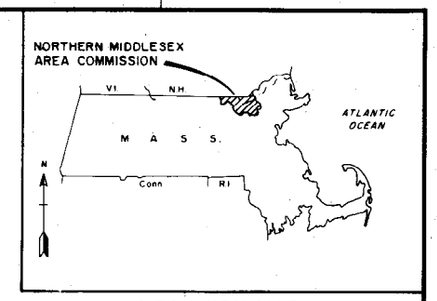
LEGEND

- RAW WASTE
- SECONDARY EFFLUENT
- AWTP EFFLUENT
- ○ EXISTING PLANT (ANY TYPE)
- △ PROPOSED PLANT (BY OTHERS)
- ■ SUGGESTED PLANT-SECONDARY (BY ANCO.)
- ● SUGGESTED PLANT-AWTP (BY ANCO.)
- ON-LOT TREATMENT
- LAND DISPOSAL

DEGREE OF TREATMENT

- 1 PRIMARY
- 2 SECONDARY
- 3 ADVANCED WASTEWATER TREATMENT
- * REQUIRES COORDINATION WITH ANOTHER CONTRACTOR

Note:
Letters Indicate Sewerage Options.
For Enumeration See Summary Sheets.



LOCATION MAP

- RECOMMENDED
- FUTURE
- EXISTING

- EXISTING
- 1990
- 2020

GRAPHIC SCALES

MILES: 1 mi, 1/2 mi, 0, 1 mi

FEET: 1000, 0, 3000, 7000

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED: CHIEF, SECTION
APPROVAL RECOMMENDED: CHIEF, TECH. ENG. BRANCH
REVIEWED: PROJECT ENGINEER
APPROVAL RECOMMENDED: CHIEF BRANCH

NORTHERN MIDDLESEX AREA COMMISSION

WATER ORIENTED DECENTRALIZED SYSTEMS

APPROVED — CHIEF, ENGINEERING DIVISION — DATE 10-15-73

SCALE | SPEC. NO.

DRAWING NUMBER
PLATE NO. 1

SHEET 1

1. Water Oriented - Decentralized Systems

2. Water Oriented - Decentralized Secondary-Regional AWT Plant

3. Water Oriented - Centralized Systems

4. Land Oriented - Decentralized Systems

5. Land Oriented - Centralized Systems

6. Land-Water Combination - Decentralized Systems

7. Land-Water Combination - Centralized Systems

Treatment plants for the decentralized systems were located from USGS maps, considering the trade-offs between additional facilities and transportation of wastewater (raw or treated) to a more distant location.

In the centralized scheme, treatment plants were located at or near existing population centers, industrial parks, possible regional solid waste disposal areas or possible land application areas.

On the following pages are presented the wastewater alternatives which evolved from the second iteration of screening.

SECOND ITERATION OF WASTEWATER ALTERNATIVES

NORTHERN MIDDLESEX AREA COMMISSION

ALTERNATE NO. 1
Water Oriented
Decentralized Secondary and Advanced
Wastewater Treatment

Pepperell

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Fitchburg
   d. waste to Dunstable

2. Build secondary plant - serving Pepperell and West Dunstable
   Effluent to
   a. AWT plant in Fitchburg
   b. AWT plant in Groton
   c. AWT plant in Westford
   d. AWT plant in Pepperell

3. Build AWT plant
   a. industrial reuse
   b. local flow augmentation
   c. discharge to Nashua River

Dunstable

1. Build nothing
   a. on-lot systems
   b. west Dunstable to Pepperell
   c. east Dunstable to Tyngsborough
   d. east Dunstable to Westford
   e. all Dunstable to Groton

2. Build secondary plant
   Effluent to
   a. AWT plant in Pepperell
   b. AWT plant in Westford
   c. AWT plant in Groton

No AWT plant because town is too small, too far away from watercourse. geographically not suitable.

Tyngsborough

1. Build nothing
   a. on-lot systems
   b. West Tyngsborough to Dunstable
   c. sewered areas to Dracut
   d. east of Merrimack River to Dracut, west to Chelmsford
   e. east of Merrimack River to Dracut, west to Westford
   f. whole town to Westford

Previous engineering reports have recognized that Tyngsborough is not in an ideal location for a treatment plant and would be better off tying in with another town.

Westford

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Chelmsford

2. Build one secondary plant at Nabnasset Pond - only one because it would be too expensive to treat at two places than transport the waste elsewhere for tertiary treatment.
   Effluent to
   a. AWT plant in Groton
   b. AWT plant in Westford
   c. AWT plant in Chelmsford
   d. AWT plant in Billerica

3. Build AWT plant
   Effluent to
   a. local flow augmentation
   b. Merrimack River
   c. industrial reuse in Chelmsford and Lowell

Chelmsford

1. Build nothing
   a. waste to Lowell
   b. west Chelmsford to Westford, east to Lowell
   c. west Chelmsford to Westford, east to Billerica
   d. whole town to Billerica

Chelmsford (continued)

2. Build secondary plant
   Effluent to
   a. AWT plant in Westford
   b. AWT plant in Billerica
   c. AWT plant in Chelmsford

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. Concord River
   c. Reuse in Lowell, Chelmsford and Billerica industries

Dracut

1. Build nothing
   a. on-lot systems
   b. waste to Lowell
   c. E. Dracut to Methuen

As Dracut has already come to an agreement with Lowell to use the Lowell STP, it is unfeasible to suggest Dracut build anything.

Lowell

1. Secondary plant already under construction serving Lowell, most of Dracut, Tewksbury, part of Chelmsford and part of Tyngsborough
   Effluent to
   a. AWT plant in Lowell
   b. AWT plant in Billerica
   c. AWT plant in Andover
   d. reuse in low water quality industries

2. Build AWT plant
   Effluent to
   a. Merrimack River
   b. canals in Lowell
   c. industrial reuse

Tewksbury

1. Build nothing
   a. on-lot systems where feasible
   b. all waste to Lowell

These should be the only alternatives as the Lowell plant is designed to handle waste flow from Tewksbury.

Billerica

1. Keep existing secondary plant in operation
   Effluent to
   a. AWT plant in Billerica
   b. AWT plant in Andover
   c. AWT plant in Westford
   d. AWT plant in Chelmsford

2. Upgrade to AWT plant
   Effluent to
   a. Concord River
   b. Merrimack River
   c. industrial reuse in Billerica, Lowell and Chelmsford
   d. canals in Lowell

ALTERNATE NO. 2
Water Oriented
Decentralized Secondary and Centralized
Advanced Wastewater Treatment

Pepperell

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Fitchburg
   d. waste to Dunstable

2. Build secondary plant - serving Pepperell and W. Dunstable
   Effluent to
   a. AWT plant in Fitchburg
   b. AWT plant in Groton
   c. AWT plant in Westford

Dunstable

1. Build nothing
   a. on-lot systems
   b. west Dunstable to Pepperell
   c. east Dunstable to Tyngsborough
   d. east Dunstable to Westford
   e. all Dunstable to Groton

2. Build secondary plant
   Effluent to
   a. AWT plant in Westford
   b. AWT plant in Groton

Tyngsborough

1. Build nothing
   a. on-lot systems
   b. west Tyngsborough to Dunstable
   c. sewered areas to Dracut
   d. east of Merrimack River to Dracut, west to Chelmsford
   e. east of Merrimack River to Dracut, west to Westford
   f. whole town to Westford

Westford

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Chelmsford

2. Build secondary plant
   Effluent to
   a. AWT plant in Westford
   b. AWT plant in Groton
   c. AWT plant in Billerica

3. Build AWT plant
   Effluent to
   a. local flow augmentation
   b. Merrimack River
   c. industrial reuse in Lowell and Chelmsford

Chelmsford

1. Build nothing
   a. waste to Lowell
   b. west Chelmsford to Westford, east to Lowell
   c. west Chelmsford to Westford, east to Billerica

2. Build secondary plant
   Effluent to
   a. AWT plant in Westford
   b. AWT plant in Billerica

Dracut

1. Build nothing
   a. on-lot systems
   b. waste to Lowell
   c. East Dracut to Methuen

Lowell

Secondary plant under construction
Effluent to
a. AWT plant in Andover
b. AWT plant in Billerica
c. reuse in low water quality industries

Tewksbury

1. Build nothing
   a. on-lot systems where feasible
   b. waste to Lowell

Billerica

1. Keep existing secondary plant
   Effluent to
   a. AWT plant in Billerica
   b. AWT plant in Andover
   c. AWT plant in Westford

2. Upgrade to AWT plant
   Effluent to
   a. Concord River
   b. Merrimack River
   c. industrial reuse in Billerica, Chelmsford and Lowell
   d. canals in Lowell

ALTERNATE NO. 3
Water Oriented
Centralized Advanced Wastewater
Treatment

Pepperell

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Fitchburg
   d. waste to Dunstable

2. Build secondary plant serving Pepperell and W. Dunstable
   Effluent to
   a. AWT plant in Fitchburg
   b. AWT plant in Groton
   c. AWT plant in Billerica

Dunstable

1. Build nothing
   a. on-lot systems
   b. West Dunstable to Pepperell
   c. East Dunstable to Tyngsborough
   d. East Dunstable to Westford
   e. all Dunstable to Groton

Tyngsborough

1. Build nothing
   a. on-lot systems
   b. sewered areas to Dracut
   c. east of Merrimack R. to Dracut, west to Chelmsford
   d. east of Merrimack R. to Dracut, west to Westford
   e. whole town to Westford

Westford

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Chelmsford

Westford (continued)

2. Build secondary plant
   Effluent to
   a. AWT plant in Groton
   b. AWT plant in Billerica

Chelmsford

1. Build nothing
   a. waste to Lowell
   b. west Chelmsford to Westford, east to Lowell
   c. west Chelmsford to Westford, east to Billerica
   d. whole town to Billerica

Dracut

1. Build nothing
   a. on-lot systems
   b. waste to Lowell
   c. E. Dracut to Methuen

Lowell

1. Secondary plant under construction
   Effluent to
   a. AWT plant in Billerica
   b. reuse in low water quality industries

Tewksbury

1. Build nothing
   a. on-lot systems where feasible
   b. waste to Lowell

Billerica - existing secondary plant

1. Upgrade existing plant to AWT plant treating entire basin.
   Effluent to
   a. Concord River
   b. Merrimack River
   c. industrial reuse in Billerica, Chelmsford & Lowell
   d. canals in Lowell

Billerica (continued)

Billerica was chosen as the site of the AWT plant for the following reasons:

1. There already is an existing secondary plant.
2. The Concord River sometimes needs flow augmentation.
3. There isn't enough space at the Lowell site to treat the entire area's flow.
4. The NMAC would like to see a regional environmental control facility at this site.
5. It is fairly centrally located in the populated area.

ALTERNATE NO. 4
Land Oriented Decentralized Systems

Pepperell

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Fitchburg
   d. waste to Dunstable

2. Build secondary plant - serving Pepperell & W. Dunstable
   Effluent to
   a. land in pepperell
   b. land in Groton Area
   c. land in Fitchburg Area
   d. land in Westford

Dunstable

1. Build nothing
   a. on-lot systems
   b. west Dunstable to Pepperell
   c. east Dunstable to Tyngsborough
   d. east Dunstable to Westford
   e. all Dunstable to Groton

Tyngsborough

1. Build nothing
   a. on-lot systems
   b. sewered areas to Dracut
   c. east of Merrimack R. to Dracut, west to Chelmsford
   d. east of Merrimack R. to Dracut, west to Westford
   e. whole town to Westford

Westford

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Chelmsford

Westford (continued)

2. Build secondary plant
   Effluent to
   a. land disposal in Westford
   b. land disposal in Groton Area
   c. land disposal in Billerica
   d. land disposal in MDC Area

3. Build AWT plant
   Effluent to
   a. groundwater recharge in Westford
   b. groundwater recharge in Groton Area
   c. land disposal in Billerica

Chelmsford

1. Build nothing
   a. waste to Lowell
   b. west Chelmsford to Westford, east to Lowell
   c. west Chelmsford to Westford, east to Billerica
   d. whole town to Billerica

2. Build secondary plant
   Effluent to
   a. land in Billerica
   b. land in Westford
   c. land in MDC area

Dracut

1. Build nothing
   a. on-lot systems
   b. waste to Lowell
   c. E. Dracut to Methuen

Lowell

1. Secondary plant under construction
   Effluent to
   a. land in Andover
   b. land in Dracut

Tewksbury

1. Build nothing
   a. on-lot systems where feasible
   b. waste to Lowell

Billerica

1. Keep existing secondary plant
   Effluent to
   a. land in Billerica
   b. land in Andover
   c. land in Westford

2. Upgrade to AWT
   Effluent to
   a. groundwater recharge in Andover
   b. groundwater recharge in Westford
   c. land disposal in Billerica

ALTERNATE NO. 5
Land Oriented
Centralized System

Pepperell

1. Build nothing

   a. on-lot systems
   b. waste to Groton
   c. waste to Fitchburg
   d. waste to Dunstable

2. Build secondary plant
   Effluent to
   a. land in Pepperell
   b. land in Groton area
   c. land in Fitchburg area
   d. land in Westford

Dunstable

1. Build nothing
   a. on-lot systems
   b. west Dunstable to Pepperell
   c. west Dunstable to Tyngsborough
   d. west Dunstable to Westford
   e. all Dunstable to Groton

Tyngsborough

1. Build nothing
   a. on-lot systems
   b. sewered areas to Dracut
   c. east of Merrimack River to Dracut, west to Chelmsford
   d. east of Merrimack River to Dracut, west to Westford
   e. whole town to Westford

Westford

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Chelmsford

Westford (continued)

2. Build secondary plant
   Effluent to
   a. land in Westford
   b. land in Groton area
   c. land in Billerica
   d. land in MDC area

Chelmsford

1. Build nothing
   a. waste to Lowell
   b. west Chelmsford to Westford, east to Lowell
   c. west Chelmsford to Westford, east to Billerica
   d. whole town to Billerica

Dracut

1. Build nothing
   a. on-lot systems
   b. waste to Lowell
   c. E. Dracut to Methuen

Lowell

1. Secondary plant under construction
   Effluent to
   a. land in Andover
   b. land in Dracut

Tewksbury

1. Build nothing
   a. on-lot systems where feasible
   b. waste to Lowell

Billerica

1. Keep existing secondary plant
   Effluent to
   a. land in Billerica
   b. Land in Andover
   c. land in Westford

Should it become unfeasible to discharge secondary effluent to the land in any of these towns, an AWT plant would be built in Billerica to treat the waste of the entire basin; the effluent would then be used to augment the groundwater supply where necessary.

ALTERNATE NO. 6

Land/Water
Decentralized Systems

Pepperell

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Fitchburg
   d. waste to Dunstable

2. Build secondary plant
   Effluent to
   a. land in Pepperell
   b. AWT plant in Groton
   c. AWT plant in Fitchburg
   d. AWT plant in Westford

Not land in Westford because Westford is well supplied and groundwater may become contaminated

Not land in any other area because it would be too little to really be of any use.

Dunstable

1. Build nothing
   a. on-lot systems
   b. west Dunstable to Pepperell
   c. east Dunstable to Tyngsborough
   d. east Dunstable to Westford
   e. all Dunstable to Groton

Tyngsborough

1. Build nothing
   a. on-lot sewers
   b. sewered areas to Dracut
   c. east of Merrimack River to Dracut, west to Chelmsford
   d. east of Merrimack River to Dracut, west to Westford
   e. whole town to Westford

Westford

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Chelmsford

2. Build secondary plant
   Effluent to
   a. land in MDC area
   b. land in Groton area
   c. AWT plant in Westford
   d. AWT plant in Billerica

No land application of secondary waste because of reasons previously outlined.

3. Build AWT plant
   Effluent to
   a. land in Westford
   b. local flow augmentation
   c. Merrimack River
   d. flow augmentation or groundwater recharge in MDC

Chelmsford

1. Build nothing
   a. waste to Lowell
   b. west Chelmsford to Westford, east to Lowell
   c. West Chelmsford to Westford, east to Billerica
   d. whole town to Billerica

2. Build secondary plant
   Effluent to
   a. land in Billerica
   b. AWT plant in Westford
   c. AWT plant in Billerica

Dracut

1. Build nothing
   a. on-lot systems
   b. waste to Lowell
   c. E. Dracut to Methuen

As Dracut has already come to an agreement with Lowell to use the Lowell STP, it is unfeasible to suggest Dracut build anything.

Lowell

1. Secondary plant under construction
   Effluent to
   a. land in Dracut
   b. land in Andover
   c. AWT plant in Andover
   d. AWT plant in Billerica

Not really enough room in Lowell to build AWT plant.

Tewksbury

1. Build nothing
   a. on-lot systems where feasible
   b. all waste to Lowell

These should be the only alternatives as the Lowell plant is designed to handle waste flow from Tewksbury.

Billerica

1. Keep existing secondary plant in operation
   Effluent to
   a. AWT plant in Billerica
   b. AWT plant in Andover

Probably not land application unless it were needed in Andover.

2. Upgrade to AWT plant
   Effluent to
   a. Concord River
   b. Merrimack River
   c. industrial reuse in Billerica, Lowell and Chelmsford
   d. canals in Lowell

ALTERNATE NO. 7
Land/Water
Centralized System

Pepperell

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Fitchburg
   d. waste to Dunstable

2. Build secondary plant
   Effluent to
   a. land in Pepperell
   b. AWT plant in Groton
   c. AWT plant in Fitchburg
   d. land in Westford (if possible W. Q. ?)

Dunstable

1. Build nothing
   a. on-lot systems
   b. west Dunstable to Pepperell
   c. east Dunstable to Tyngsborough
   d. east Dunstable to Westford
   e. all Dunstable to Groton

Tyngsborough

1. Build nothing
   a. on-lot systems
   b. sewered areas to Dracut
   c. east of Merrimack River to Dracut, west to Chelmsford
   d. east of Merrimack River to Dracut, west to Westford
   e. whole town to Westford

Westford

1. Build nothing
   a. on-lot systems
   b. waste to Groton
   c. waste to Chelmsford

2. Build secondary plant
   Effluent to
   a. land in Westford (if possible)
   b. land in MDC area
   c. land in Groton area
   d. AWT plant in Groton
   e. AWT plant in Billerica

Chelmsford

1. Build nothing
   a. waste to Lowell
   b. West Chelmsford to Westford, east to Lowell
   c. west Chelmsford to Westford, east to Billerica
   d. whole town to Billerica

Dracut

1. Build nothing
   a. on-lot systems
   b. waste to Lowell
   c. E. Dracut to Methuen

Lowell

1. Secondary plant under construction
   Effluent to
   a. land in Dracut
   b. land in Andover
   c. AWT plant in Andover
   d. AWT plant in Billerica

Tewksbury

1. Build nothing
   a. on-lot systems where feasible
   b. all waste to Lowell

Billerica

1. Keep existing secondary plant in operation
   Effluent to
   a. AWT plant in Billerica
   b. AWT plant in Andover

2. Upgrade to AWT plant
   Effluent to
   a. Concord River
   b. Merrimack River
   c. industrial reuse in Billerica, Lowell and Chelmsford
   d. canals in Lowell

ALTERNATE NO. 1
Water Oriented
Decentralized Secondary and Advanced Wastewater Treatment

Andover

1. Building nothing
   a. on-lot systems where feasible
   b. waste to North Andover

2. Build AWT plant to treat wastes from GLSD secondary plant and wastes from Lowell area
   Effluent to
   a. Merrimack River
   b. local flow augmentation
   c. reuse in Lawrence area industries

Methuen

1. Build nothing
   a. on-lot systems
   b. waste to North Andover

Lawrence

1. Build nothing
   a. all flow to North Andover

North Andover

1. Secondary plant has been bid serving Andover, Methuen, Lawrence and North Andover
   a. on-lot systems in south North Andover
   b. south North Andover to MDC area
   c. south North Andover to Boxford

2. Build secondary plant as bid
   Effluent to
   a. AWT plant in North Andover
   b. AWT plant in Andover
   c. AWT plant in Haverhill
   d. reuse in low water quality industries

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. local flow augmentation
   c. reuse in Lawrence Area industries

Haverhill

1. Build nothing
   a. Waste to GLSD
   b. Waste to W. Newbury
   c. waste to Merrimac

2. Build secondary plant
   Effluent to
   a. AWT plant in Haverhill
   b. AWT plant in North Andover
   c. reuse in low water quality industries

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. local flow augmentation
   c. industrial reuse

Boxford

1. Build nothing
   a. on-lot systems
   b. North Boxford to Haverhill, south to MDC
   c. North Boxford to North Andover, south to MDC
   d. all Boxford to Haverhill
   e. All Boxford to North Andover
   f. All Boxford to Georgetown
   g. All Boxford to Rowley

2. Build secondary plant
   Effluent to
   a. AWT plant in Rowley
   b. AWT plant in Georgetown
   c. AWT plant in North Andover
   d. AWT plant in Haverhill

Groveland

1. Build nothing
   a. on-lot systems
   b. waste to Haverhill

c. waste to Boxford
d. waste to Georgetown
e. waste to W. Newbury

Georgetown

1. Build nothing
   a. on-lot systems
   b. waste to W. Newbury
   c. waste Boxford
   d. waste to Rowley
   e. waste to Groveland

2. Build secondary plant
   Effluent to
   a. AWT plant in Georgetown
   b. AWT plant in Rowley
   c. AWT plant in Newburyport

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. Parker River
   c. area flow augmentation
   d. Artichoke Reservoir

Rowley

1. Build nothing
   a. on-lot systems
   b. waste to Newbury
   c. waste to Boxford
   d. waste to Georgetown
   e. waste to MDC area

2. Build secondary plant
   Effluent to
   a. AWT plant in Rowley
   b. AWT plant in Georgetown
   c. AWT plant in Newburyport
   d. AWT plant in MDC area
   c. Plum Island Sound

3. Build AWT plant
   Effluent to
   a. Rowley River

b. Parker River
c. Plum Island Sound
d. Artichoke Reservoir
e. MDC area

Newbury

1. Build nothing
   a. on-lot systems
   b. waste to W. Newbury
   c. waste to Newburyport

West Newbury

1. Build nothing
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Newburyport
   d. waste to Haverhill
   e. waste to Amesbury

2. Build secondary plant
   Effluent to
   a. AWT plant in Newburyport
   b. AWT plant in Salisbury
   c. estuary

Merrimac

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Haverhill

2. Build secondary plant
   Effluent to
   a. AWT plant in Haverhill
   b. AWT plant in Salisbury
   c. AWT plant in Newburyport

Amesbury

1. Abandon existing plant
   a. on-lot systems
   b. waste to Merrimac

c. waste to Salisbury
d. waste to Newburyport

2. Alter existing secondary plant for
Effluent to
a. AWT plant in Newburyport
b. AWT plant in Salisbury

Salisbury

1. Build nothing
a. on-lot systems
b. waste to Amesbury
c. waste to Newburyport

2. Build secondary plant
Effluent to
a. AWT plant in Salisbury
b. AWT plant in Newburyport
c. deep ocean outfall
d. the estuary

3. Build AWT plant
Effluent to
a. Merrimack River
b. the estuary
c. the ocean
d. industrial reuse in area industry
e. Artichoke Reservoir

Newburyport - existing primary plant

1. Existing primary plant can serve only Newburyport-
Abandon plant
Waste to
a. Salisbury
b. Amesbury
c. West Newbury
2. Relocate upgrade to secondary plant
Effluent to
a. AWT plant in Newburyport
b. deep ocean outfall
c. the estuary
d. AWT plant in Salisbury

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. the estuary
   c. the ocean
   d. Parker River
   e. Artichoke Reservoir
   f. industrial reuse

ALTERNATE NO. 2
Water Oriented
Decentralized Secondary and Centralized Advanced
Wastewater Treatment

Andover

1. Build nothing
   a. on-lot systems where fessible
   b. waste to North Andover

Methuen

1. Build nothing
   a. on-lot systems
   b. waste to North Andover

Lawrence

1. Build nothing
   a. all flow to North Andover

North Andover

1. Secondary plant has been bid serving Andover, Methuen Lawrence and North Andover
   a. on-lot systems in south North Andover
   b. south North Andover to MDC area
   c. south North Andover to Boxford

2. Build secondary plant as bid
   Effluent to
   a. AWT plant in North Andover
   b. reuse in low water quality industries

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. local flow augmentation
   c. reuse in Lawrence area industries

Haverhill

1. Build nothing
   a. waste to GLSD
   b. waste to West Newbury
   c. waste to Merrimac

2. Build secondary plant
   Effluent to
   a. AWT plant in North Andover
   b. reuse in low water quality industries

Boxford

1. Build nothing
   a. on-lot systems
   b. North Boxford to Haverhill, south to MDC
   c. North Boxford to North Andover, south to MDC
   d. all Boxford to Haverhill
   e. all Boxford to North Andover
   f. all Boxford to Georgetown
   g. all Boxford to Rowley

2. Build secondary plant
   Effluent to
   a. AWT plant in North Andover
   b. AWT plant in MDC area

Groveland

1. Build nothing
   a. on-lot systems
   b. waste to Haverhill
   c. waste to Boxford
   d. waste to Georgetown
   e. waste to W. Newbury

Georgetown

1. Build nothing
   a. on-lot systems
   b. waste to W. Newbury
   c. waste to Boxford
   d. waste to Rowley
   e. waste to Groveland

2. Build secondary plant
   Effluent to
   a. AWT plant in Newburyport
   b. AWT plant in North Andover
   c. AWT plant in MDC area

Rowley

1. Build nothing
   a. on-lot systems
   b. waste to Newbury
   c. waste to Boxford
   d. waste to Georgetown
   e. waste to MDC area

2. Build secondary plant
   Effluent to
   a. AWT plant in Newburyport
   b. AWT plant in MDC area
   c. Plum Island Sound

Newbury

1. Build nothing
   a. on-lot systems
   b. waste to Newbury
   c. waste to Newburyport

West Newbury

1. Build nothing
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Newburyport
   d. waste to Haverhill
   e. waste to Amesbury

2. Build secondary plant
   Effluent to
   a. AWT plant in Newburyport
   b. estuary

Merrimac

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Haverhill

2. Build secondary plant
   Effulent to
   a. AWT plant in Newburyport
   b. the estuary

Amesbury

1. Abandon existing plant
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Salisbury
   d. waste to Newburyport

2. Alter existing secondary plant for
   Effluent to
   a. AWT plant in Newburyport
   b. the estuary

Salisbury

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Newburyport

2. Build secondary plant
   Effluent to
   a. AWT plant in Newburyport
   b. deep ocean outfall
   c. the estuary

Newburyport-existing primary plant

1. Existing primary plant can serve only Newburyport -
   Abandon plant
   Waste to
   a. Salisbury
   b. Amesbury
   c. West Newbury

2. Relocate and make into secondary plant
   Effluent to
   a. AWT plant in Newburyport
   b. deep ocean outfall
   c. the estuary

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. the estuary
   c. the ocean

d. Parker River
e. Artichoke Reservoir
f. industrial reuse

ALTERNATE NO. 3

Water Oriented
Centralized Systems

Andover

1. Build nothing
   a. on-lot systems where feasible
   b. waste to North Andover

Methuen

1. Build nothing
   a. on-lot systems
   b. waste to North Andover

Lawrence

1. Build nothing
   a. all flow to North Andover

North Andover

1. Secondary plant has been bid serving Andover, Methuen, Lawrence and North Andover
   a. on-lot systems in south North Andover
   b. south North Andover to MDC area
   c. south North Andover to Boxford

2. Build secondary plant as bid
   Effluent to
   a. AWT plant in North Andover
   b. reuse in low water quality industries

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. local flow augmentation
   c. reuse in Lawrence area industries

Haverhill

1. Build nothing
   a. waste to GLSD
   b. waste to West Newbury
   c. waste to Merrimac

2. Build secondary plant
   Effluent to
   a. AWT plant in North Andover
   b. reuse in low water quality industries

Boxford

1. Build nothing
   a. on-lot systems
   b. North Boxford to Haverhill, south to MDC
   c. North Boxford to North Andover, southto MDC
   d. All Boxford to Haverhill
   e. All Boxford to North Andover
   f. All Boxford to Georgetown

Groveland

1. Build nothing
   a. on-lot systems
   b. waste to Haverhill
   c. waste to Georgetown
   d. waste to West Newbury

Georgetown

1. Build nothing
   a. on-lot systems
   b. waste to West Newbury
   c. waste to Groveland (then to Haverhill)

2. Build secondary plant
   Effluent to
   a. AWT plant in Newburyport
   b. AWT plant in North Andover
   c. AWT plant in MDC area

Rowley

1. Building nothing
   a. on-lot systems
   b. waste to Newbury
   c. waste to Georgetown
   d. waste to MDC area

Newbury

1. Build nothing
   a. on-lot systems
   b. waste to West Newbury
   c. waste to Newburyport

West Newbury

1. Build nothing
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Newburyport
   d. waste to Haverhill
   e. waste to Amesbury

Merrimac

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Haverhill

2. Build secondary plant
   Effluent to
   a. AWT plant in Newburyport
   b. the estuary

Amesbury

1. Abandon existing plant
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Salisbury
   d. waste to Newburyport

2. Alter existing secondary plant for
   Effluent to
   a. AWT plant in Newburyport
   b. the estuary

Salisbury

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Newburyport

2. Build secnndary plant
   Effluent to
   a. AWT plant in Newburyport
   b. deep ocean outfall
   c. the estuary

Newburyport - existing primary plant

1. Existing primary plant can serve only Newburyport - Abandon plant
   Waste to
   a. Salisbury
   b. Amesbury

2. Relocate and make into secondary plant
   Effluent to
   a. AWT plant in Newburyport
   b. deep ocean outfall
   c. the estuary

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. the estuary
   c. the ocean
   d. Parker River
   e. Artichoke Reservoir
   f. industrial reuse

ALTERNATE NO. 4
Land Oriented
Decentralized Systems

Andover

1. Build nothing
   a. on-lot systems
   b. waste to North Andover

Methuen

1. Build nothing
   a. on-lot systems
   b. waste to North Andover

Lawrence

1. Build nothing
   a. all waste to North Andover

North Andover

1. In areas not indicated for service
   a. on-lot systems
   b. waste to MDC area
   c. waste to Boxford

2. For secondary plant
   Effluent to
   a. land in Boxford and Haverhill
   b. land in Andover
   c. land in Methuen and Haverhill

3. Build AWT plant
   Effluent to
   a. land in Boxford and Haverhill
   b. land in Andover
   c. land in Methuen and Haverhill

Haverhill

1. Build nothing
   a. waste to GLSD
   b. waste to West Newbury
   c. waste to Merrimac

2. Build secondary plant
   Effluent to
   a. land in Boxford and Haverhill
   b. land in Methuen and Haverhill
   c. land in Merrimac
   d. land in West Newbury

Boxford

1. Build nothing
   a. on-lot systems
   b. North Boxford to Haverhill, south to MDC
   c. North Boxford to North Andover, south to MDC
   d. all Boxford to Haverhill
   e. all Boxford to North Andover
   f. all Boxford to Georgetown
   g. all Boxford to Rowley

2. Build secondary plant
   Effluent to
   a. land in Boxford and Haverhill
   b. land in West Newbury
   c. land in Andover
   d. land in MDC area

Groveland

1. Build nothing
   a. on-lot systems
   b. waste to Haverhill
   c. waste to Boxford
   d. waste to Georgetown
   e. waste to West Newbury

Georgetown

1. Build nothing
   a. on-lot systems
   b. waste to West Newbury
   c. waste to Boxford
   d. waste to Rowley
   e. waste to Groveland

2. Build secondary plant
   Effluent to
   a. land in Boxford and Haverhill

b. land in West Newbury
c. land in MDC area

Rowley

1. Build nothing
   a. on-lot systems
   b. waste to Newbury
   c. waste to Boxford
   d. waste to Georgetown
   e. waste to MDC area

2. Build secondary plant
   Effluent to
   a. land in West Newbury
   b. land in Boxford and Haverhill
   c. land in MDC area

Newbury

1. Build nothing
   a. on-lot systems
   b. waste to West Newbury
   c. waste to Newburyport

West Newbury

1. Build nothing
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Newburyport
   d. waste to Haverhill
   e. waste to Amesbury

2. Build secondary plant
   Effluent to
   a. land in West Newbury and Newbury
   b. land in Merrimac and Haverhill

Merrimac

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Haverhill

2. Build secondary plant
   Effluent to
   a. land in Merrimac and Haverhill
   b. land in West Newbury

Amesbury

1. Abandon existing plant
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Salisbury
   d. waste to Newburyport

2. Alter existing secondary plant for
   Effluent to
   a. land in Merrimac and Haverhill
   b. land in Newbury and W. Newbury
   c. land in Amesbury and Salisbury

Salisbury

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Newburyport

2. Build secondary plant
   Effluent to
   a. land in Amesbury and Salisbury
   b. land in Newbury and West Newbury

Newburyport

1. Existing primary plant can only serve Newburyport
   Abandon plant
   a. waste to Salisbury
   b. waste to Amesbury
   c. waste to West Newbury

2. Relocate and make into secondary plant
   Effluent to
   a. land in Newbury and West Newbury
   b. land in Amesbury and Salisbury
   c. land in Merrimac and Haverhill

ALTERNATE NO. 5
Land Oriented
Centralized Systems

Andover

1. Build nothing
   a. on-lot systems
   b. waste to North Andover

Methuen

1. Build nothing
   a. on-lot systems
   b. waste to North Andover

Lawrence

1. Build nothing
   a. all waste to North Andover

North Andover

1. In areas not indicated for service
   a. on-lot systems
   b. waste to MDC area
   c. waste to Boxford

2. For secondary plant
   Effluent to
   a. land in Boxford and Haverhill
   b. land in Andover
   c. land in Methuen and Haverhill

Haverhill

1. Build nothing
   a. waste to GLSD
   b. waste to W. Newbury
   c. waste to Merrimac
2. Build secondary plant
   Effluent to
   a. land in Boxford and Haverhill
   b. land in Methuen and Haverhill
   c. land in Merrimac
   d. land in West Newbury

Boxford

1. Build nothing

   a. on-lot systems
   b. North Boxford to Haverhill, south to MDC
   c. North Boxford to North Andover, south to MDC
   d. all Boxford to Haverhill
   e. all Boxford to North Andover
   f. all Boxford to Georgetown

Groveland

1. Build nothing
   a. on-lot systems
   b. waste to Haverhill
   c. waste to Georgetown
   d. waste to West Newbury

Georgetown

1. Build nothing
   a. on-lot systems
   b. waste to West Newbury
   c. waste to Groveland (then Haverhill)

2. Build secondary plant
   Effluent to
   a. land in Boxford and Haverhill
   b. land in West Newbury
   c. land in MDC area

Rowley

1. Build nothing
   a. on-lot systems
   b. waste to Newbury
   c. waste to Georgetown
   d. waste to MDC area

Newbury

1. Build nothing
   a. on-lot systems
   b. waste to West Newbury
   c. waste to Newburyport

West Newbury

1. Build nothing
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Newburyport
   d. waste to Haverhill
   e. waste to Amesbury

Merrimac

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Haverhill

2. Build secondary plant
   Effluent to
   a. land in Merrimac and Haverhill
   b. land in West Newbury

Amesbury

1. Abandon existing plant
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Salisbury
   d. waste to Newburyport

2. Alter existing secondary plant for
   Effluent to
   a. land in Merrimac and Haverhill
   b. land in Newbury and West Newbury
   c. land in Amesbury and Salisbury

Salisbury

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Newburyport

2. Build secondary plant
   Effluent to
   a. land in Amesbury and Salisbury

b. land in Newbury and West Newbury

Newburyport

1. Existing primary plant can only serve Newburyport
   Abandon plant
   a. waste to Salisbury
   b. waste to Amesbury

2. Relocate and make into secondary plant
   Effluent to
   a. land in Newbury and West Newbury
   b. land in Amesbury and Salisbury
   c. land in Merrimac and Haverhill

ALTERNATE NO. 6
Land/Water
Decentralized Systems

Andover

1. Build nothing
   a. on-lot systems
   b. waste to North Andover

Methuen

1. Build nothing
   a. on-lot systems
   b. waste to North Andover

Lawrence

1. Build nothing
   a. waste to North Andover

North Andover

1. Secondary plant has been bid. Areas not proposed for sewers
   a. on-lot systems
   b. south North Andover to MDC
   c. south North Andover to Boxford

2. Build secondary plant as bid
   Effluent to
   a. land in Boxford and Haverhill
   b. land in Methuen and Haverhill
   c. land in Andover
   d. AWT plant in North Andover
   e. reuse in low water quality industries

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. local flow augmentation
   d. reuse in Lawrence area industries

Haverhill

1. Build nothing
   a. waste to GLSD
   b. waste to West Newbury
   c. waste to Merrimac

2. Build secondary plant
   Effluent to
   a. land in Boxford and Haverhill
   b. land in Methuen and Haverhill
   c. land in West Newbury
   d. land in Merrimac
   e. AWT plant in Haverhill
   f. AWT plant in North Andover
   g. reuse in low water quality industries

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. local flow augmentation
   c. industrial reuse

Boxford

1. Build nothing
   a. on-lot systems
   b. North Boxford to Haverhill, south to MDC
   c. North Boxford to North Andover, south to MDC
   d. all Boxford to Haverhill
   e. all Boxford to North Andover
   f. all Boxford to Rowley

Groveland

1. Build nothing
   a. on-lot systems
   b. waste to Haverhill
   c. waste to Boxford
   d. waste to Georgetown
   e. waste to West Newbury

Georgetown

1. Build nothing
   a. on-lot systems
   b. waste to West Newbury

c. waste to Rowley
d. waste to Groveland

2. Build secondary plant
Effluent to
a. land in Boxford and Haverhill
b. land in West Newbury
c. land in MDC area
d. AWT plant in Georgetown
e. AWT plant in Haverhill
f. AWT plant in North Andover

3. Build AWT plant
Effluent to
a. Merrimack River
b. Parker River
c. area flow augmentation
d. Artichoke Reservoir

Rowley

1. Build nothing
a. on-lot systems
b. waste to Newbury
c. waste to Georgetown
d. waste to MDC area

2. Build secondary plant
Effluent to
a. land in West Newbury
b. land in Boxford and Haverhill
c. land in MDC area
d. AWT plant in Georgetown
e. AWT plant in Newburyport
f. AWT plant in MDC area
g. Plum Island Sound

Newbury

1. Build nothing
a. on-lot systems
b. waste to W, Newbury
c. waste to Newburyport
d. waste to Rowley

West Newbury

1. Build nothing
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Newburyport
   d. waste to Haverhill
   e. waste to Amesbury

2. Build secondary plant
   Effluent to
   a. land in West Newbury and Newbury
   b. land in Merrimac and Haverhill
   c. AWT plant in Newburyport
   d. the estuary

Merrimac

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Haverhill

2. Build secondary plant
   Effluent to
   a. land in Merrimac and Haverhill
   b. land in West Newbury
   c. AWT plant in Newburyport
   d. AWT plant in Haverhill
   e. the estuary

Amesbury

1. Abandon existing plant
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Salisbury
   d. waste to Newbury

2. Alter existing secondary plant for
   Effluent to
   a. land in Amesbury and Salisbury
   b. land in Newbury and West Newbury
   c. land in Merrimac and Haverhill
   d. AWT plant in Newburyport
   e. the estuary

Salisbury

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Newburyport

2. Build secondary plant
   Effluent to
   a. land in Salisbury and Amesbury
   b. land in Newbury and West Newbury
   c. AWT plant in Newburyport
   d. deep ocean outfall
   e. the estuary

Newburyport

1. Existing primary plant can only serve Newburyport
   Abandon plant
   a. waste to Salisbury
   b. waste to Amesbury
   c. waste to West Newbury

2. Relocate and upgrade to secondary plant
   Effluent to
   a. AWT plant in Newburyport
   b. land in Newbury and West Newbury
   c. land in Amesbury and Salisbury
   d. land in Merrimac and Haverhill
   e. deep ocean outfall
   f. the estuary

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. Parker River
   c. Artichoke Reservoir
   d. the ocean
   e. the estuary
   f. industrial reuse

ALTERNATE NO. 7
Land / Water
Centralized Systems

Andover

1. Build nothing
   a. on-lot systems
   b. waste to North Andover

Methuen

1. Build nothing
   a. on-lot systems
   b. waste to North Andover

Lawrence

1. Build nothing
   a. waste to North Andover

North Andover

1. Secondary plant has been bid. Areas not proposed for sewers
   a. on-lot systems
   b. south North Andover to MDC
   c. south North Andover to Boxford

2. Build secondary plant as bid
   Effluent to
   a. land in Boxford and Haverhill
   b. land in Methuen and Haverhill
   c. land in Andover
   d. AWT plant in North Andover
   e. reuse in low water quality industries

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. local flow augmentation
   c. reuse in Lawrence area industries

Haverhill

1. Build nothing
   a. waste to GLSD

b. Waste to West Newbury
c. waste to Merrimac

2. Build secondary plant
Effluent to
a. land in Boxford and Haverhill
b. land in Methuen and Haverhill
c. land in West Newbury
d. land in Merrimac
e. AWT plant in North Andover
f. reuse in low water quality industries

Boxford

1. Build nothing
a. on-lot systems
b. North Boxford to Haverhill, south to MDC
c. North Boxford to North Andover, south to MDC
d. all Boxford to Haverhill
e. all Boxford to North Andover
f. all Boxford to Georgetown

Groveland

1. Build nothing
a. on-lot systems
b. waste to Haverhill
c. waste to Georgetown
d. waste to W. Newbury

Georgetown

1. Build nothing
a. on-lot systems
b. waste to West Newbury
c. waste to Groveland

2. Build secondary plant
Effluent to
a. land in Boxford and Salisbury
b. land in West Newbury
c. land in MDC area
d. AWT plant in North Andover

Rowley

1. Build nothing
   a. on-lot systems
   b. waste to Newbury
   c. waste to Georgetown
   d. waste to MDC area

Newbury

1. Build nothing
   a. on-lot systems
   b. waste to West Newbury
   c. waste to Newburyport

West Newbury

1. Build nothing
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Newburyport
   d. waste to Haverhill
   e. waste to Amesbury

Merrimac

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Haverhill

2. Build secondary plant
   Effluent to
   a. land in Merrimac and Haverhill
   b. land in West Newbury
   c. AWT plant in Newburyport
   d. the estuary

Amesbury

1. Abandon existing plant
   a. on-lot systems
   b. waste to Merrimac
   c. waste to Salisbury
   d. waste to Newburyport

2. Alter existing secondary plant for
   Effluent to
   a. land in Amesbury and Salisbury
   b. land in Newbury and West Newbury
   c. land in Merrimac and Haverhill
   d. AWT plant in Newburyport
   e. the estuary

Salisbury

1. Build nothing
   a. on-lot systems
   b. waste to Amesbury
   c. waste to Newburyport

2. Build secondary plant
   Effluent to
   a. land in Salisbury and Amesbury
   b. land in Newbury and West Newbury
   c. AWT plant in Newburyport
   d. deep ocean outfall
   e. the estuary

Newburyport

1. Existing primary plant can only serve Newburyport
   Abandon plant
   a. waste to Salisbury
   b. waste to Amesbury

2. Relocate and upgrade to secondary plant
   Effluent to
   a. AWT plant in Newburyport
   b. land in Newbury and West Newbury
   c. land in Amesbury and Salisbury
   d. land in Merrimac and Haverhill
   e. deep ocean outfall
   f. the estuary

3. Build AWT plant
   Effluent to
   a. Merrimack River
   b. Parker River
   c, Artichoke Reservoir
   d. the ocean
   e. the estuary
   f. industrial reuse

(4) Third Iteration

Methodology

The listing of sewerage alternatives and the accompanying plans which were developed in the second iteration of wastewater alternatives were distributed to all of the study team members as well as to the Northern Middlesex Area and Merrimack Valley Planning Commissions for use at the planning workshops with their member communities.

In order to achieve the best results from the RPA workshops, specific considerations were highlighted in a brief text which accompanied the listing of alternatives. Excerpts from this text are reproduced here:

> "Following is a listing of the considerations and input which would be most helpful in screening these alternatives even further; or in formulating additional alternatives for consideration:
>
> 1. Specific industrial reuse needs and locations.
>
> 2. Potential cases and sites for combined solid waste (or power plant) and wastewater treatment facilities.
>
> 3. Towns which will have to look to the Merrimack River for future drinking water supply.
>
> 4. Locations where groundwater quality is less critical than surface water quality (as a source of drinking water).
>
> 5. Potential sites for treatment plant locations.
>
> 6. Indication of preference for certain alternative(s).
>
> 7. Any other considerations which have not been embodied in the alternatives presented.

"The pollution problem in the Merrimack is an obvious one. Pollution is a clear fact of life to the residents of the Basin and an impediment to the healthy development of the region's economic and social potential. Ultimately, it will be the people that must decide the future of the River. Wastewater is a resource too valuable to discard, and its fullest and best use would be to make it and its constituent pollutants available for reuse; but only if a concerned and interested public dictates the direction of the Basin as a whole."

"The solution can be technically determined, however, the ultimate decision must come from the public. They must decide what is to become of the River. It is the purpose of these alternative layouts to give the people the facts. The outlines for comprehensive regional recovery are presented. This is the time for discussion and feedback from the Regional Planning Commissions, the governmental agencies, and the people. The study will go on to completion with or without these inputs. If this study is to achieve all of the objectives, the public will have to react and actively participate at this and future stages of the work."

Criteria for Screening

In addition to the listing and maps of the second iteration alternatives, a set of screening criteria were also distributed to the RPA's and all other agencies participating in the study. These criteria are presented below:

General

1. Options with obviously high costs, such as pumping waste to a treatment plant, rather than gravity flow to a different location, or a fifteen-mile pipeline, rather than a five-mile line, will be discarded.

2. All options for advanced wastewater treatment (AWT) effluent to be applied to the land will be discarded in favor of adding sand filtration to secondary plants with the effluent going to land application.

3. In the Lowell area, industrial reuse is not considered a viable alternative, as the industries that are presently supplied by the Merrimack River will continue to use the river as a source of supply if the water is cleaned by upstream elimination or treatment of discharge.

4. It is not proposed that every community be entirely sewered. However, all urban built-up areas will be sewered, and it is understood that unless an area experiences problems with on-lot systems, that area will remain on private systems.

5. Although it appears that the shortest pipeline will be the most feasible alternative, should a pressing need arise, for example, groundwater recharge for water supply, the benefit versus the cost will be considered. In addition, analysis of long pipelines versus cost of additional treatment will be performed in marginal cases.

6. Unless there exists an urgent requirement, there will be no splitting of advanced process effluent for purposes of multiple use.

7. Existing sanitary districts (where formal, by contract, or by agreement) will be kept intact.

8. Treatment plants will be located as near the source of the waste and the discharge point of the effluent as possible.

Decentralized Schemes

1. Except for discharge to the Merrimack River, no two advanced process effluents will be used for the same purpose; e.g. flow augmentation to the Concord River.

2. Long detention times for raw sewage in a pipeline result in septic conditions. Options with long lines carrying raw sewage have been avoided, wherever possible.

3. Wherever space permits, existing secondary plants will be upgraded to advanced treatment status, rather than constructing a new advanced treatment facility.

4. Adjacent municipal advanced wastewater treatment plants will be discouraged. It has been assumed that the downstream plant would treat the flow from the upstream community.

Centralized Schemes

1. In screening the alternatives on the centralized schemes, many of the criteria set down for the decentralized schemes may be violated. For instance, in a centralized scheme, long pipelines and frequent pumping of wastewater may be justified by savings in capital and operating costs; reliability and flexibility of performance; and operational controls which are more possible with larger regional facilities.

2. Regional facilities will be located as close to the major concentrations of wastewater sources as possible to avoid long transportation of large quantities of flow.

Other Considerations

1. The wastewater alternatives will be modified and further screened to include the following considerations:

   a. Environmental Interactions
   b. Reuse Options
   c. Stormwater Alternatives (Combined Systems)

Listing of Alternatives

As a result of information gathered by the RPA's at their workshops; a meeting with and correspondence from the staff of the MVPC; a meeting with the NMAC; separate conferences with representatives of the Massachusetts Division of Water Pollution Control and Department of Public Health; correspondence from members of the study team; and meetings with the assessment

contractors on the study, a third iteration of wastewater alternatives was developed and the resultant listing is presented on subsequent pages. In addition to the listing of alternatives, a revised set of plans graphically depicting the sewerage options for each community was also prepared. A sample of one of these plans is presented as Plate No. 2. The reader will note that the third iteration listing differentiates between initial and phased (1983 and 1985) construction options and has produced six technical alternates for both the Northern Middlesex Area and Merrimack Valley Planning Commissions.

THIRD ITERATION OF WASTEWATER ALTERNATIVES

NORTHERN MIDDLESEX AREA COMMISSION

ALTERNATE NO. 1
Water Oriented
Decentralized Systems

Pepperell

Construct secondary treatment plant.
Effluent to
a. Nashua River (until 1983)
b. AWT plant in Groton (after 1983)
*Upgrade to an advanced plant discharging to Nashua River.

Dunstable

Continue to use private on-lot systems.
*When a need for sewerage arises, West Dunstable to Pepperell, East Dunstable to North Chelmsford. (via Tyngsborough)

Tyngsborough

Wastewater to North Chelmsford.

Westford

Wastewater to North Chelmsford

Chelmsford

1. Construct secondary plant (to be upgraded to an AWT plant) in North Chelmsford. Effluent to the Merrimack River.
2. Construct a secondary plant in South Chelmsford.
Effluent to
a. Concord River (until 1983)
b. AWT plant in Billerica (after 1983)

Dracut

Wastewater to Lowell.

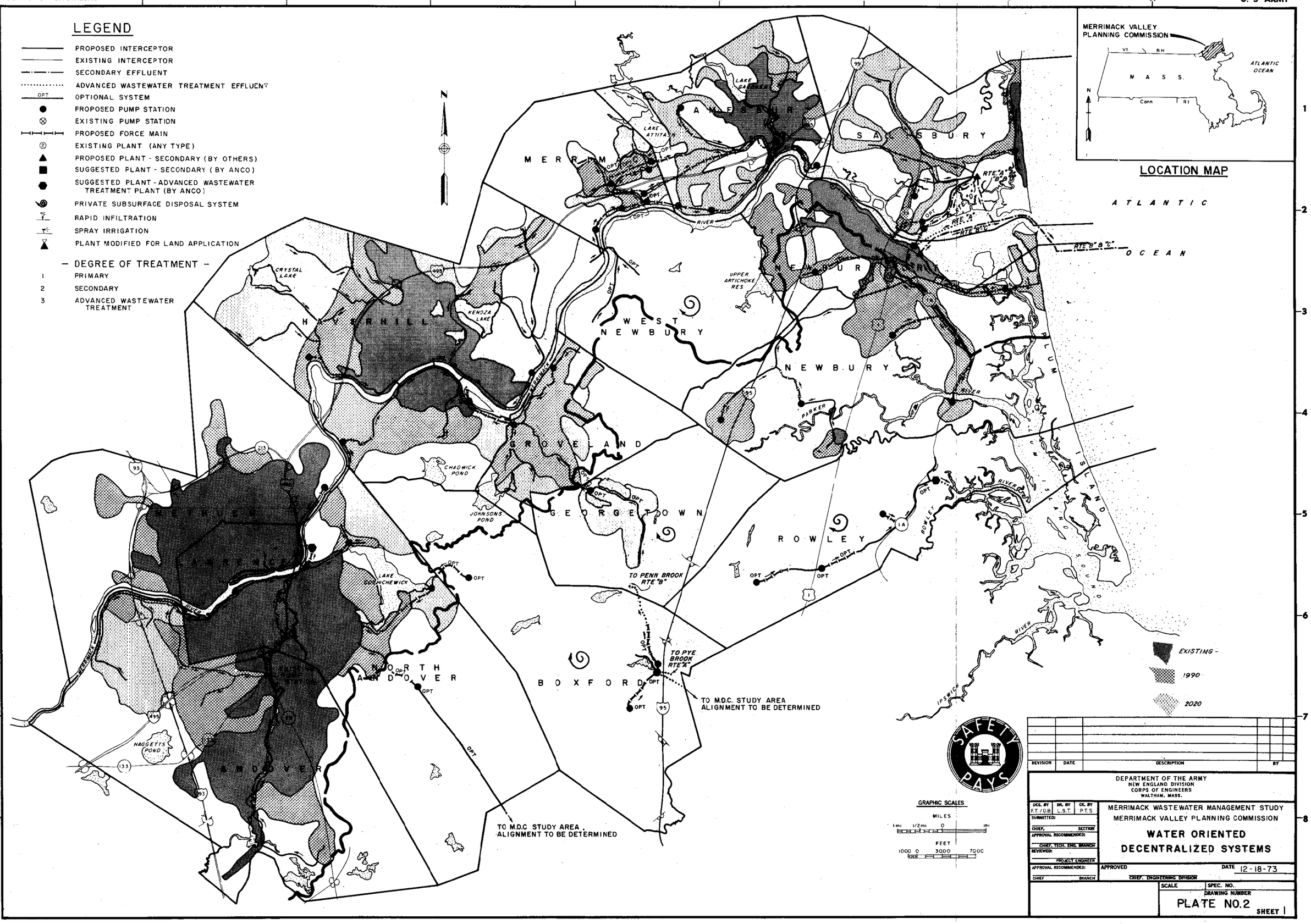
CORPS OF ENGINEERS U. S ARMY

LEGEND

- PROPOSED INTERCEPTOR
- EXISTING INTERCEPTOR
- SECONDARY EFFLUENT
- ADVANCED WASTEWATER TREATMENT EFFLUENT
- OPT — OPTIONAL SYSTEM
- PROPOSED PUMP STATION
- EXISTING PUMP STATION
- PROPOSED FORCE MAIN
- EXISTING PLANT (ANY TYPE)
- PROPOSED PLANT - SECONDARY (BY OTHERS)
- SUGGESTED PLANT - SECONDARY (BY ANCO)
- SUGGESTED PLANT - ADVANCED WASTEWATER TREATMENT PLANT (BY ANCO)
- PRIVATE SUBSURFACE DISPOSAL SYSTEM
- RAPID INFILTRATION
- SPRAY IRRIGATION
- PLANT MODIFIED FOR LAND APPLICATION

– DEGREE OF TREATMENT –

1 PRIMARY
2 SECONDARY
3 ADVANCED WASTEWATER TREATMENT



REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY
F.T./D.B.	L.S.T.	P.T.S.

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION

WATER ORIENTED DECENTRALIZED SYSTEMS

APPROVED DATE 12-18-73
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
PLATE NO.2
SHEET 1

Lowell

Construct a secondary plant on Duck Island (to be upgraded to an AWT plant). Effluent to the Merrimack River.

Tewksbury

Wastewater to Lowell.

Billerica

Existing secondary plant to be upgraded to an AWT plant by 1983. Effluent to the Concord River.

*Options to be costed.

NORTHERN MIDDLESEX AREA COMMISSION

ALTERNATE NO. 2
Water Oriented
Partially Decentralized Systems

Pepperell

Construct a secondary treatment plant.
Effluent to
a. Nashua River (until 1983)
b. AWT plant in Groton (after 1983)
*Upgraded to an AWT plant discharging to Nashua River.

Dunstable

Continue to use private on-lot systems.
*When a need for sewerage arises, West Dunstable to Pepperell, East Dunstable to North Chelmsford. (via Tyngsborough)

Tyngsborough

Wastewater to North Chelmsford.

Westford

Wastewater to North Chelmsford

Chelmsford

1. Construct a secondary plant (to be upgraded to an AWT plant) in North Chelmsford. Effluent to the Merrimack River.
2. South Chelmsford to Billerica.

Dracut

Wastewater to Lowell.

Lowell

Construct a secondary plant at Duck Island.
Effluent to
a. Merrimack River (until 1983)
b. AWT plant in Billerica (after 1983)

Tewksbury

Wastewater to Lowell.

Billerica

Existing secondary plant to be upgraded to AWT plant by 1983. Effluent to Concord River.

*Options to be costed.

NORTHERN MIDDLESEX AREA COMMISSION

ALTERNATE NO. 3
Water Oriented
Centralized Systems

Pepperell

Wastewater to Groton.

Dunstable

Continue to use private on-lot systems.
*When a need for sewerage arises, West Dunstable to Pepperell, East Dunstable to North Chelmsford. (via Tyngsborough)

Tyngsborough

Wastewater to North Chelmsford.

Westford

Wastewater to North Chelmsford.

Chelmsford

1. Construct a secondary treatment plant (to be upgraded to an advanced plant) in North Chelmsford. Effluent to the Merrimack River.
2. South Chelmsford to Billerica.

Dracut

Wastewater to Lowell.

Lowell

Construct a secondary plant at Duck Island.
Effluent to
a. Merrimack River (until 1983)
b. AWT plant in Billerica (after 1983)

Tewksbury

Wastewater to Lowell

Billerica

Existing secondary plant to be upgraded to an AWT plant by 1983. Effluent to the Concord River.

*Options to be costed.

NORTHERN MIDDLESEX AREA COMMISSION

ALTERNATE NO. 4
Land Oriented
Decentralized Systems

Pepperell

Construct a secondary treatment plant, modified for land application. Effluent to a Rapid Infiltration area in Pepperell.

Dunstable

Continue to use private on-lot systems.
*When a need for sewerage arises, West Dunstable to Pepperell, East Dunstable to North Chelmsford. (via Tyngsborough)

Tyngsborough

Wastewater to North Chelmsford.

Westford

Construct a secondary treatment plant, modified for land application, to treat flows from Westford and Littleton. Effluent to the Rapid Infiltration site at Fort Devens.

Chelmsford

1. Construct a secondary plant, modified for land application, in North Chelmsford. Effluent to the Rapid Infiltration site at Fort Devens.
2. South Chelmsford to Billerica.

Dracut

Wastewater to Lowell.

Lowell

Construct a secondary plant, modified for land application. Effluent to the Rapid Infiltration area at Fort Devens.

Tewksbury

Wastewater to Lowell.

Billerica

Existing plant to be modified for land application. Effluent to the Rapid Infiltration area at Fort Devens.

*Options to be costed.

NORTHERN MIDDLESEX AREA COMMISSION

ALTERNATE NO. 5
Land Oriented
Centralized Systems

Pepperell

Construct a secondary treatment plant, modified for land application. Effluent to the Rapid Infiltration area in Pepperell.

Dunstable

Continue to use private on-lot systems.
*When a need for sewerage arises, West Dunstable to Pepperell, East Dunstable to Westford. (via Tyngsborough and North Chelmsford)

Tyngsborough

Wastewater to Westford. (via North Chelmsford)

Westford

Construct a secondary treatment plant, modified for land application, to treat flows from Westford, Littleton, Tyngsborough, and North Chelmsford. Effluent to the Rapid Infiltration site at Fort Devens.

Chelmsford

Wastewater from North Chelmsford to Westford; South Chelmsford to Billerica.

Dracut

Wastewater to Lowell.

Lowell

Construct a secondary plant, modified for land application. Effluent to the Rapid Infiltration area at Fort Devens.

Tewksbury

Wastewater to Lowell.

Billerica

Existing plant to be modified for land application. Effluent to the Rapid Infiltration area at Fort Devens.

*Options to be costed.

NORTHERN MIDDLESEX AREA COMMISSION

ALTERNATE NO. 6
Water Oriented
(Lowell-Lawrence-Haverhill)

Pepperell

Wastewater to Groton.

Dunstable

Continue to use private on-lot systems.
*When a need for sewerage arises, West Dunstable to Pepperell, East Dunstable to North Chelmsford. (via Tyngsborough)

Tyngsborough

Wastewater to North Chelmsford.

Westford

Wastewater to North Chelmsford.

Chelmsford

1. Construct a secondary treatment plant (to be upgraded to an advanced plant) in North Chelmsford. Effluent to the Merrimack River.
2. South Chelmsford to Billerica.

*Effluent from secondary plant in North Chelmsford to AWT plant in North Andover.

Dracut

Wastewater to Lowell.

Lowell

Construct a secondary plant at Duck Island.
Effluent to
a. Merrimack River (until 1983)
b. AWT plant in North Andover (after 1983)

Tewksbury

Wastewater to Lowell.

Billerica

Secondary plant until 1983 when the effluent will be taken to an AWT plant in North Andover.

*Options to be costed.

ALTERNATE NO. 1
Water Oriented
Decentralized Systems

Andover

Wastewater to North Andover.

Methuen

Wastewater to North Andover.

Lawrence

Wastewater to North Andover.

North Andover

1. Construct a secondary treatment plant (to be upgraded to an AWT plant by 1983). Effluent to the Merrimack River.

*South part of North Andover to

a. MDC study area
b. North Andover plant

Haverhill

Construct a secondary plant (to be upgraded to an AWT plant by 1983). Effluent to the Merrimack River.

Groveland

Wastewater to Haverhill.

Boxford

Continue to use private on-lot systems.

*When a need for sewerage arises:

1. North Boxford to North Andover.

Boxford (Continued)

2. Remainder of Boxford build an AWT plant with effluent to
   a. Pye Brook (to Ipswich River-Route "A")
   b. Penn Brook (to Parker River-Route "B")
   c. MDC study area (Route "C")

Rowley

Continue to use private on-lot systems.
*When a need for sewerage arises, build an AWT plant with effluent to
   a. Rowley River tributary
   b. MDC study area

Georgetown

Continue to use private on-lot systems.
*When a need for sewerage arises, wastewater to Haverhill.

Newbury

Wastewater to Newburyport.

West Newbury

Continue to use private on-lot systems.
*When a need for sewerage arises, wastewater to Merrimac.

Merrimac

Construct a secondary plant.
Effluent to
   a. Merrimack River (until 1983)
   b. AWT plant in Amesbury
*Wastewater to Amesbury.

Amesbury

Existing secondary treatment plant (under construction) to be upgraded to an advanced plant by 1983. Effluent to the Powow River.
*Effluent to Merrimack River.

Salisbury

Construct secondary treatment plant.

Effluent to

a. The estuary (Route "A")
b. The ocean (Route "B")
c. The ocean (joint outfall with Newburyport-Route "C")
d. AWT plant in Newburyport (after 1983-Route "D")

*Wastewater to Newburyport.

Newburyport

1. Upgrade existing primary plant to secondary.

Effluent to

a. The estuary (Route "A")
b. The ocean (Route "B")
c. The ocean (joint outfall with Salisbury-Route "C")

2. Expand and upgrade proposed secondary plant to an AWT plant by 1983.

Effluent to the estuary.

*Options to be costed.

MERRIMACK VALLEY PLANNING COMMISSION

ALTERNATE NO. 2
Water Oriented
Partially Decentralized Systems

Andover

Wastewater to North Andover.

Methuen

Wastewater to North Andover.

Lawrence

Wastewater to North Andover.

North Andover

1. Construct a secondary plant (to be upgraded to an AWT plant by 1983). Effluent to the Merrimack River.
2. South part of North Andover to
    a. North Andover
    b. MDC study area

Haverhill

Construct a secondary plant (to be upgraded to an AWT plant by 1983). Effluent to the Merrimack River.

Groveland

Wastewater to Haverhill.

Boxford

Continue to use private on-lot systems.
*When a need for sewerage arises,
    a. North Boxford to North Andover
    b. Construct joint AWT plant in Rowley.

Rowley

Continue to use private on-lot systems.
*When a need for sewerage arises, construct an AWT plant jointly with Boxford.
Effluent to
a. Mill River (Route "A")
b. Penn Brook tributary to Parker River (Route "B")
c. MDC study area (Route "C")

Georgetown

Continue to use private on-lot systems.
*When a need for sewerage arises, wastewater to Haverhill.

Newbury

Wastewater to Newburyport.

West Newbury

Continue to use private on-lot systems.
*When a need for sewerage arises, wastewater to Merrimac.

Merrimac

Construct a secondary plant.
Effluent to
a. Merrimack River (until 1983)
b. AWT plant in Newburyport (after 1983)
*Wastewater to Amesbury.

Amesbury

Secondary plant (under construction).
Effluent to
a. Powow River (until 1983)
b. AWT plant in Newburyport (after 1983)
*Secondary effluent to Merrimack River.

Salisbury

Construct a secondary plant.

Effluent to

a. The estuary (Route "A")
b. The ocean (Route "B")
c. The ocean (joint outfall with Newburyport-Route "C"
d. AWT plant in Newburyport (after 1983-Route "D")

*Wastewater to Newburyport.

Newburyport

1. Relocate and upgrade the existing primary plant to secondary.

   Effluent to

   a. The estuary (Route "A")
   b. The ocean (Route "B")
   c. The ocean (joint outfall with Salisbury-Route "C")

2. By 1983, further upgrade plant to an AWT plant.

   Effluent to the estuary.

*Options to be costed.

MERRIMACK VALLEY PLANNING COMMISSION

ALTERNATE NO. 3
Water Oriented
Centralized Systems

Andover

Wastewater to North Andover.

Methuen

Wastewater to North Andover.

Lawrence

Wastewater to North Andover.

North Andover

Construct a secondary plant (to be upgraded to an AWT plant by 1983). Effluent to the Merrimack River.

Haverhill

Construct a secondary plant.
Effluent to
a. Merrimack River (until 1983)
b. AWT plant in North Andover (after 1983)

Groveland

Wastewater to Haverhill.

Boxford

Continue to use private on-lot systems.
*When the need for sewerage arises:
1. North Boxford to North Andover
2. Remainder of Boxford wastewater to MDC study area

Rowley

Continue to use private on-lot systems.
*When the need for sewerage arises, connect to MDC study area.

Georgetown

Continue to use private on-lot systems.
*When the need for sewerage arises, wastewater to Haverhill.

Newbury

Wastewater to Newburyport.

West Newbury

Continue to use private on-lot systems.
*When the need for sewerage arises, wastewater to Newburyport.

Merrimac

Construct a secondary plant.
Effluent to
a. Merrimack River (until 1983)
b. AWT plant in Newburyport (after 1983)
*Wastewater to Amesbury.

Amesbury

Secondary plant (under construction) discharging to the Powow River. By 1983 the secondary effluent will go to an AWT plant in Newburyport.
*Secondary effluent to Merrimack River.

Salisbury

Construct a secondary plant.
Effluent to
a. The estuary (Route "A")
b. The ocean (Route "B")
c. The ocean (joint outfall with Newburyport-Route "C")
d. AWT plant in Newburyport (after 1983-Route "D")
*Wastewater to Newburyport.

Newburyport

1. Relocate and upgrade the existing primary plant to secondary.
   Effluent to
   a. The estuary (Route "A")
   b. The ocean (Route "B")
   c. The ocean (joint outfall with Salisbury-Route "C")
2. By 1983 further upgrade plant to an AWT plant.
   Effluent to the estuary.

*Options to be costed.

MERRIMACK VALLEY PLANNING COMMISSION

ALTERNATE NO. 4
Land Oriented
Decentralized Systems

Andover

Wastewater to North Andover.

Methuen

Wastewater to North Andover.

Lawrence

Wastewater to North Andover.

North Andover

Construct a secondary treatment plant, modified for land application. Effluent to the Rapid Infiltration area in Haverhill.

*South part of North Andover to

a. MDC study area.
b. North Andover plant.

Haverhill

Construct a secondary treatment plant, modified for land application. Effluent to the Rapid Infiltration area in Haverhill.

Groveland

Wastewater to Haverhill.

Boxford

Continue to use private on-lot systems.

*When a need for sewerage arises:

1. North Boxford to North Andover.
2. Remainder of Boxford build a secondary plant (to be modified for land application).

Effluent to land in MDC study area.

Rowley

Continue to use private on-lot systems.
*When a need for sewerage arises, build a secondary plant (to be modified for land application).
Effluent to land in MDC study area.

Georgetown

Continue to use private on-lot systems.
*When a need for sewerage arises, wastewater to Haverhill.

Newbury

Wastewater to Newburyport.

West Newbury

Continue to use private on-lot systems.
*When a need for sewerage arises, wastewater to Merrimac.

Merrimac

Construct a secondary treatment plant, modified for land application. Effluent to the Spray Irrigation area in Merrimac.
*Wastewater to Amesbury.

Amesbury

The secondary treatment plant that is under construction should be modified for land application. Effluent to the Rapid Infiltration area in Newburyport.

Salisbury

Construct a secondary treatment plant, modified for land application. Effluent to the spray Irrigation area on the Amesbury-Salisbury line.
*Wastewater to Newburyport.

Newburyport

Upgrade and expand existing primary treatment plant to a secondary plant, modified for land application.

Effluent to:

a. Rapid Infiltration area in Newburyport (Route "A").
b. Spray Irrigation area in West Newbury (Route "B").

*Options to be costed.

MERRIMACK VALLEY PLANNING COMMISSION

ALTERNATE NO. 5
Land Oriented
Centralized Systems

Andover

Wastewater to North Andover.

Methuen

Wastewater to North Andover.

Lawrence

Wastewater to North Andover.

North Andover

Construct a secondary treatment plant. Effluent to

a. the Merrimack River until a secondary plant, modified for land application, is built in Haverhill,

b. then transport North Andover effluent (for additional modified treatment) to Haverhill.

*South part of North Andover to

a. MDC study area

b. North Andover plant.

Haverhill

Construct a secondary plant, modified for land application. Effluent to the Rapid Infiltration area in Haverhill.

Groveland

Wastewater to Haverhill.

Boxford

Continue to use private on-lot systems.

*When the need for sewerage arises,

1. North Boxford to North Andover.

2. Remainder of Boxford wastewater to MDC study area for treatment and land application.

Rowley

Continue to use private on-lot systems
*When the need for sewerage arises, wastewater to MDC study area for treatment and land application.

Georgetown

Continue to use private on-lot systems.
*When a need for sewerage arises, wastewater to Haverhill.

Newbury

Wastewater to Newburyport.

West Newbury

Continue to use private on-lot systems.
*When the need for sewerage arises, wastewater to Newburyport.

Merrimac

Construct a secondary treatment plant. Effluent to modified secondary treatment and land application in Amesbury.
*Wastewater to Amesbury.

Amesbury

Secondary treatment plant under construction should be modified for land application. Effluent to the Rapid Infiltration area in Newburyport.

Salisbury

Construct a secondary treatment plant, modified for land application. Effluent to the Spray Irrigation area on the Amesbury-Salisbury line.
*Wastewater to Newburyport.

Newburyport

Relocate, upgrade and expand the existing primary plant to a secondary treatment plant, modified for land application.
Effluent to

a. Rapid Infiltration area in Newburyport. (Route "A")
b. Spray Irrigation area in West Newbury. (Route "B")

*Options to be costed.

MERRIMACK VALLEY PLANNING COMMISSION

ALTERNATE NO. 6
Water Oriented
(Lawrence-Lowell-Haverhill)

Andover

Wastewater to North Andover.

Methuen

Wastewater to North Andover.

Lawrence

Wastewater to North Andover.

North Andover

Construct a secondary plant (to be upgraded to an AWT plant serving Lowell, Lawrence, and Haverhill systems by 1983). Effluent to the Merrimack River.

Haverhill

Construct a secondary plant.
Effluent to
a. Merrimack River (until 1983)
b. AWT plant in North Andover (after 1983)

Groveland

Wastewater to Haverhill.

Boxford

Continue to use private on-lot systems.
*When the need for sewerage arises:
1. North Boxford to North Andover
2. Remainder of Boxford wastewater to MDC study area

Rowley

Continue to use private on-lot systems.
*When the need for sewerage arises, connect to MDC study area.

Georgetown

Continue to use private on-lot systems.
*When a need for sewerage arises, wastewater to Haverhill.

Newbury

Wastewater to Newburyport.

West Newbury

Continue to use private on-lot systems.
*When the need for sewerage arises, wastewater to Newburyport.

Merrimac

Construct a secondary plant.
Effluent to
a. Merrimack River (until 1983)
b. AWT plant in Newburyport (after 1983)
*Wastewater to Amesbury.

Amesbury

Secondary plant (under construction) discharging to the Powow River. By 1983 the secondary effluent will go to an AWT plant in Newburyport.
*Secondary effluent to Merrimack River.

Salisbury

Construct a secondary plant.
Effluent to
a. The estuary (Route "A")
b. The ocean (Route "B")
c. The ocean (joint outfall with Newburyport-Route "C")
d. AWT plant in Newburyport (after 1983-Route "D")
*Wastewater to Newburyport.

Newburyport

1. Relocate and upgrade the existing primary plant to secondary.
   Effluent to
   a. The estuary (Route "A")
   b. The ocean (Route "B")
   c. The ocean (joint outfall with Salisbury-Route "C")
2. By 1983 further upgrade plant to an AWT plant.
   Effluent to the estuary.

*Options to be costed.

(5) Fourth Iteration

After considerable consultations with the various state agencies, regional planning agencies, elected officials, and work shops with the public, the technical alternatives were revised to include their opinions, suggestions and recommendations to the greatest extent possible. This portion of the screening activity took place during the latter part of December, 1973 through March, 1974.

The revised alternatives were completed with associated costs and preliminary environmental impacts. Six alternatives were developed for the Merrimack Valley Planning Commission region and five alternatives for the Northern Middlesex Area Commission. These revised alternatives were presented at the mid-stage Corps of Engineers public meetings held in Billerica and Haverhill, Massachusetts on 2 and 4 April 1974, respectively. These alternatives, along with the current Environmental Protection Agency - Commonwealth of Massachusetts Implementation Program are arrayed on Tables 1 and 2, and on Plate Nos. 3 through 15. Also shown on Table 3 is a Preliminary Impact Analysis of water and land oriented type alternatives with respect to various impact categories.

These fourth iteration alternatives are described in much greater detail in Section C of this appendix, "The Selected Alternates."

TABLE 1

MERRIMACK WASTEWATER MANAGEMENT STUDY

NORTHERN MIDDLESEX AREA COMMISSION

WASTEWATER MANAGEMENT ALTERNATIVES

Community	Current State Program	Alternative 1 (Water) (Decentralized)	Alternative 2 (Water-Partially) (Centralized)	Alternative 3 (Water-Centralized)	Alternative 4 (Water-Regional)	Alternative 5 (Land)
Pepperell	Secondary Treatment Plant (Sec STP) (Proposed)	Advanced Wastewater Treatment Plant (AWT)	Sec. STP Effluent to Proposed Regional AWT in Ayer	Untreated Wastewater to Proposed Regional AWT in Ayer	Untreated Wastewater to Proposed Regional AWT in Ayer	Effluent to Sec STP in Pepperell; Rapid Infiltration (RI) Land Application Site in Pepperell
Dunstable*	Not Applicable	West Dunstable to Pepperell AWT; East Dunstable to North Chelmsford AWT	West Dunstable to Pepperell Sec STP; East Dunstable to Lowell Sec STP	West Dunstable to Ayer AWT; East Dunstable to Billerica AWT	West Dunstable to Ayer AWT; East Dunstable to Billerica Sec STP	West Dunstable to Pepperell Sec STP; East Dunstable to North Chelmsford Sec STP
Tyngsborough	Area East of Merrimack River to Lowell Sec STP	East Tyngsborough to Lowell AWT; West Tyngsborough to North Chelmsford AWT	Untreated Wastewater to Lowell Sec STP	East Tyngsborough to Lowell Sec STP; West Tyngsborough to Billerica AWT	East Tyngsborough to Lowell Sec STP; West Tyngsborough to Billerica Sec STP	East Tyngsborough to Lowell Sec STP; West Tyngsborough to North Chelmsford Sec STP
Westford*	Not Applicable	Untreated Wastewater to North Chelmsford AWT	Untreated Wastewater to Lowell Sec STP	Untreated Wastewater to Billerica Sec STP	Untreated Wastewater to Billerica Sec STP	Sec STP in Westford; Effluent to Spray Irrigation (SI) Land Application Site in Westford
Chelmsford	Five Million Gallons per Day (MGD) untreated wastewater to Lowell Sec STP	AWT in North Chelmsford; Sec STP in South Chelmsford; Sec STP Effluent to Billerica AWT	North Chelmsford Untreated Wastewater to Lowell Sec STP; South Chelmsford Untreated Wastewater to Billerica AWT	Untreated Wastewater to Billerica AWT	Untreated Wastewater to Billerica Sec STP	Sec STP in North Chelmsford; Effluent to RI Land Application Site in Tyngsborough; South Chelmsford Untreated Wastewater to Billerica Sec STP

* These communities will continue with on-lot disposal until sewerage is needed.
The alternatives are suggested for the day when the need for sewerage is demonstrated.

Sec STP: Secondary Treatment Plant AWT: Advanced Wastewater Treatment Plant RI: Rapid Infiltration SI: Spray Irrigation

TABLE 1 (continued)

MERRIMACK WASTEWATER MANAGEMENT STUDY

NORTHERN MIDDLESEX AREA COMMISSION

WASTEWATER MANAGEMENT ALTERNATIVES

Community	Current State Program	Alternative 1 (Water) (Decentralized)	Alternative 2 (Water-Partially) (Centralized)	Alternative 3 (Water-Centralized)	Alternative 4 (Water-Regional)	Alternative 5 (Land)
Dracut	Untreated Wastewater to Lowell Sec STP	Untreated Wastewater to Lowell AWT	Untreated Wastewater to Lowell Sec STP	Untreated Wastewater to Lowell Sec STP	Untreated Wastewater to Lowell Sec STP	To Lowell Sec STP
Lowell	Sec STP (Under Construction)	AWT (If Space is Available) if not, Sec STP Effluent to Billerica AWT	Sec STP Effluent to Billerica AWT	Sec STP Effluent to Billerica AWT	Sec STP Effluent to Greater Lawrence Sanitary District (GLSD) in North Andover (AWT)	Sec STP in Lowell; Effluent to RI Land Application Site at Fort Devens in Lancaster
Tewksbury	Untreated Wastewater to Lowell Sec STP	Untreated Wastewater to Lowell AWT	Untreated Wastewater to Lowell Sec STP	Untreated Wastewater to Lowell Sec STP	Untreated Wastewater to Lowell Sec STP	To Lowell Sec STP
Billerica	Sec STP (Existing)	AWT; Effluent to Concord River at AWT Site	AWT; Effluent to Merrimack River	AWT; Effluent to Headwaters of Concord River	Sec STP; Effluent to GLSD in North Andover (AWT)	Effluent to Sec STP in Billerica; RI Land Application Site in Concord-Carlisle Area (Upper Concord River)

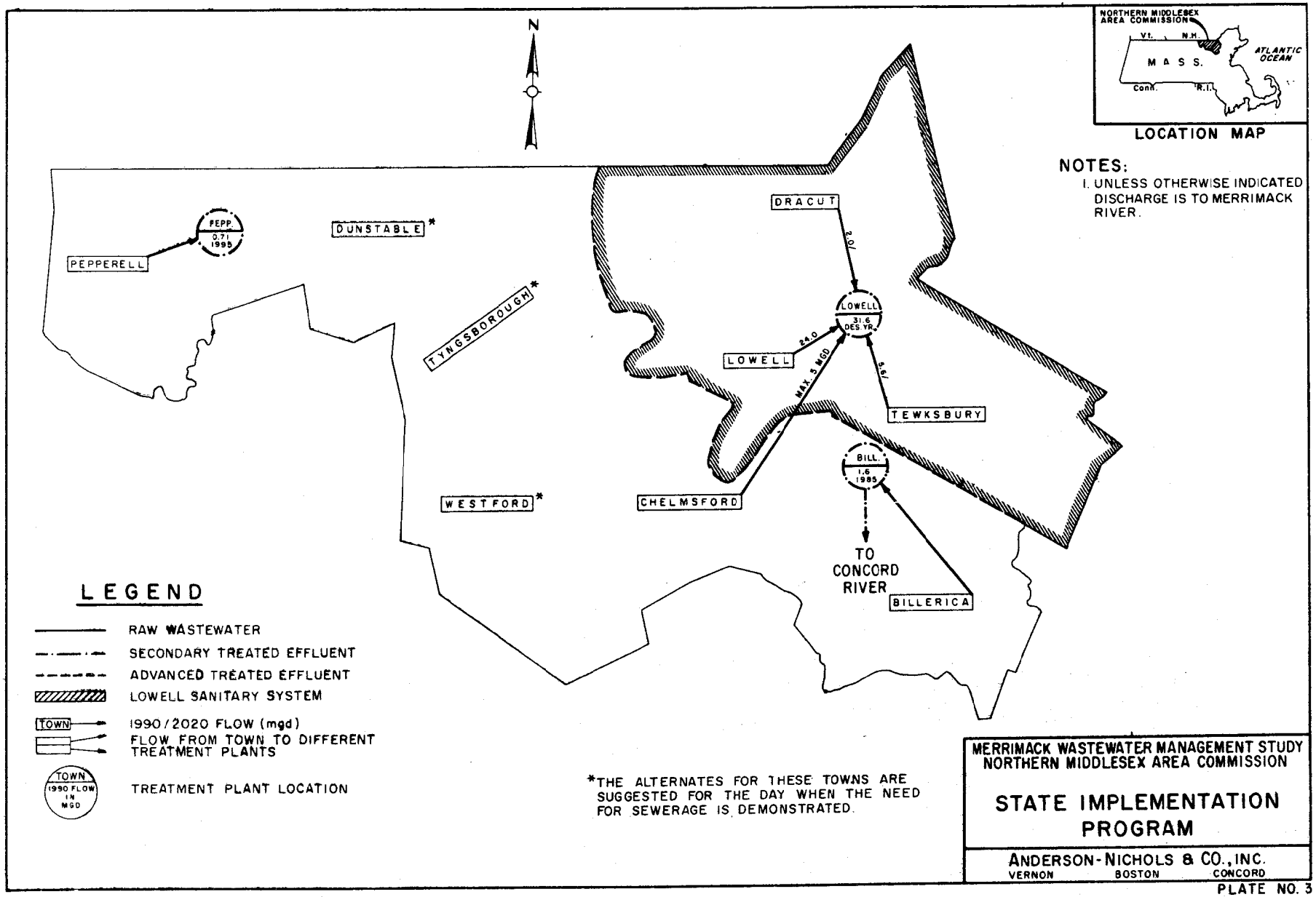
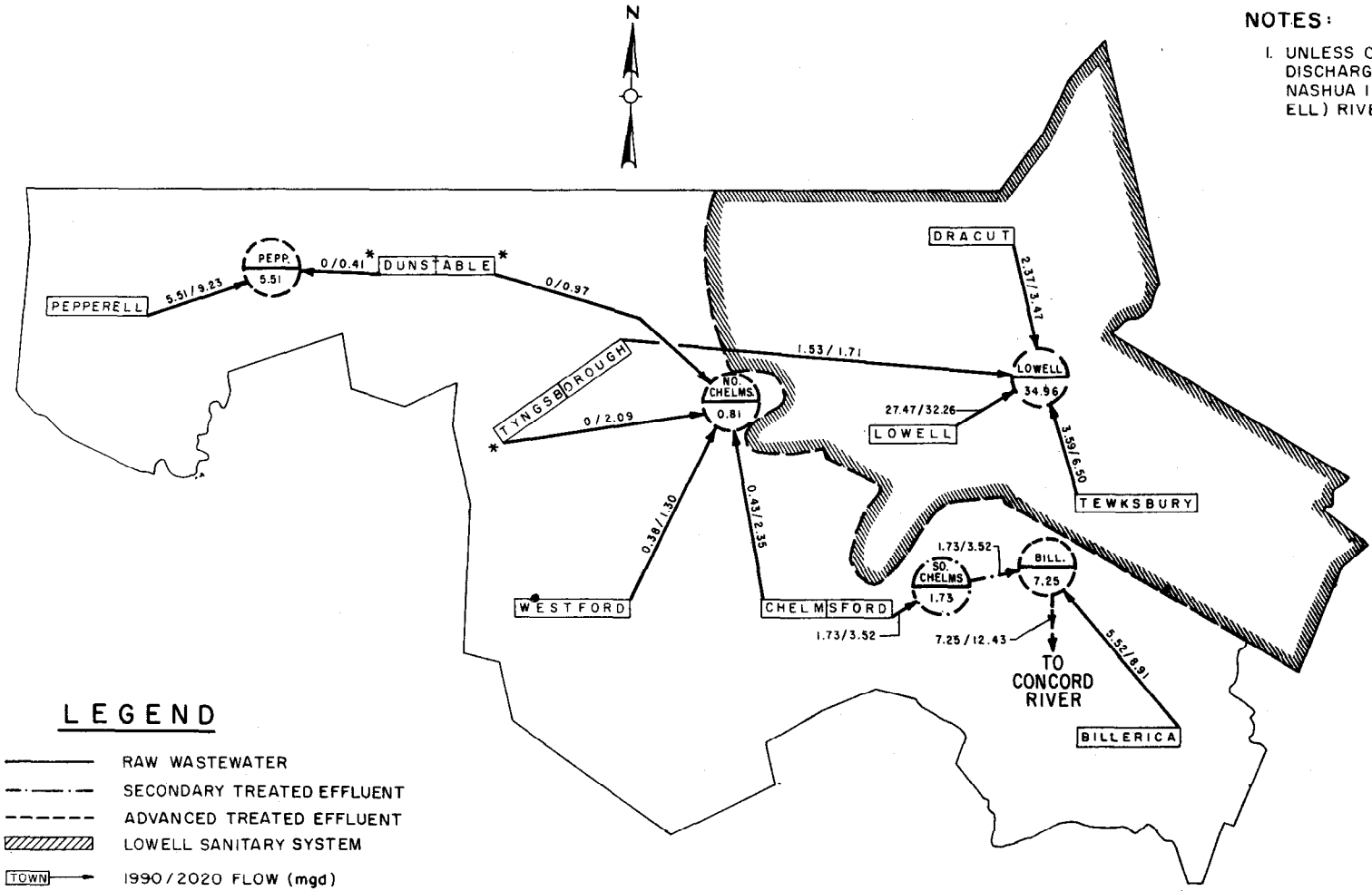

N
PEPPERELL
PEPP.
0.71
1995
DUNSTABLE*
TYNGSBOROUGH*
WESTFORD*
DRACUT
2.0/
LOWELL
31.6
DES. YR.
LOWELL
24.0
MAX. 5 MGD
5.6/
TEWKSBURY
CHELMSFORD
BILL.
1.6
1995
TO
CONCORD
RIVER
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
NORTHERN MIDDLESEX AREA COMMISSION
VT.
N.H.
MASS.
CONN.
R.I.
ATLANTIC OCEAN
LOCATION MAP
NOTES:
1. UNLESS OTHERWISE INDICATED DISCHARGE IS TO MERRIMACK RIVER.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
STATE IMPLEMENTATION PROGRAM
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

PLATE NO. 3



NOTES:

1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER.

LEGEND

- RAW WASTEWATER
- SECONDARY TREATED EFFLUENT
- ADVANCED TREATED EFFLUENT
- LOWELL SANITARY SYSTEM
- TOWN → 1990/2020 FLOW (mgd)
- FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
- TOWN / 1990 FLOW IN MGD — TREATMENT PLANT LOCATION

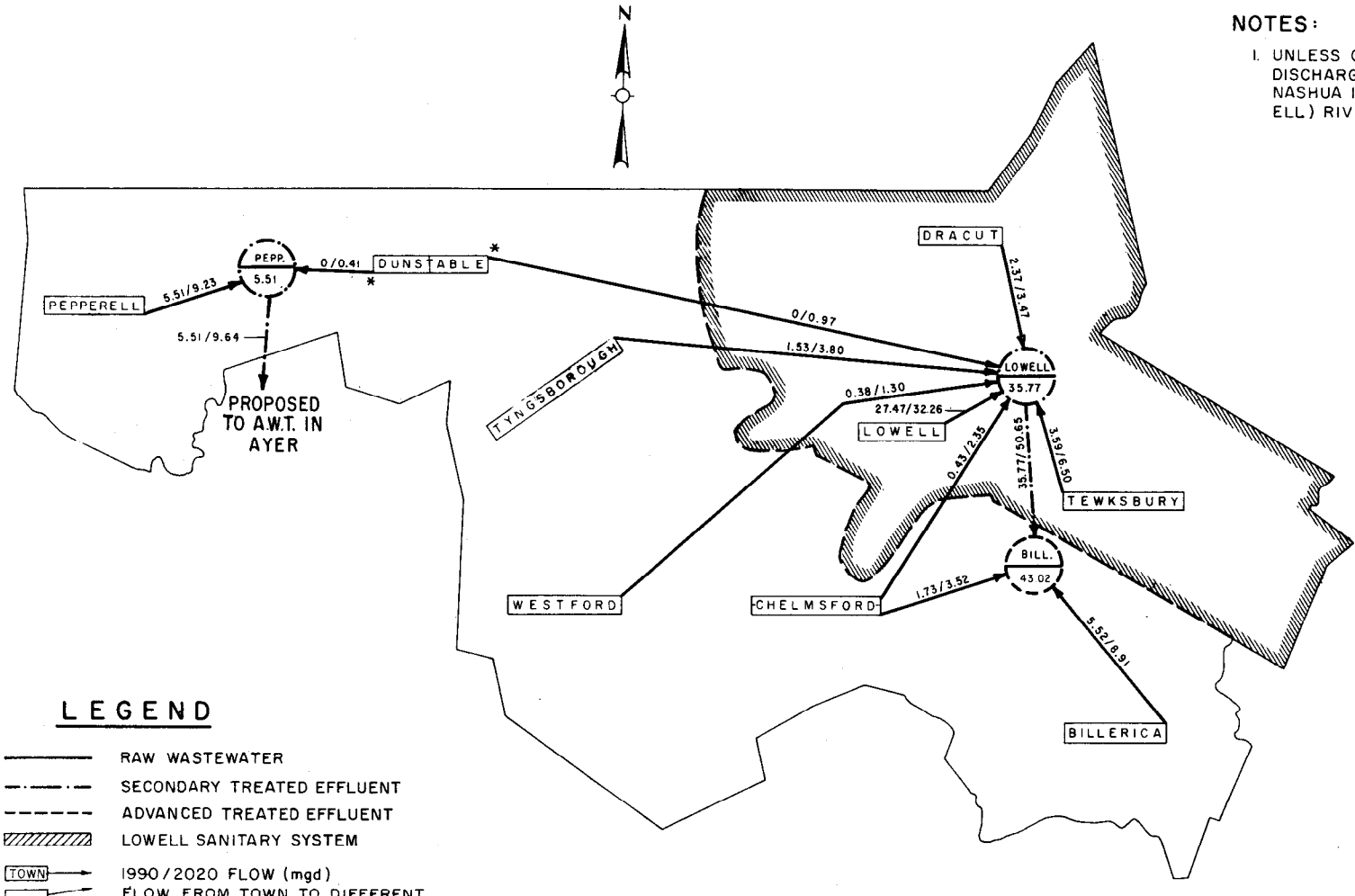
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.

MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION

ALTERNATE I
WATER - DECENTRALIZED

ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

PLATE NO. 4



NOTES:

1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER.

LEGEND

- RAW WASTEWATER
- SECONDARY TREATED EFFLUENT
- ADVANCED TREATED EFFLUENT
- LOWELL SANITARY SYSTEM
- TOWN → 1990/2020 FLOW (mgd)
- FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
- TOWN / 1990 FLOW IN MGD — TREATMENT PLANT LOCATION

*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.

MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION

ALTERNATE 2
WATER - PARTIALLY DECENTRALIZED

ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

PLATE NO. 5

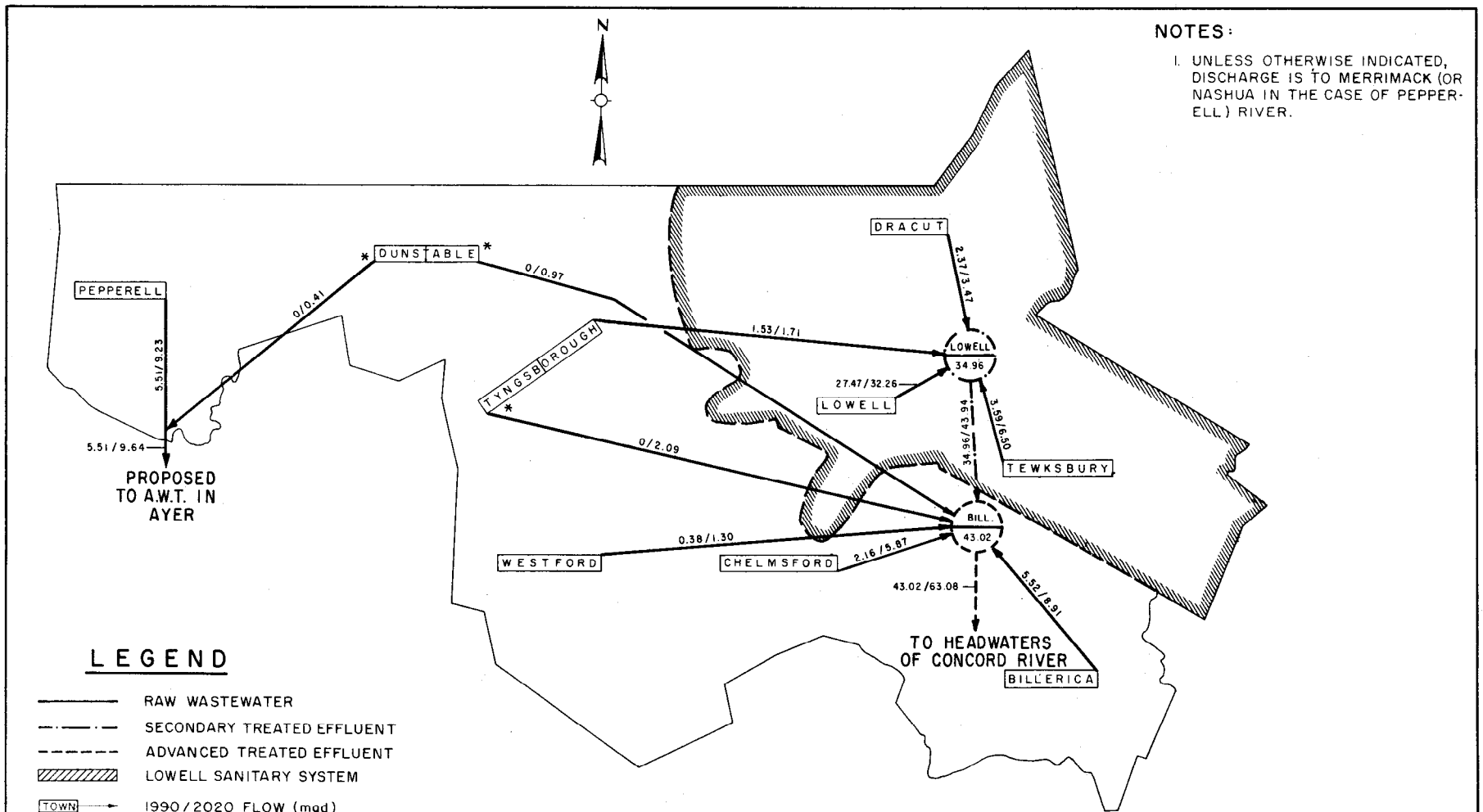
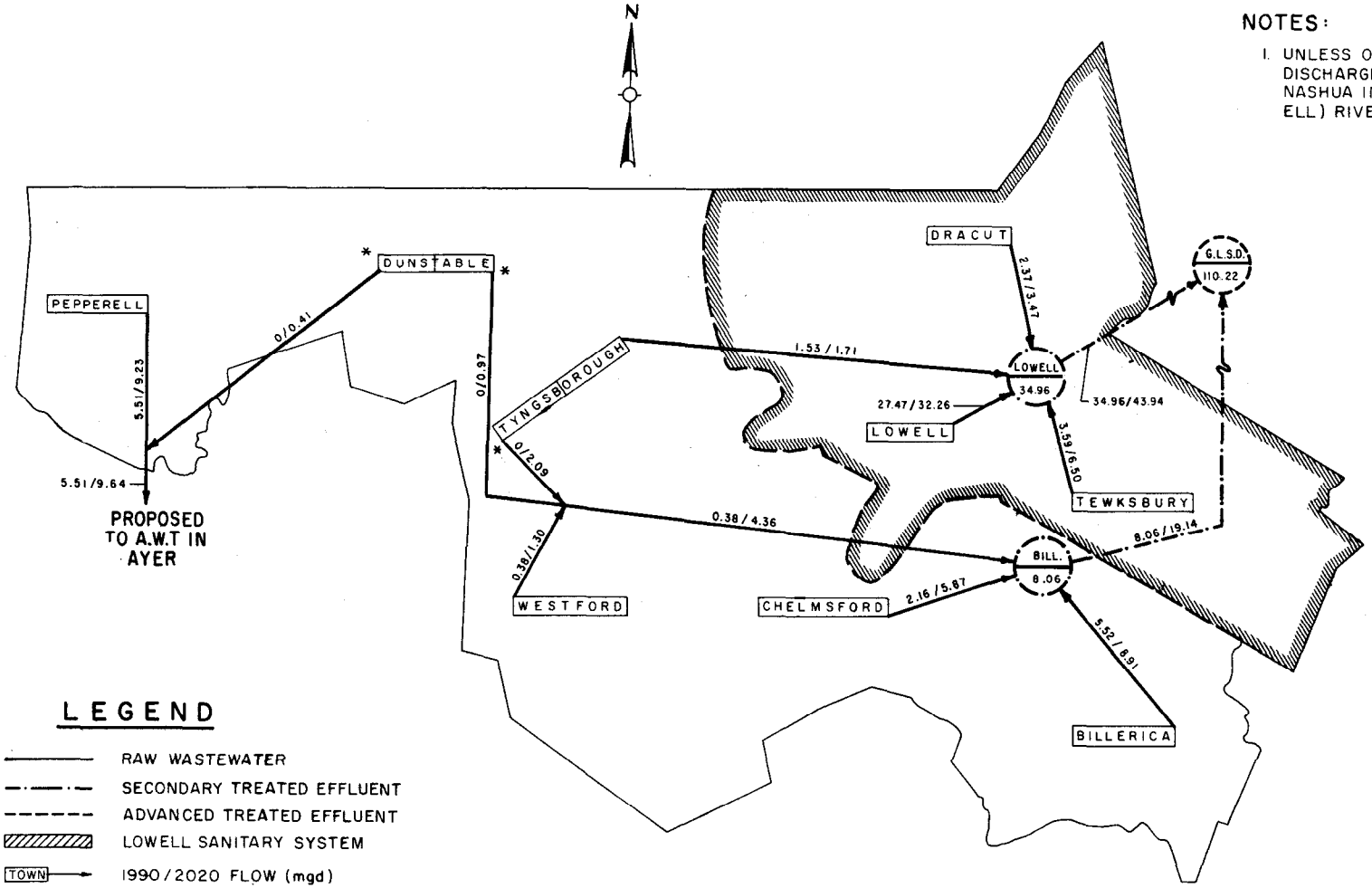

N
NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER.
PEPPERELL
DUNSTABLE
TYNGSBOROUGH
DRACUT
LOWELL
TEWKSBURY
BILL.
WESTFORD
CHELMSFORD
BILLERICA
0/0.41
0/0.97
1.53/1.71
2.37/3.47
27.47/32.26
34.96
34.96/43.94
3.69/6.50
0/2.09
0.38/1.30
2.16/5.87
43.02
43.02/63.08
5.52/8.91
5.51/9.23
5.51/9.64
PROPOSED TO A.W.T. IN AYER
TO HEADWATERS OF CONCORD RIVER
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
ALTERNATE 3
WATER-CENTRALIZED
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

PLATE NO. 6



NOTES:

1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER.

LEGEND

- RAW WASTEWATER
- SECONDARY TREATED EFFLUENT
- ADVANCED TREATED EFFLUENT
- LOWELL SANITARY SYSTEM
- TOWN — 1990/2020 FLOW (mgd)
- FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
- TOWN 1990 FLOW IN MGD — TREATMENT PLANT LOCATION

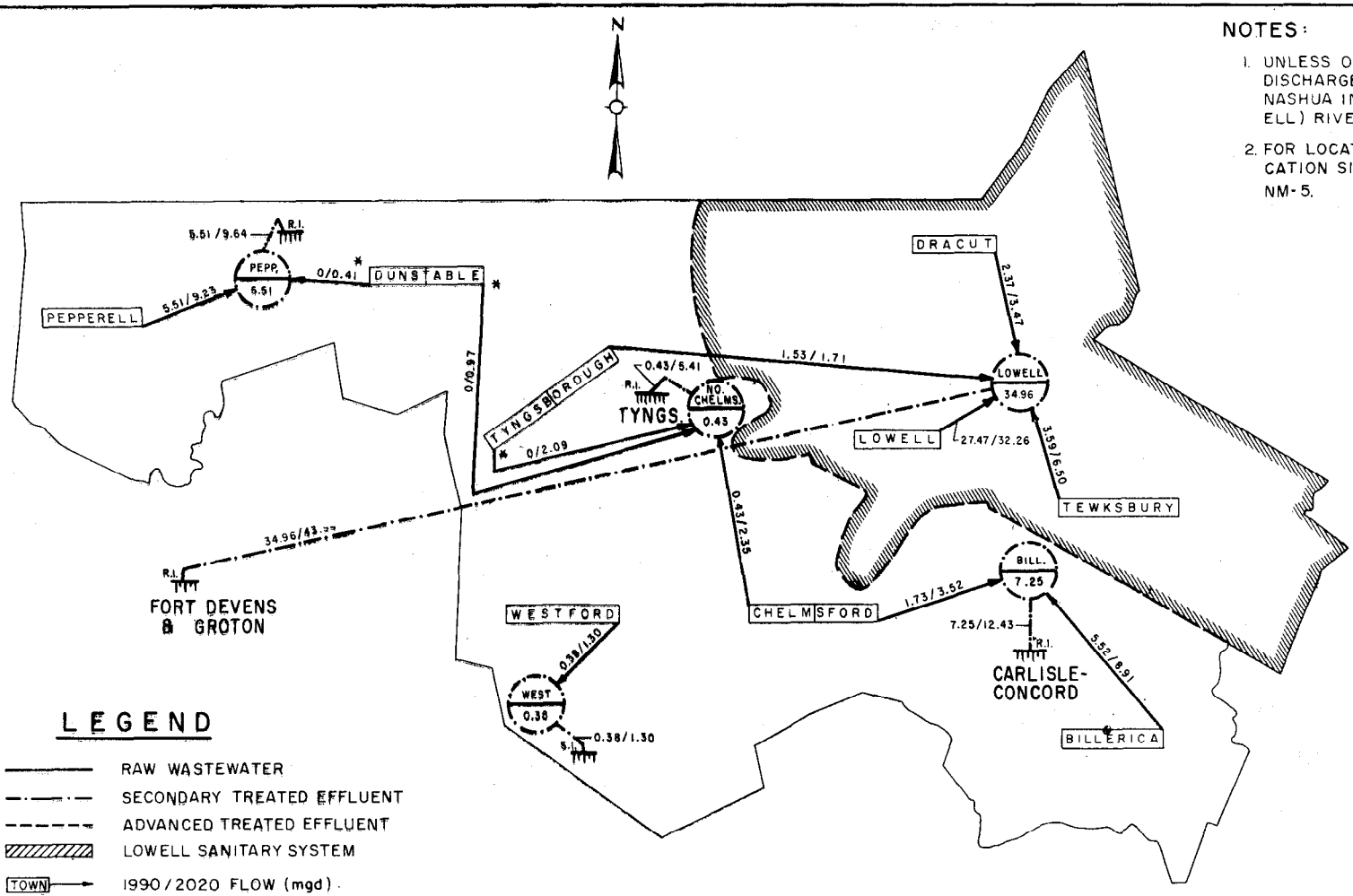
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.

MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION

ALTERNATE 4
WATER-REGIONAL

ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

PLATE NO. 7



NOTES:

1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER.
2. FOR LOCATIONS OF LAND APPLICATION SITES REFER TO PLATE NM-5.

LEGEND

- RAW WASTEWATER
- SECONDARY TREATED EFFLUENT
- ADVANCED TREATED EFFLUENT
- LOWELL SANITARY SYSTEM
- TOWN — 1990/2020 FLOW (mgd)
- FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
- TOWN 1990 FLOW IN MGD — TREATMENT PLANT LOCATION
- SPRAY IRRIGATION OR RAPID INFILTRATION

*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.

MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION

ALTERNATE 5
LAND

ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

PLATE NO. 8

TABLE 2

MERRIMACK WASTEWATER MANAGEMENT STUDY

MERRIMACK VALLEY PLANNING COMMISSION

WASTEWATER MANAGEMENT ALTERNATIVES

Community	Current State Program	Alternative 1 (Water) (Decentralized)	Alternative 2 (Water Partially) (Centralized)	Alternative 3 (Water-Centralized)	Alternative 4 (Water-Regional)	Alternative 5 (Land) (Decentralized)	Alternative 6 (Land-Centralized)
Greater Lawrence Sanitary District (GLSD)	Secondary Treatment Plant (Sec STP) in North Andover (Under Construction)	Advanced Wastewater Treatment Plant (AWT) in North Andover	AWT in North Andover	AWT in North Andover	AWT in North Andover (this alternative includes Haverhill and Lowell area communities)	Insufficient Land Available; AWT in North Andover	Insufficient Land Available; AWT in North Andover
Andover	GLSD	GLSD	GLSD	GLSD	GLSD	GLSD	GLSD
Methuen	GLSD	GLSD	GLSD	GLSD	GLSD	GLSD	GLSD
Lawrence	GLSD	GLSD	GLSD	GLSD	GLSD	GLSD	GLSD
No. Andover	Northern Area to GLSD; Southern Area Not Applicable	GLSD	Northern Area to GLSD; Southern Area to MDC Study Area	GLSD	GLSD	GLSD	GLSD
Haverhill	Secondary Treatment Plant (Sec STP) (Proposed)	AWT; East Haverhill to Merrimac Sec STP	AWT; East Haverhill to Newburyport Sec STP	Sec STP Effluent to GLSD AWT; East Haverhill to Amesbury Sec STP	Sec STP Effluent to GLSD AWT; East Haverhill to Amesbury Sec STP	Sec STP in Haverhill; Effluent to Rapid Infiltration (RI) Land Application Sites in Groveland and Haverhill; East Haverhill to Merrimac Sec STP	Sec STP in Haverhill; Effluent to Rapid Infiltration (RI) Land Application Sites in Groveland and Haverhill; East Haverhill to Merrimac Sec STP

*These communities will continue with on-lot disposal until sewerage is needed. The Schemes are suggested for the day when the need for sewerage is demonstrated.

**The infiltration of salt water into sewers may eliminate land application alternatives for Newburyport.

Sec STP: Secondary Treatment Plant AWT: Advanced Wastewater Treatment Plant RI: Rapid Infiltration SI: Spray Irrigation

TABLE 2 (Continued)

MERRIMACK WASTEWATER MANAGEMENT STUDY

MERRIMACK VALLEY PLANNING COMMISSION

WASTEWATER MANAGEMENT ALTERNATIVES

Community	Current State Program	Alternative 1 (Water) (Decentralized)	Alternative 2 (Water Partially) (Centralized)	Alternative 3 (Water-Centralized)	Alternative 4 (Water-Regional)	Alternative 5 (Land) (Decentralized)	Alternative 6 (Land-Centralized)
Groveland	Untreated Wastewater to Haverhill Sec STP	Untreated Wastewater to Haverhill AWT	Untreated Wastewater to Haverhill AWT	Untreated Wastewater to Haverhill Sec STP	Untreated Wastewater to Haverhill Sec STP	To Haverhill Sec STP	To Haverhill Sec STP
Boxford*	Not Applicable	North Boxford to GLSD AWT; AWT in South Boxford, Effluent to 1) Pye Br. (Ipswich R.) 2) Penn Br. (Parker R.)	North Boxford to GLSD AWT; South Boxford to MDC Study Area	North Boxford to GLSD AWT; South Boxford to Haverhill Sec STP	North Boxford to GLSD AWT; South Boxford to Haverhill Sec STP	North Boxford to GLSD AWT; Sec STP in South Boxford, Effluent to Spray Irrigation (SI) Land Application Site in Boxford	North Boxford to GLSD AWT; South Boxford untreated Wastewater to Georgetown Sec STP
Georgetown*	Not Applicable	Untreated Wastewater to Haverhill AWT	Untreated Wastewater to Haverhill AWT	Untreated Wastewater to Haverhill Sec STP	Untreated Wastewater to Haverhill Sec STP	Sec STP in Georgetown; Effluent to SI Land Application Site in Georgetown	Sec STP in Georgetown; Effluent to SI Land Application Sites in Georgetown and Boxford
Newbury	Portions to Newburyport Sec STP	Untreated Wastewater to Newburyport Sec STP	Untreated Wastewater to Newburyport Sec STP	Untreated Wastewater to Newburyport AWT	Untreated Wastewater to Newburyport AWT	To Newburyport Sec STP	To Newburyport Sec STP
West Newbury*	Not Applicable	Untreated Wastewater to Merrimac Sec STP	Untreated Wastewater to Newburyport Sec STP	Untreated Wastewater to Newburyport AWT	Untreated Wastewater to Newburyport AWT	Sec STP in West Newbury; Effluent to SI Land Application Site in West Newbury	To Merrimac Sec STP
Merrimac	Sec STP (Proposed) Further Study Required	Sec STP Effluent to Amesbury AWT	Untreated Wastewater to Newburyport Sec STP	Untreated Wastewater to Amesbury Sec STP	Untreated Wastewater to Amesbury Sec STP	Sec STP in Merrimac; Effluent to SI Land Application Site in Merrimac	Sec STP in Merrimac; Effluent to SI Land Application Site in West Newbury

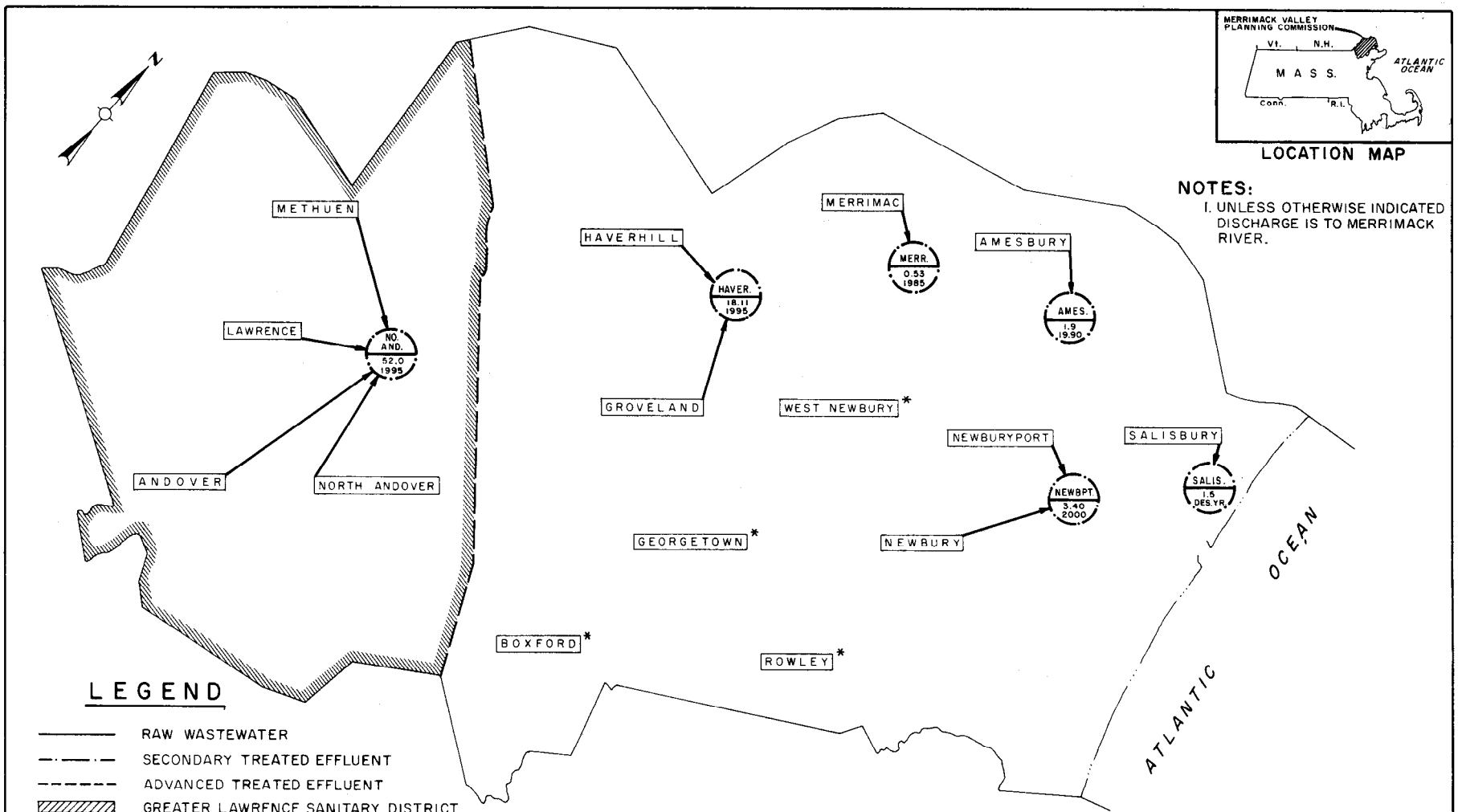
TABLE 2 (Continued)

MERRIMACK WASTEWATER MANAGEMENT STUDY

MERRIMACK VALLEY PLANNING COMMISSION

WASTEWATER MANAGEMENT ALTERNATIVES

Community	Current State Program	Alternative 1 (Water (Decentralized))	Alternative 2 (Water Partially Centralized)	Alternative 3 (Water-Centralized)	Alternaitve 4 (Water-Regional)	Alternative 5 (Land (Decentralized))	Alternative 6 (Land-Centralized)
Amesbury	Sec STP (Under Construction)	AWT Effluent to Powwow River	AWT Effluent to Merrimack River	Sec STP Effluent to Newburyport AWT	Sec STP Effluent to Newburyport AWT	Sec STP in Amesbury; Effluent to RI Land Application Site in Amesbury	Sec STP in Amesbury; Effluent to RI Land Application Site in Amesbury
Salisbury	Sec STP (Proposed) Further Study Required	Sec STP Effluent to 1) Estuary 2) Ocean	Sec STP Effluent to Joint Ocean Outfall with Newburyport	Sec STP Effluent to Newburyport AWT	Untreated Wastewater to Newburyport AWT	Sec STP in Salisbury; Effluent to RI Land Application Site in Salisbury	Sec STP in Salisbury; Effluent to RI Land Application Site in Salisbury
Newburyport**	Sec STP (Primary Plant in Operation) Further Study Required	Sec STP Effluent to 1) Estuary 2) Ocean	Sec STP Effluent to Joint Ocean Outfall with Salisbury	AWT Effluent to Estuary	AWT Effluent to Estuary	Sec STP in Newburyport; Effluent to Estuary	Sec STP in Newburyport; Effluent to Estuary
Rowley *	Not Applicable	AWT Effluent to Rowley River	Untreated Wastewater to MDC Study Area	Untreated Wastewater to Newburyport AWT	Untreated Wastewater to Newburyport AWT	Sec STP in Rowley; Effluent to SI Land Application Site in Rowley	Sec STP in Rowley; Effluent to SI Land Application Site in Rowley

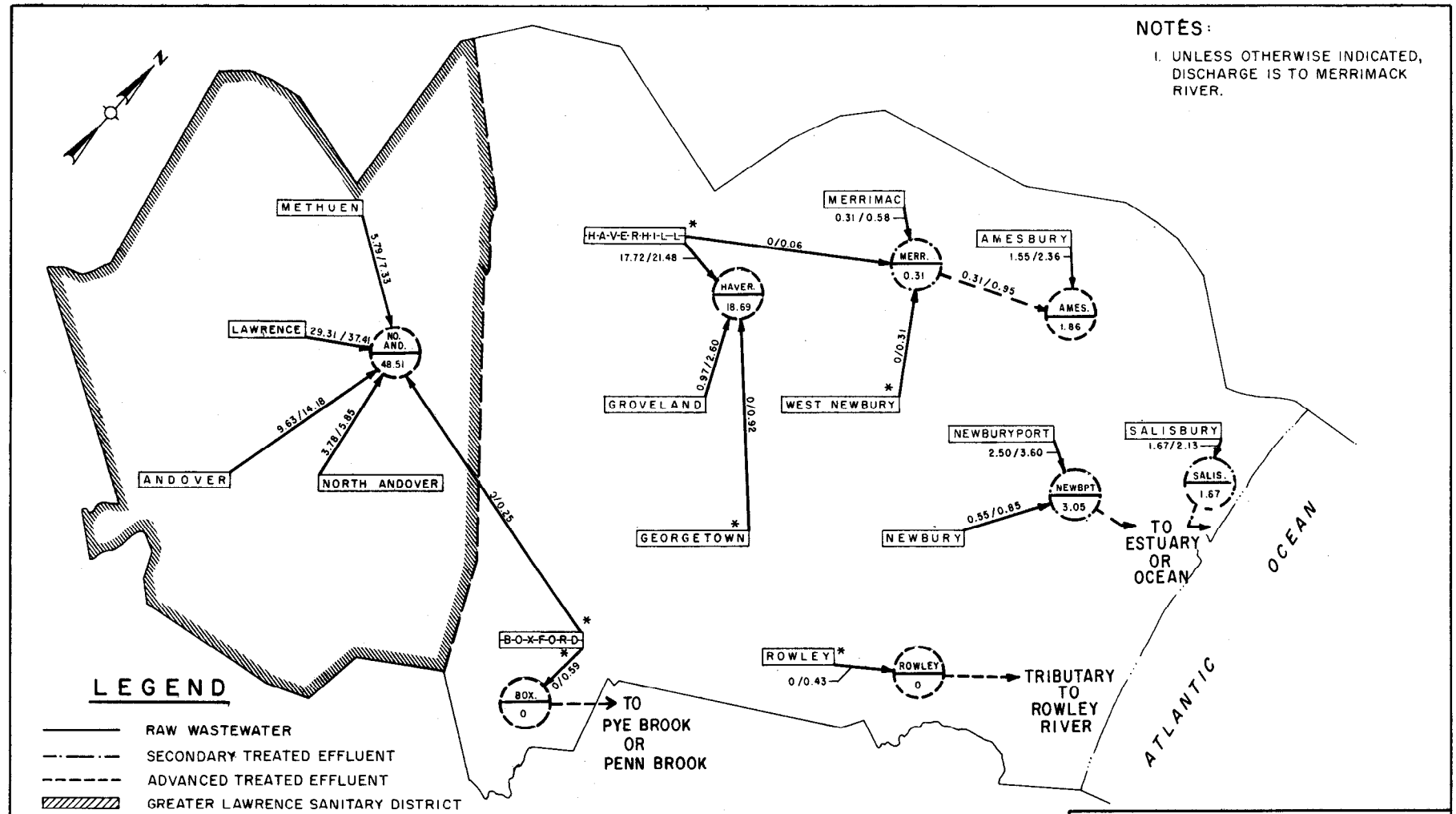


MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION

STATE IMPLEMENTATION PROGRAM

ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

PLATE NO. 9

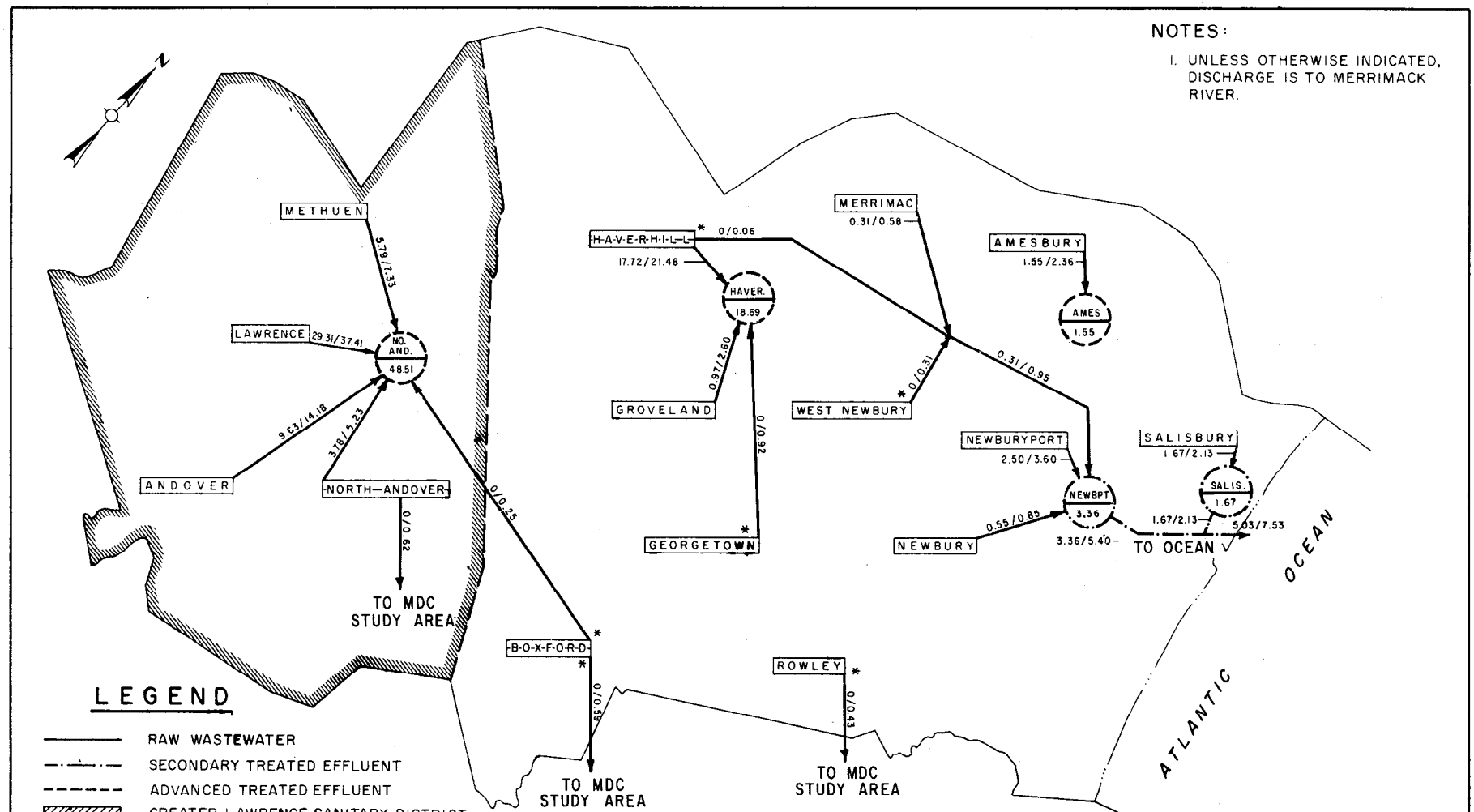


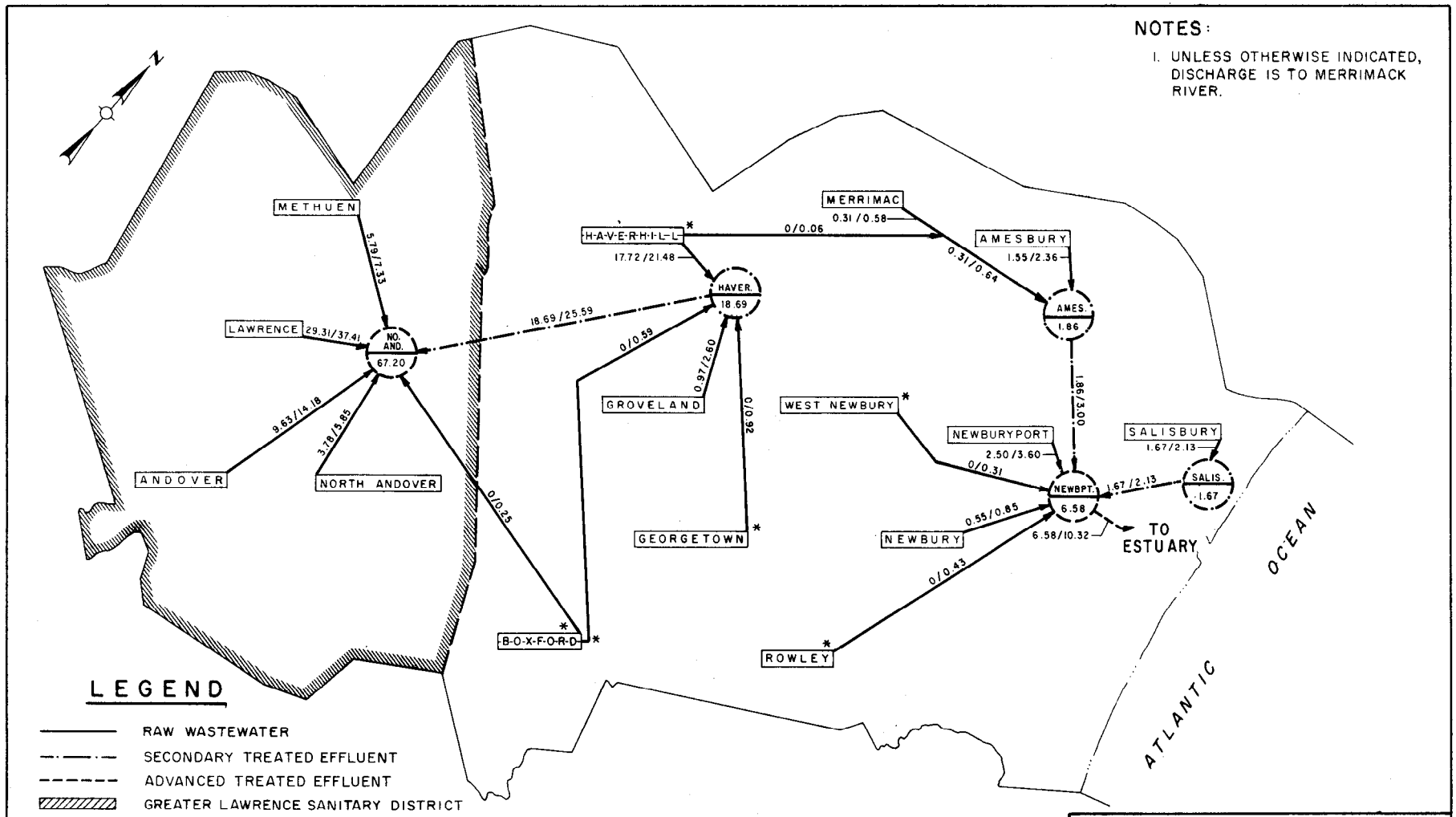
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION

ALTERNATE I
WATER - DECENTRALIZED

ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

PLATE NO. 10


NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
METHUEN
5.79/1.33
LAWRENCE
29.31/37.41
NO. AND.
48.51
9.63/14.18
3.78/5.23
ANDOVER
NORTH-ANDOVER
0/0.62
TO MDC STUDY AREA
0/0.25
HAVERHILL
0/0.06
17.72/21.48
HAVER.
18.69
0.97/2.60
GROVELAND
0/0.92
GEORGETOWN
MERRIMAC
0.31/0.58
AMESBURY
1.55/2.36
AMES
1.55
0.31/0.95
0/0.31
WEST NEWBURY
NEWBURYPORT
2.50/3.60
NEWBPT
3.36
0.55/0.85
NEWBURY
3.36/5.40
SALISBURY
1.67/2.13
SALIS.
1.67
1.67/2.13
5.03/7.53
TO OCEAN
OCEAN
ATLANTIC
BOXFORD
0/0.59
TO MDC STUDY AREA
ROWLEY
0/0.43
TO MDC STUDY AREA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS.
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
ALTERNATE 2
WATER-PARTIALLY DECENTRALIZED
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD
PLATE NO.11

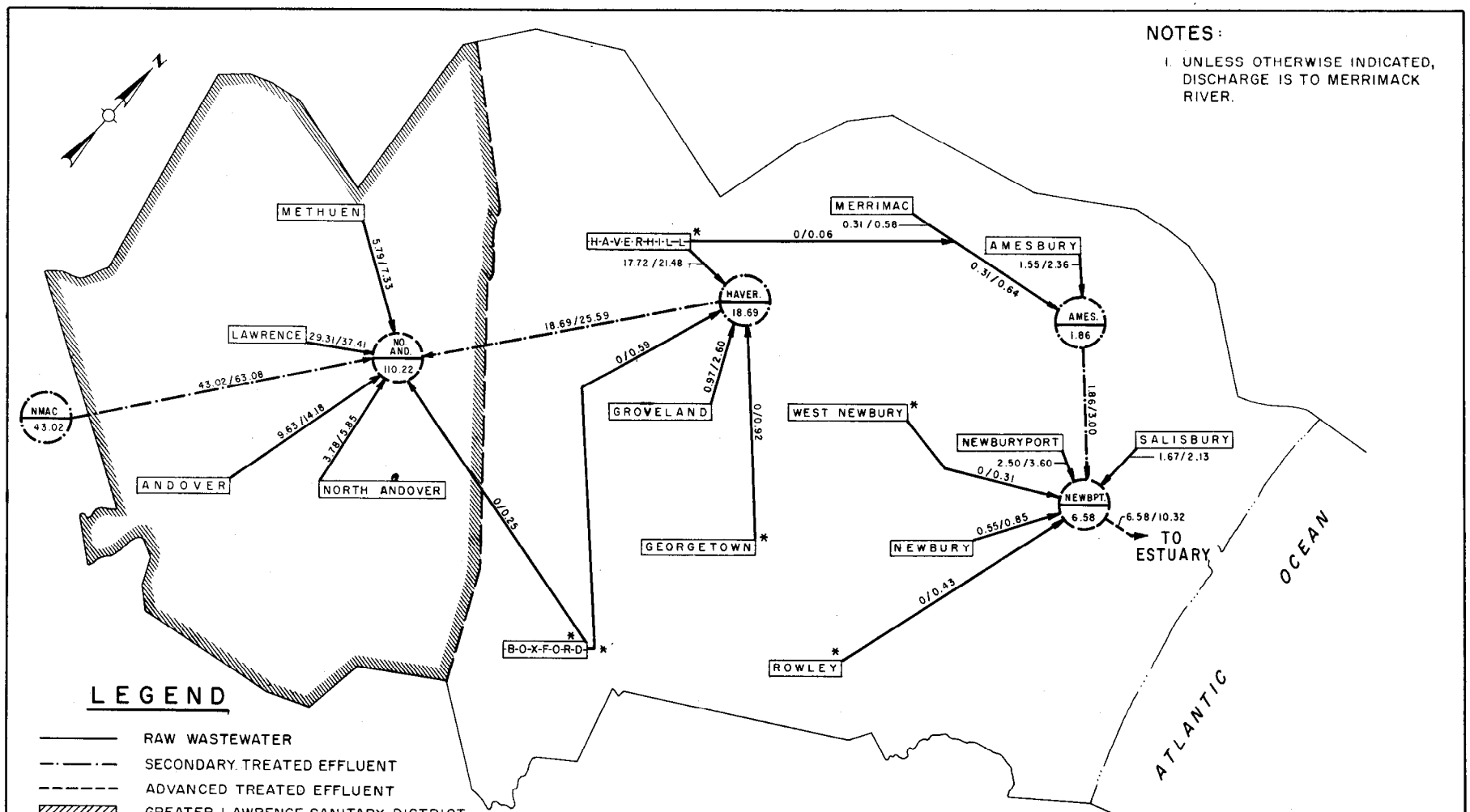


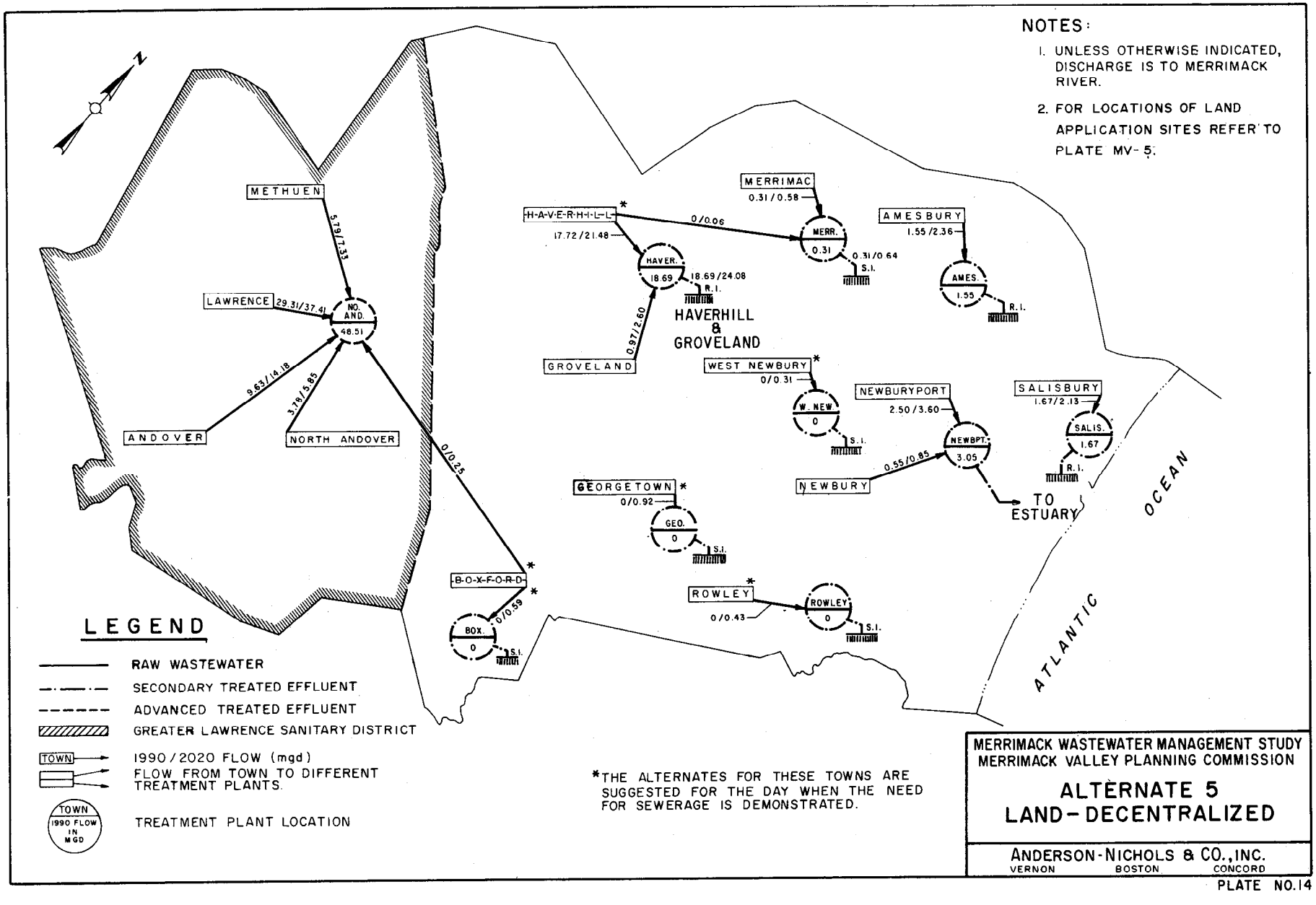
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION

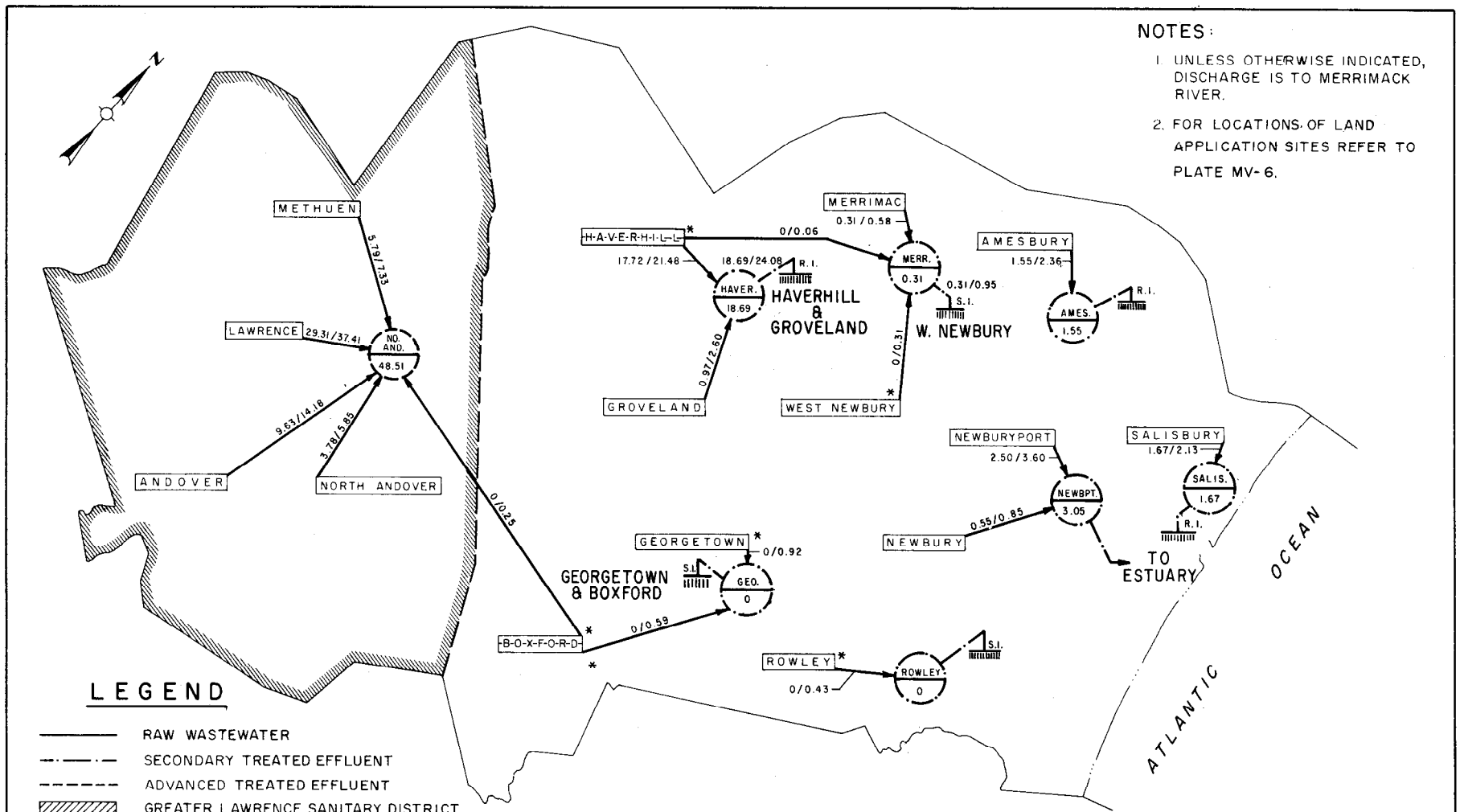
ALTERNATE 3
WATER-CENTRALIZED

ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

PLATE NO. 12


NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
METHUEN
5.79/7.33
LAWRENCE 29.31/37.41
NO. AND. 110.22
18.69/25.59
NMAC 43.02
43.02/63.08
9.63/14.18
3.78/5.85
ANDOVER
NORTH ANDOVER
0/0.25
HAVERHILL
17.72/21.48
0/0.06
HAVER. 18.69
0/0.59
0.97/2.60
0/0.92
GROVELAND
GEORGETOWN
B-O-X-F-O-R-D
MERRIMAC
0.31/0.58
AMESBURY
1.55/2.36
0.31/0.64
AMES. 1.86
1.86/3.00
WEST NEWBURY
NEWBURYPORT
2.50/3.60
0/0.31
SALISBURY
1.67/2.13
NEWBPT. 6.58
6.58/10.32
TO ESTUARY
0.55/0.85
NEWBURY
0/0.43
ROWLEY
ATLANTIC OCEAN
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN 1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS.
TOWN 1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
ALTERNATE 4
WATER-REGIONAL
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD
PLATE NO. 13


NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
2. FOR LOCATIONS OF LAND APPLICATION SITES REFER TO PLATE MV-5.
METHUEN
5.79/7.33
LAWRENCE
29.31/37.41
NO. AND.
48.51
9.63/14.18
3.78/5.85
ANDOVER
NORTH ANDOVER
0/0.25
B-O-X-F-O-R-D
0/0.59
BOX.
0
S.I.
H-A-V-E-R-H-I-L-L
17.72/21.48
0/0.06
HAVER.
18.69
18.69/24.08
R.I.
0.97/2.60
GROVELAND
HAVERHILL & GROVELAND
MERRIMAC
0.31/0.58
MERR.
0.31
0.31/0.64
S.I.
AMESBURY
1.55/2.36
AMES.
1.55
R.I.
WEST NEWBURY
0/0.31
W. NEW.
0
S.I.
NEWBURYPORT
2.50/3.60
NEWBPT.
3.05
0.55/0.85
NEWBURY
SALISBURY
1.67/2.13
SALIS.
1.67
R.I.
TO ESTUARY
OCEAN
ATLANTIC
GEORGETOWN
0/0.92
GEO.
0
S.I.
ROWLEY
0/0.43
ROWLEY
0
S.I.
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS.
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
ALTERNATE 5
LAND-DECENTRALIZED
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD
PLATE NO. 14



MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION

ALTERNATE 6
LAND-CENTRALIZED

ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

PLATE NO. 15

TABLE 3

MERRIMACK WASTEWATER MANAGEMENT STUDY

PRELIMINARY IMPACT ANALYSIS

IMPACT CATEGORY *

	Land Use	Recreation	Municipal Finance	Political Process	Employment	Public Health	Transportation
WATER ORIENTED ALTERNATIVES	Land along the river banks will increase in value and be subject to greater demands for development	The Merrimack River will become available for a wider range of recreational uses, i.e. swimming, fishing, & water skiing	Advanced waste treatment plants are usually more costly to operate and maintain than land application systems	Regional Authorities for operation & maintenance of advanced waste treatment plants may be required	Large numbers of people will be required for building, operating & maintaining advanced treatment plants	Water quality will be improved for purposes of water supply & recreation. Reliability & effectiveness of large advanced waste treatment plants can be questioned	Transmission line construction will create short-term inconveniences in traffic movement
LAND ORIENTED ALTERNATIVES	Land application sites will preserve open space & can provide a tool for implementing rational growth & development	Land application sites can be used for multiple-use purposes: hiking, hunting, cross-country skiing, etc.	With suitable conditions, land application systems are generally less costly to construct, operate & maintain than water-oriented systems. Land acquisition requirements will be greater	Large acreages of land will be required. Existing community zoning plans may require revision	Lesser numbers of people will be required for operating & maintaining land application systems	Prevention of groundwater contamination cannot be certain without proper management	Small access roads may have to be eliminated. Same considerations as above

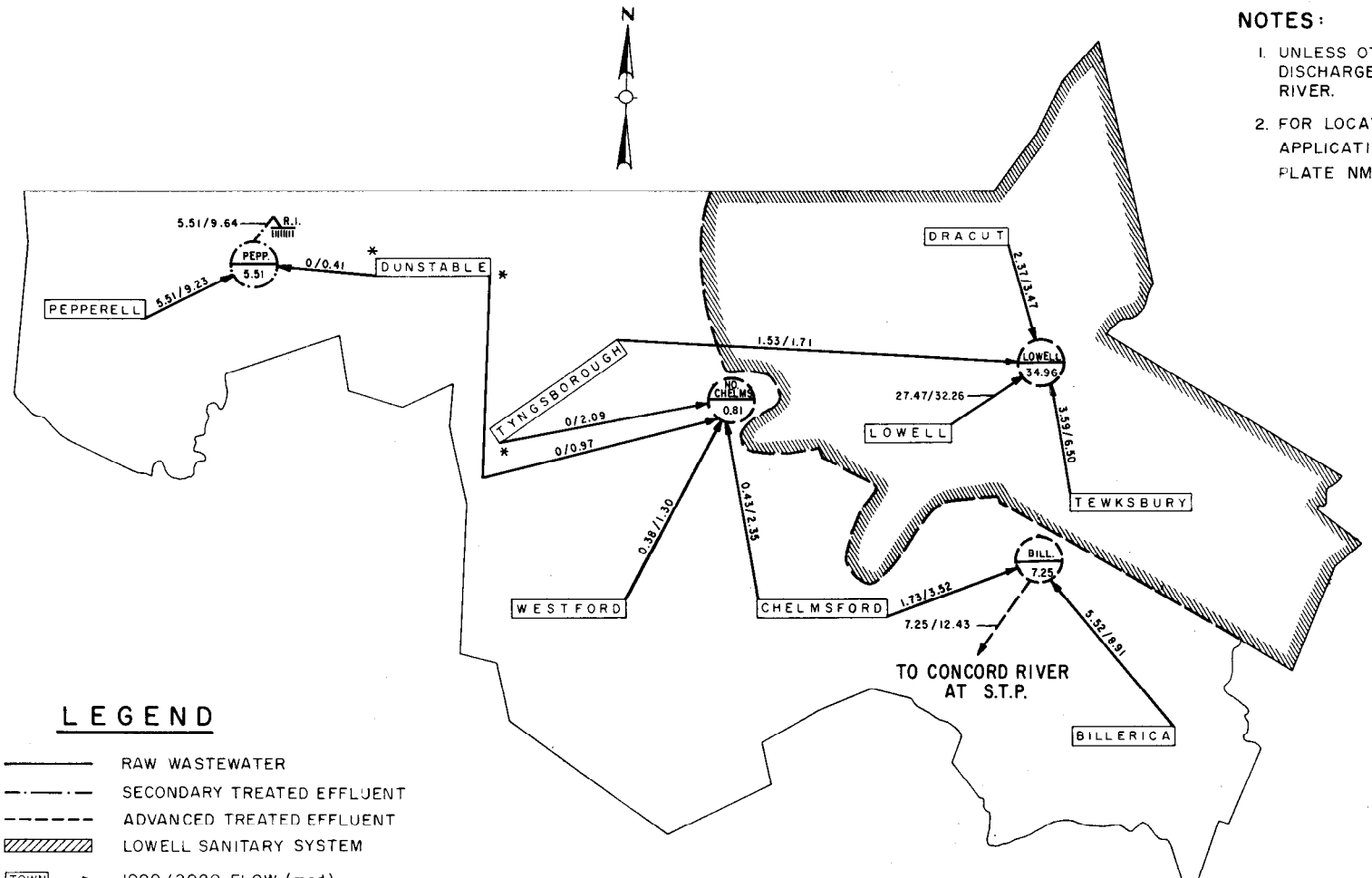
* The magnitude of the impact will vary from alternative to alternative depending on the degree of regionalization or decentralization involved with each alternative.

Note: The above impact categories and related statements only serve as examples and should not be interpreted as complete or inclusive.

h. Least Cost Alternatives

The alternatives, as presented at the public meetings on 2 and 4 April 1974, were favorably received and were given further development with respect to engineering and impacts. In addition, a Least Cost Alternative was developed and displayed for each regional planning agency. The "least cost" meaning lowest cost from a monetary standpoint only without consideration of any impact assessments. These alternatives were published in a handout and presented at late stage Corps of Engineers public meetings held in Haverhill and Chelmsford, Massachusetts, on 25 and 27 June 1974, respectively. The least cost alternatives and costs were also given considerable public exposure through workshops and various presentations prior to the public meetings.

Schematics of the least cost alternatives for the NMAC and MVPC are presented as Plate Nos. 16 and 17, respectively. These alternatives are more fully described in Section C of this appendix.



NOTES:

1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
2. FOR LOCATIONS OF LAND APPLICATION SITES REFER TO PLATE NM-5.

LEGEND

- RAW WASTEWATER
- SECONDARY TREATED EFFLUENT
- ADVANCED TREATED EFFLUENT
- LOWELL SANITARY SYSTEM
- TOWN — 1990/2020 FLOW (mgd)
- FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
- TOWN 1990 FLOW IN MGD — TREATMENT PLANT LOCATION

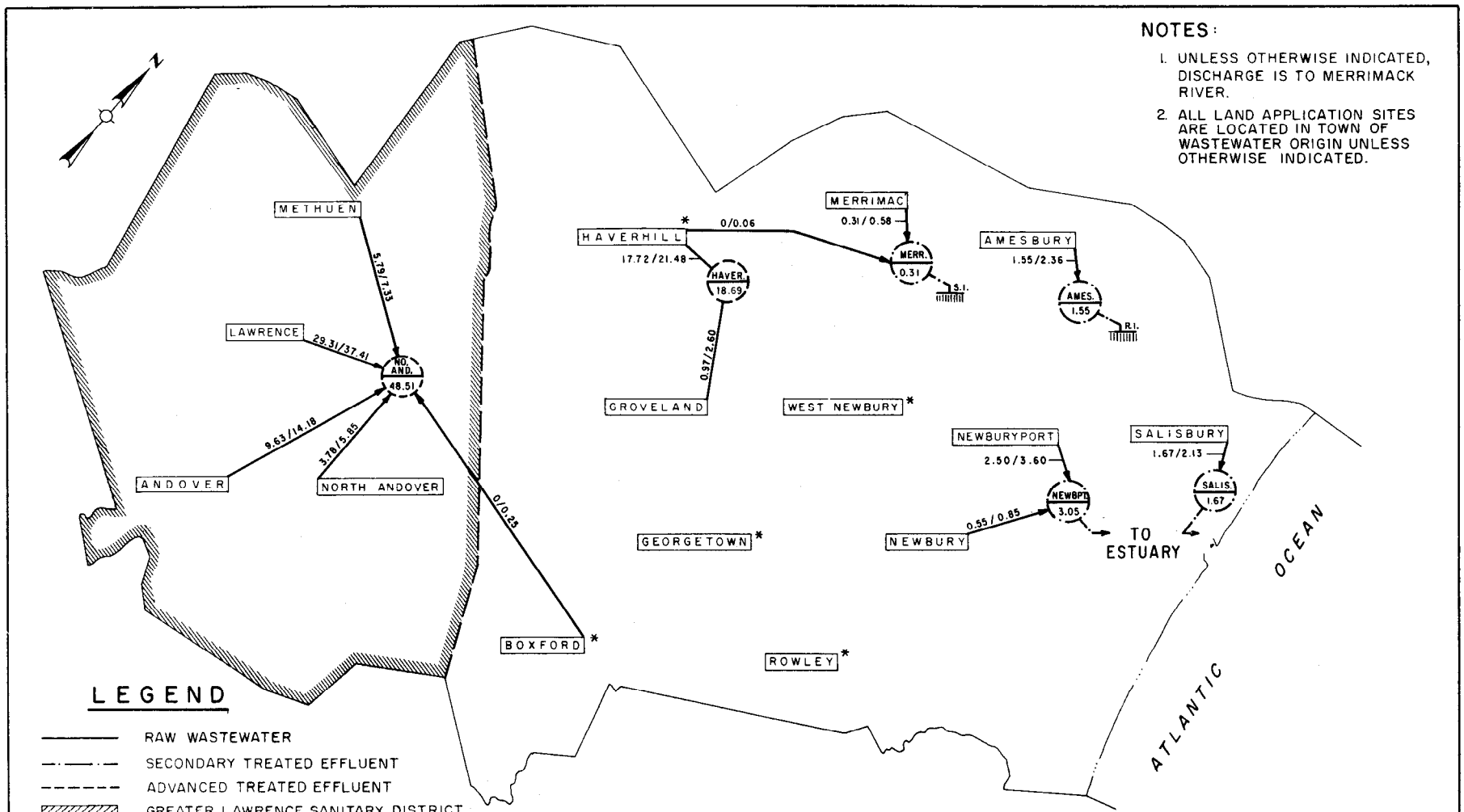
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.

MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION

LEAST COST ALTERNATE

ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

PLATE NO. 16



MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION

LEAST COST ALTERNATE

ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

PLATE NO. 17

C. THE SELECTED ALTERNATES

Introduction

As was discussed in the previous section under "Screening of Alternates", there were, at the outset of the study, many possible options for wastewater collection and treatment for each town. The screening was needed in order to arrive at a manageable number of options for further, more detailed, consideration. Facilities which were either existing or presently proposed under the EPA-State Implementation Program (See Section G of Appendix I) were taken as "givens" and were included under every alternate. These givens are the facilities at Lowell, Billerica, North Andover, Haverhill, Amesbury, Newburyport (although the advanced facilities of this plant were relocated in some alternates), and Pepperell (with one exception which is later fully discussed).

Given these restraints, the object of the screening was to determine the optimum sewage systems (centralized or decentralized) on the basis of cost alone. In order to make this type of decision, alternates were developed and are presented in this section in such a manner that, in the water-oriented alternates, they range from completely decentralized to totally regional. In the land-oriented schemes, alternates have been developed to utilize the limited suitable land available for land application. Investigations by Goldberg-Zoino, Soils Consultants, reveal that the land in the Merrimack River Basin is topographically characterized by "low rounded hills and broad poorly drained low lands" in the eastern portion of the basin and in the west, "the relief gradually changes .... Here the topographic forms are accentuated; higher, steeper hills are seen and the rivers appear incised into narrower valleys". In addition, it is reported that depths to bedrock are generally shallow and outcroppings are not uncommon. Since land application requires shallow sloped hills, low groundwater tables and a reasonable depth to bedrock, most of the sparsely inhabited areas of the basins where land treatment would be practiced require extensive modification for use as application sites.

In addition to the quality of the land, the quantity of land required for land application of treatment plant effluent becomes a dominant factor. Rapid infiltration requires 34.5 acres per mgd including a 25% contingency allowance based on a loading rate of 2.5 gallons per day per square foot for 7 days, while for spray irrigation 550 acres per mgd are needed for application

and an additional 44 acres per mgd are required for storage during the winter months. These area requirements are based on a loading rate of 1" for 14 weeks and 1.5" for 12 weeks and also include a 25% allowance for unusable land, berms control facilities, etc. Where sufficient land with acceptable characteristics is available, spray irrigation sites are proposed, otherwise, rapid infiltration options are considered. In some cases, where land requirements exceed that available, no land-oriented alternates are proposed.

Since advanced treatment, either by water or land-oriented facilities, is under many alternates performed at a different site than secondary treatment, a temporary outfall may be required until the advanced facilities are constructed to meet the 1983 and 1985 water quality goals.

In the alternates to be presented in this section, wherever municipal collection systems have been installed or proposed, they have been incorporated into the collection systems proposed by this study. In many cases, it has been necessary to increase the sizes of some proposed pipelines to accommodate wastewater flow from neighboring communities. These, as well as all other major interceptors, proposed in this study are shown on the attached plates.

The following narrative is an explanation of the collection and treatment facilities as shown on Plates NM-1 through NM-5 for the Northern Middlesex Area Commission and Plates MV-1 through MV-6 for the Merrimack Valley Planning Commission.

This narrative will describe in detail the final alternates which survived the rigorous and lengthy screening process which was fully discussed in Section B of this appendix, "Formulation of Alternates."

It is from these final alternates that the preferred plan will ultimately be selected, although this final plan will more likely be comprised of portions taken from several of the final alternates which are presented on the following pages.

1. Alternates for the Northern Middlesex Area Commission

The Northern Middlesex Area Commission presents a slightly different problem than the Merrimack Valley Planning Area, because it is smaller and an existing semi-regional sewer district is pending which is composed of Lowell, Dracut, Tewksbury and the eastern part of Tyngsborough. Since out of the 9 towns in this regional planning agency, 3 are essentially committed to a sewer district already, Dunstable is very sparsely developed at the present time, and Pepperell is part of both the Merrimack and the Nashua River study areas, the number of alternatives for collection and treatment are limited. As was previously discussed, the treatment plants at Lowell and Billerica are taken as givens, further decreasing the number of possible options for the remaining towns.

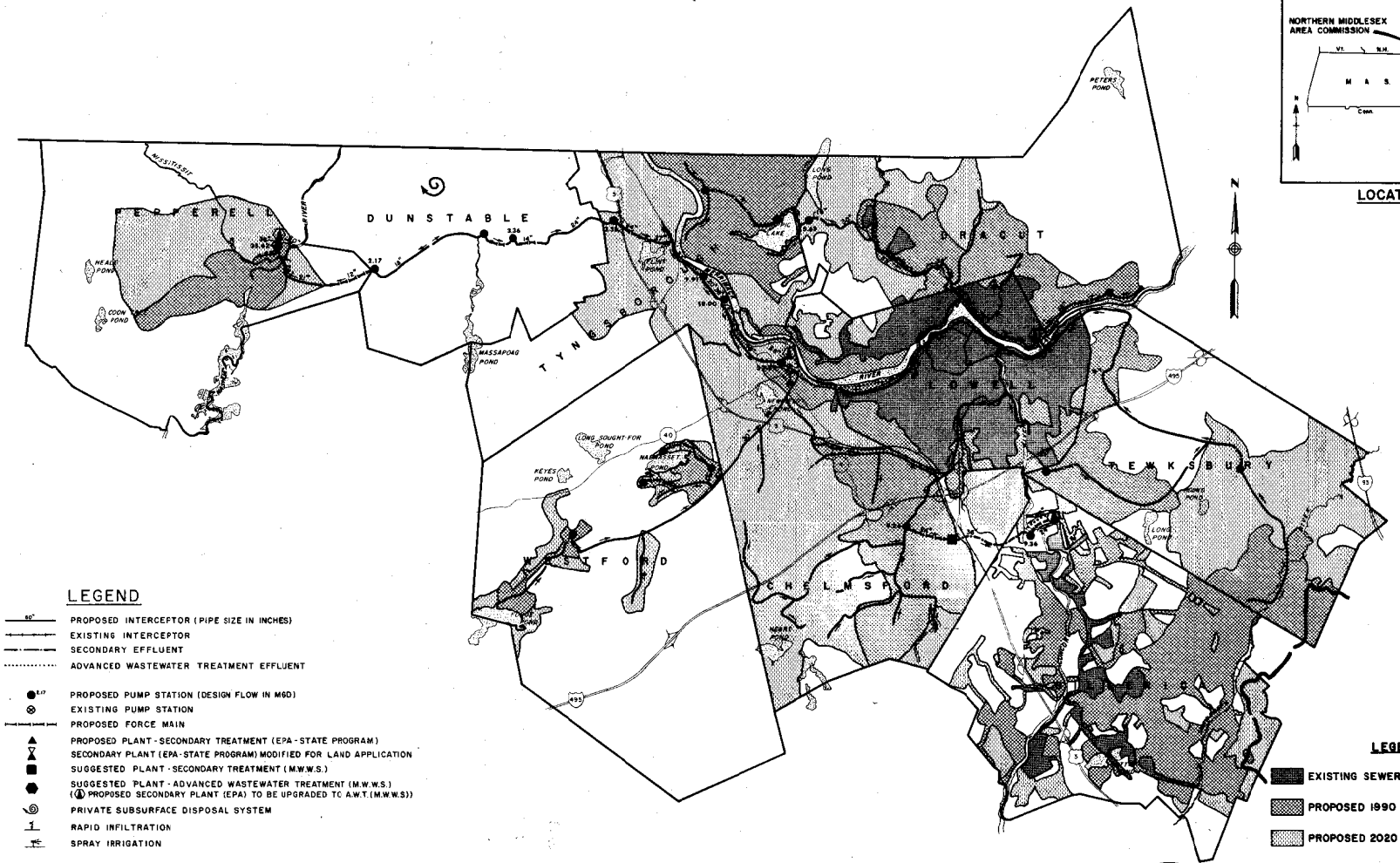
a. Water-Oriented Plans

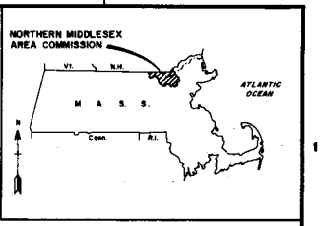
(1) Decentralized Systems - Alternate 1 (Plate NM-1)

The decentralized plan, Alternate 1, Plate NM-1, sites secondary treatment plants that will be upgraded to advanced treatment plants by 1985 in Pepperell, North Chelmsford, Lowell and Billerica, and a secondary treatment plant in South Chelmsford. In a preliminary report to the Town of Pepperell, it was suggested that a secondary treatment facility be built just below the confluence of the Nissitissit and Nashua Rivers discharging to the Nashua River. Due to a large industrial flow in Pepperell, it was further suggested that this industrial wastewater receive some form of pretreatment before being allowed into the municipal treatment plant. Consequently, plans and specification were drawn up and approved by the Massachusetts Division of Water Pollution Control for a secondary activated sludge treatment plant which, under this study, would be upgraded to an advanced wastewater treatment plant by 1985. This treatment plant would serve only the domestic wastewater flow until 1983, when best practicable treatment would be implemented for municipal plants and best available treatment for industries. In 1983, the industrial treated secondary effluent would receive advanced treatment at the municipal plant and be discharged to the Nashua River.

As was the case in Boxford, Rowley and similar towns in the Merrimack Valley Planning Area, the Town of Dunstable is not presently in need of wastewater collection and treatment. Although it is recommended that the Town retain on-lot systems for as long as possible, a collection system is shown and treatment options have been developed for the day when the need for sewerage is demonstrated.

CORPS OF ENGINEERS U. S. ARMY





LOCATION MAP

LEGEND

- PROPOSED INTERCEPTOR (PIPE SIZE IN INCHES)
- EXISTING INTERCEPTOR
- SECONDARY EFFLUENT
- ADVANCED WASTEWATER TREATMENT EFFLUENT
- PROPOSED PUMP STATION (DESIGN FLOW IN MGD)
- EXISTING PUMP STATION
- PROPOSED FORCE MAIN
- PROPOSED PLANT - SECONDARY TREATMENT (EPA - STATE PROGRAM)
- SECONDARY PLANT (EPA - STATE PROGRAM) MODIFIED FOR LAND APPLICATION
- SUGGESTED PLANT - SECONDARY TREATMENT (M.W.W.S.)
- SUGGESTED PLANT - ADVANCED WASTEWATER TREATMENT (M.W.W.S.) (PROPOSED SECONDARY PLANT (EPA) TO BE UPGRADED TO A.W.T. (M.W.W.S))
- PRIVATE SUBSURFACE DISPOSAL SYSTEM
- RAPID INFILTRATION
- SPRAY IRRIGATION

LEGEND

- EXISTING SEWER SERVICE AREA
- PROPOSED 1990 SEWER SERVICE AREA
- PROPOSED 2020 SEWER SERVICE AREA

NOTES

1. M.W.W.S. = MERRIMACK WASTEWATER MANAGEMENT STUDY
2. EXCEPT FOR BILLERICA, WHICH HAS AN EXISTING SECONDARY PLANT, THE OTHER EXISTING SEWERS DISCHARGE UNTREATED WASTES DIRECTLY INTO THE WATERWAYS.

SAFETY PAYS

GRAPHIC SCALE

MILES: 1 mi 1/2 mi 0 1 mi

FEET: 1000 0 3000 7000

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

ANDERSON-NICHOLS & CO., INC.
CONSULTING ENGINEERS
VERNON BOSTON CONCORD

MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION

WATER ORIENTED DECENTRALIZED-ALTERNATE I

DESIGNED BY:	DRAWN BY:	CHECKED BY:
D.L.B./F.L.T.	L.S.T./D.S.G.	P.T.S.

CONTRACT No. DACW33-74-C-0013

DATE: JUNE, 1974

PLATE: NM-1

In Tyngsborough, there is a unique problem in that the Merrimack River divides the town. In the eastern part of the town, there is heavy residential development around Mascuppic Lake causing pollution of the lake. In order to alleviate such problems, Tyngsborough is negotiating an arrangement with Lowell and Dracut to transport wastewater originating from the area around the lake, via the Dracut intercepting system to the Lowell treatment facility. The western part of the town is very sparsely populated at this time and no initial construction is being recommended. However, as in Dunstable, in order to provide an alternative for the future, collection systems have been shown which would transport wastewater under this alternate, to the proposed north Chelmsford facility.

In Westford, though a preliminary engineering report has been prepared, there has been no need to implement any of the recommendations for sewerage; nor has the State found reason to place the town under order to abate pollution. Consequently, there is no apparent need that initial construction be undertaken in Westford, however, it is anticipated that the town will grow rapidly, and the proposed sewered areas have been shown. This decentralized alternate delineates expected problem areas and proposes that these areas be sewered and the wastewater be transported to the proposed treatment plant in north Chelmsford.

The State has ordered the Town of Chelmsford to stop polluting the Merrimack River and its tributaries, specifically the Chelmsford Center and north Chelmsford areas. Town meeting vote in 1972 disapproved authorization of funds for design of a town-wide collection system tied to a secondary treatment plant in north Chelmsford. However, an engineering report prepared for the town in 1973 determined that it would be less expensive for Chelmsford to construct its own facilities rather than tie into the Lowell system. In Alternate 1, it is proposed that a secondary plant to be later upgraded to an advanced treatment plant be constructed in North Chelmsford, just downstream of Tyngs Island between the B&M railroad ROW and the Merrimack River; the same location that was proposed in a preliminary report for treatment facilities. In the southern part of Chelmsford, it is proposed that a secondary treatment plant be constructed just north of the intersection of Rt. 3 and 129. Secondary effluent from this facility would be discharged to the Concord River until 1983, when the secondary effluent would be transported to and receive advanced treatment at the Billerica facility, just across the Concord River.

Although not officially formalized into a sewer district, the towns of Lowell, Dracut and Tewksbury are negotiating an agreement to

jointly treat wastewater at Lowell. Lowell will soon construct a secondary facility at Duck Island, which would treat wastewater flow from Lowell, Dracut, Tewksbury, part of Tyngsborough, and a maximum of 5 MGD from Chelmsford. In this alternate, it is proposed that the secondary facility at Duck Island be expanded to handle the anticipated extra flows in the regional plan and upgraded by 1983 to achieve best practicable and advanced wastewater treatment by 1985. It is questionable whether the site at Lowell is sufficient to allow construction of advanced treatment facilities without further enlargement. However, it is anticipated that sufficient land can be made available for purposes of presenting this alternate. As far as the orientation of towns contributing to this treatment plant, although it is not a formal sewer district, it has been accepted as a given and, in all alternates, Lowell, Dracut, Tewksbury and east Tyngsborough will always be served by the Lowell plant.

Billerica has an existing plant that is presently being expanded and upgraded. The plant is located on the east bank of the Concord River adjacent to the B&M Railroad ROW in the triangle formed by the Lowell and Tewksbury town lines with Billerica. Due to its location, near the center of the population of this RPA, it is anticipated that this plant could serve as a nucleus around which more centralized alternates could be constructed. As an existing plant, it will be included under all alternates.

(2) Partially Decentralized Systems - Alternate 2 (Plate NM-2)

In this alternate, there is only one proposed advanced wastewater treatment facility in the study area; that being in Billerica. In Pepperell, as was proposed in Alternate 1, a secondary treatment facility will be built at the site recommended in Pepperell's preliminary engineering report. In 1983, when the time comes for upgrading of the treatment plant, it is proposed that the secondary effluent be transported to a proposed advanced wastewater treatment plant in Ayer, in the Nashua River Basin. It is not possible at this time to determine the cost of this alternate for Pepperell, as it is not known what type of advanced treatment facility nor the quantity of flow that will be treated at the Ayer facility. Consequently, in order to indicate a cost for Pepperell, under this alternate, only the cost of secondary treatment plus the cost of transportation to the town line has been determined. For the remainder of the study area, there will be a secondary treatment plant in Lowell, which will serve Lowell, Dracut, Tewksbury, Tyngsborough and Westford. Due to the small amount of land available at the site of the Lowell plant, it is proposed, in this alternate, that only secondary treatment be provided at the Duck Island site. When the time comes for advanced treatment, secondary effluent which until 1983 will be discharged to the Merrimack River, will be piped to the Billerica facility, which will be upgraded by 1983 to best practicable treatment, and advanced

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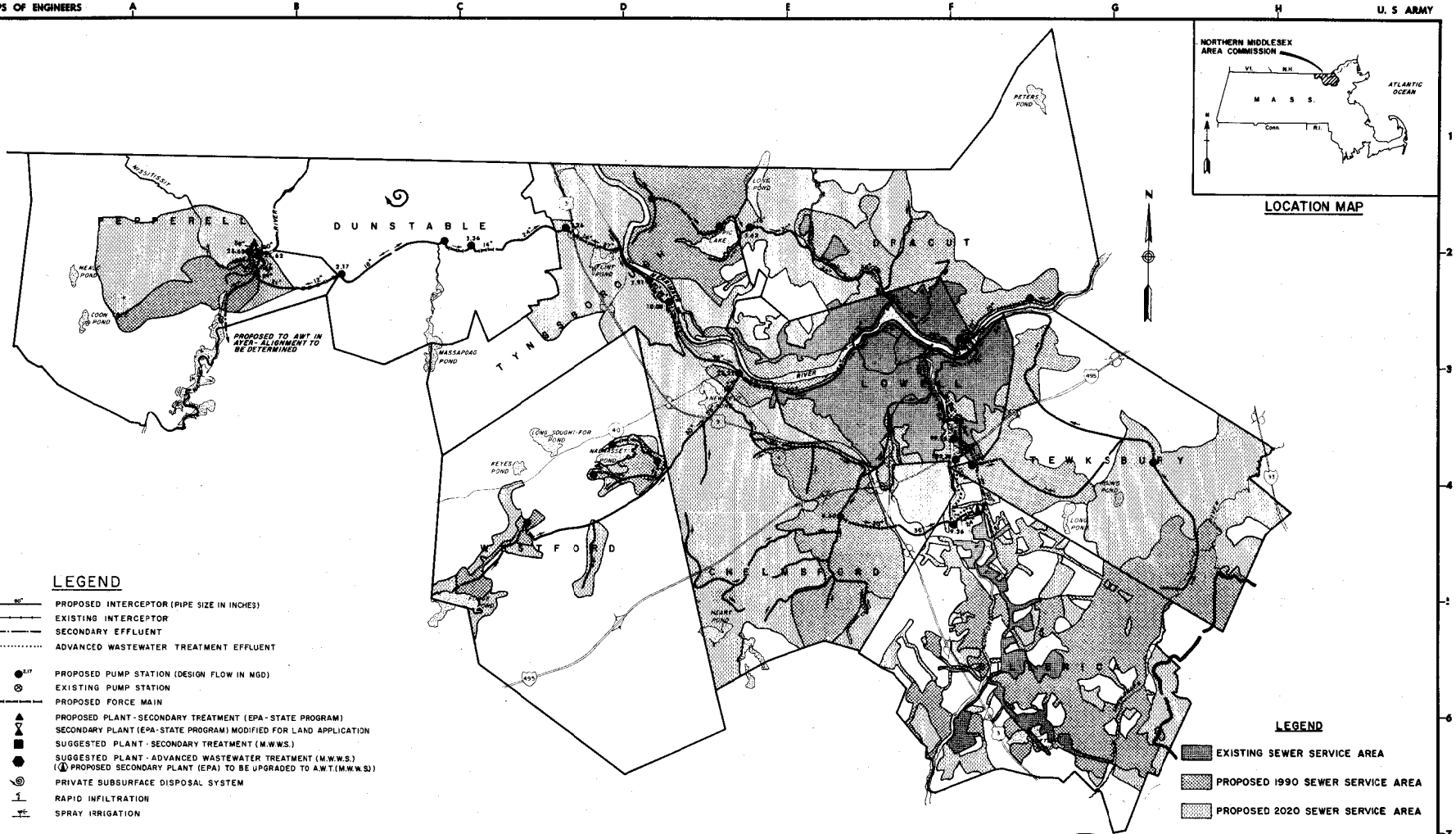

LOCATION MAP

LEGEND

- PROPOSED INTERCEPTOR (PIPE SIZE IN INCHES)
- EXISTING INTERCEPTOR
- SECONDARY EFFLUENT
- ADVANCED WASTEWATER TREATMENT EFFLUENT
- PROPOSED PUMP STATION (DESIGN FLOW IN MGD)
- EXISTING PUMP STATION
- PROPOSED FORCE MAIN
- PROPOSED PLANT - SECONDARY TREATMENT (EPA - STATE PROGRAM)
- SECONDARY PLANT (EPA - STATE PROGRAM) MODIFIED FOR LAND APPLICATION
- SUGGESTED PLANT - SECONDARY TREATMENT (M.W.W.S.)
- SUGGESTED PLANT - ADVANCED WASTEWATER TREATMENT (M.W.W.S.) (PROPOSED SECONDARY PLANT (EPA) TO BE UPGRADED TO A.W.T.(M.W.W.S))
- PRIVATE SUBSURFACE DISPOSAL SYSTEM
- RAPID INFILTRATION
- SPRAY IRRIGATION

LEGEND

- EXISTING SEWER SERVICE AREA
- PROPOSED 1990 SEWER SERVICE AREA
- PROPOSED 2020 SEWER SERVICE AREA

NOTES

1. M.W.W.S. = MERRIMACK WASTEWATER MANAGEMENT STUDY
2. EXCEPT FOR BILLERICA, WHICH HAS AN EXISTING SECONDARY PLANT, THE OTHER EXISTING SEWERS DISCHARGE UNTREATED WASTES DIRECTLY INTO THE WATERWAYS.

GRAPHIC SCALES

MILES: 1 mi 1/2 mi 0 1 mi

FEET: 1000 0 3000 7000

SAFETY PAYS

DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WALTHAM, MASS.	ANDERSON-NICHOLS & CO., INC CONSULTING ENGINEERS VERNON BOSTON CONCORD

MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION

WATER ORIENTED PARTIALLY DECENTRALIZED ALTERNATE 2

DESIGNED BY:	DRAWN BY:	CHECKED BY:
D.L.B./F.L.T.	L.S.T./D.S.G.	P.T.S.

CONTRACT No: DACW33-74-C-0013

DATE: JUNE, 1974

PLATE: NM-2

treatment by 1985. The treatment plant in Billerica discharging to the Merrimack River will serve as the focal point for advanced wastewater treatment throughout this RPA. It will initially serve only South Chelmsford and Billerica, but eventually will accept the secondary effluent from the Lowell complex and treat to advanced treatment levels. Although the Concord River is very close and an outfall to the Concord River would seem to be the most obvious choice, it is not known at this time whether the Concord River would be adversely affected by the large quantity of effluent being discharged from the Billerica treatment plant by 1983. During periods of low flow, the effluent would almost double the flow in the Concord River and possible scouring and other harmful effects could result. Consequently, until further study can assess the potential problem, the effluent from the Billerica facility will be piped to the Merrimack for final discharge.

(3) Centralized Systems - Alternate 3 (Plate NM-3)

This alternate carries the idea of centralization one step farther, in that there are only two treatment plants in the RPA; one in Lowell and one in Billerica. It is proposed in this alternate that the Pepperell facility not be constructed; rather the untreated wastewater be transported to the proposed advanced regional plant in Ayer. As in the previous alternate, it is not possible at this time to determine what the entire cost to Pepperell would be for the same reason previously outlined. For the rest of the RPA, the treatment facility at Lowell will again be a secondary facility, serving Lowell, Dracut, Tewksbury and the eastern part of Tyngsborough. The Billerica treatment plant will serve Westford, Chelmsford, and Billerica. As was the case in Alternate 2, the problem of land availability in Lowell is again prevalent in this alternate; consequently, as was previously discussed, secondary effluent after 1983 will be treated to advanced quality in the Billerica facility but, instead of discharging to the Merrimack River, as was proposed under Alternate 2, under this alternate it is proposed that the high quality effluent from the Billerica facility be transported to the headwaters of the Concord River for flow augmentation. In discussion with the residents and officials in the area, it has been indicated that, during the summer months, the flow from the Concord River drops to very low levels. At times, since the Billerica domestic water is supplied by a water treatment facility upstream, the only flow in the river is the treatment plant effluent. Since the proposed advanced treatment will produce a standard of effluent that is of very high quality, it may be possible without harmful effects, to augment the flow of the Concord River during the summer months.

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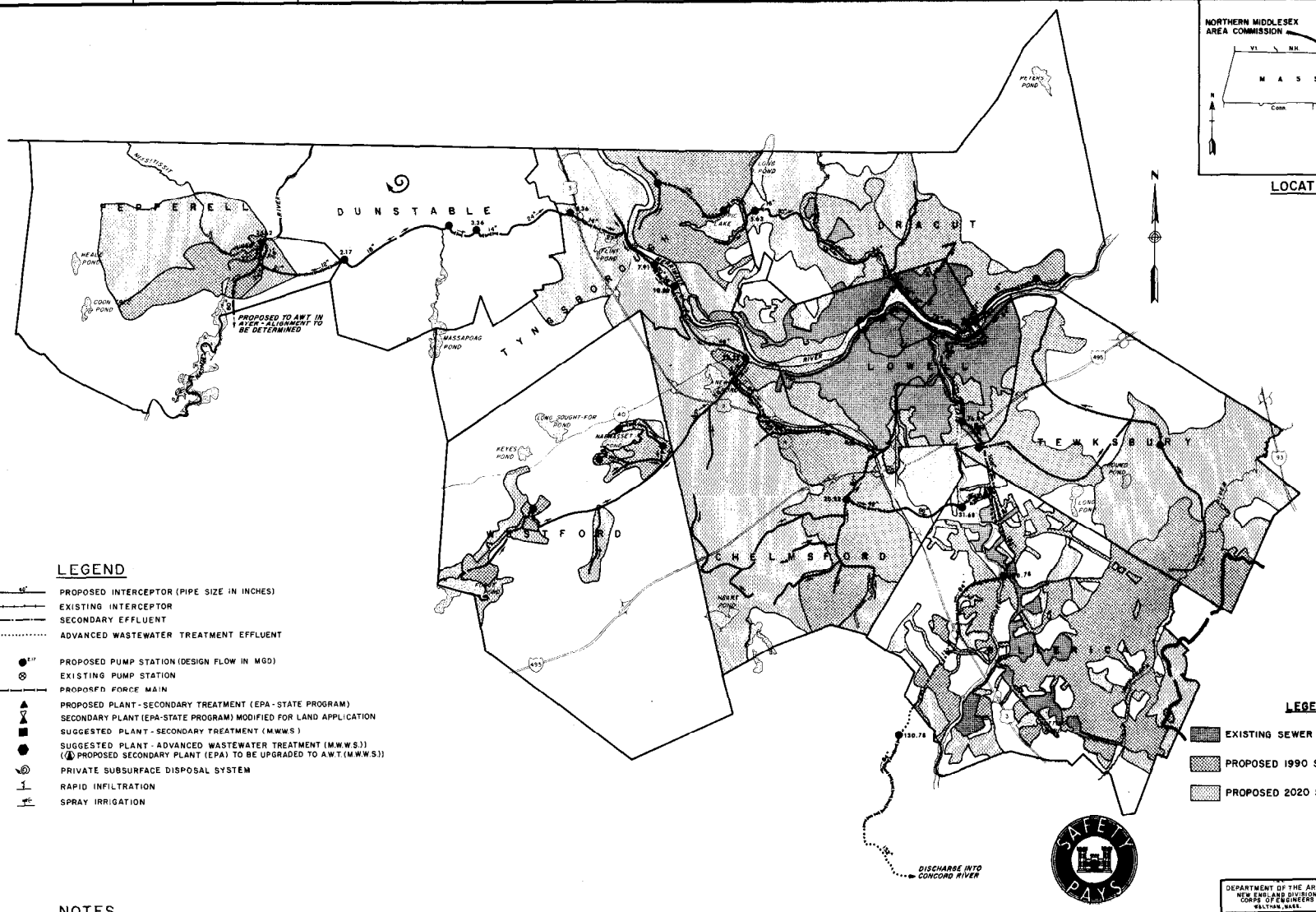

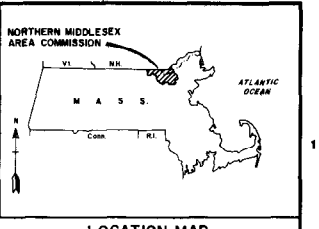

LOCATION MAP

LEGEND

- PROPOSED INTERCEPTOR (PIPE SIZE IN INCHES)
- EXISTING INTERCEPTOR
- SECONDARY EFFLUENT
- ADVANCED WASTEWATER TREATMENT EFFLUENT
- PROPOSED PUMP STATION (DESIGN FLOW IN MGD)
- EXISTING PUMP STATION
- PROPOSED FORCE MAIN
- PROPOSED PLANT - SECONDARY TREATMENT (EPA - STATE PROGRAM)
- SECONDARY PLANT (EPA-STATE PROGRAM) MODIFIED FOR LAND APPLICATION
- SUGGESTED PLANT - SECONDARY TREATMENT (M.W.W.S.)
- SUGGESTED PLANT - ADVANCED WASTEWATER TREATMENT (M.W.W.S.)) ((PROPOSED SECONDARY PLANT (EPA) TO BE UPGRADED TO A.W.T. (M.W.W.S.))
- PRIVATE SUBSURFACE DISPOSAL SYSTEM
- RAPID INFILTRATION
- SPRAY IRRIGATION

LEGEND

- EXISTING SEWER SERVICE AREA
- PROPOSED 1990 SEWER SERVICE AREA
- PROPOSED 2020 SEWER SERVICE AREA

NOTES

1. M.W.W.S. - MERRIMACK WASTEWATER MANAGEMENT STUDY
2. EXCEPT FOR BILLERICA, WHICH HAS AN EXISTING SECONDARY PLANT, THE OTHER EXISTING SEWERS DISCHARGE UNTREATED WASTES DIRECTLY INTO THE WATERWAYS.

GRAPHIC SCALES

MILES: 1 mi 1/2 mi 0 1 mi

FEET: 1000 0 3000 7000

SAFETY PAYS

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MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION

WATER ORIENTED CENTRALIZED - ALTERNATE 3

DESIGNED BY:	DRAWN BY:	CHECKED BY:
D.L.B./F.L.T.	L.S.T./D.S.G.	P.T.S.

CONTRACT Nº DACW33-74-C-0013

DATE: JUNE, 1974

PLATE: NM-3

(4) Regional System - Alternate 4 (Plate NM-4)

This alternate will be presented under Part 3 of this section, "The Combined MVPC-NMAC Alternate."

b. Land Oriented Plans

(1) Decentralized Systems - Alternate 5 (Plate NM-5)

As was discussed in the introduction to this section and in the land-oriented systems for the Merrimack Valley, little land is available for land application in the Merrimack River Basin as a whole, and especially, in the Northern Middlesex Area. Consequently, in order to have a land application alternate in this RPA, many small application sites are necessary, and, consequently, many treatment plants are necessary because it is not feasible to discharge large quantities of effluent to many small sites because the piping costs would be extremely high, and the problem of storage would be insurmountable. In this alternate, it is proposed that there be secondary treatment plants, modified for land application, In Pepperell, North Chelmsford, Westford, Billerica and Lowell, The Pepperell facility would be situated in the same location as in previous alternates, and after secondary treatment, the effluent would be discharged to rapid infiltration sites located along the Nashua River in Pepperell and Dunstable.

The treatment facility in Westford would comprise aerated lagoons for secondary treatment and advanced treatment by land application. It is proposed that the aerated lagoons be constructed in Westford near the Westford-Littleton town line, south of Route 495, just off of Littleton Road (Rt. 110). The land application area would have to be developed immediately because there is no acceptable receiving stream to discharge secondary effluent in Westford. The effluent from the aerated lagoons would be applied to several sites in Westford by spray irrigation. In addition to the sites in Westford, due to the low loading rates necessitated by the available soils, an additional site in Chelmsford would be needed.

In the north Chelmsford facility, a problem exists in that the location of the treatment plant is above the intake for the Lowell water supply system. Since in all likelihood, discharge of secondary effluent to the Merrimack River above the Lowell intake would be unacceptable to the Department of Public Health, a treatment plant modified for land application would be constructed

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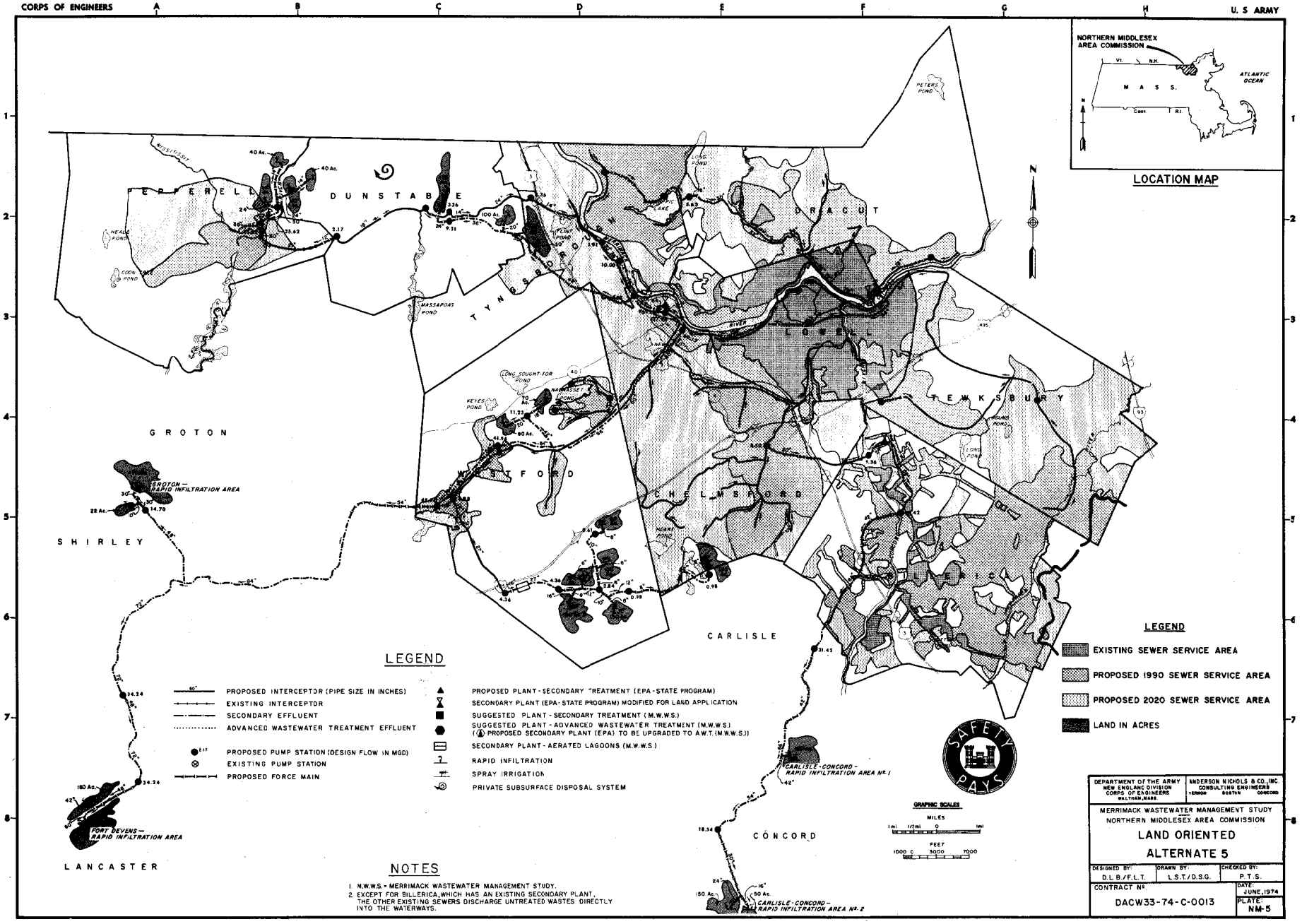

NOTES

1. M.W.W.S. = MERRIMACK WASTEWATER MANAGEMENT STUDY.
2. EXCEPT FOR BILLERICA, WHICH HAS AN EXISTING SECONDARY PLANT, THE OTHER EXISTING SEWERS DISCHARGE UNTREATED WASTES DIRECTLY INTO THE WATERWAYS.

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MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION

LAND ORIENTED
ALTERNATE 5

DESIGNED BY:	DRAWN BY:	CHECKED BY:
D.L.B./F.L.T.	L.S.T./D.S.G.	P.T.S.
CONTRACT Nº DACW33-74-C-0013		DATE: JUNE, 1974
		PLATE: NM-5

in north Chelmsford in the same area as previously proposed and secondary effluent from this treatment plant would be applied to the land immediately rather than waiting until 1985 by use of rapid infiltration basins in the northern part of Tyngsborough and also in Dunstable.

In the Lowell and Billerica plants, quantities of flow are large and in order to find enough land to use land application for these towns, it is necessary to look outside the study area for available suitable land. After receiving secondary treatment, the effluent from Lowell would be transported westerly, along the Merrimack River, and split just before the site of the north Chelmsford facility; part of the flow would be transported northerly, and joined with the effluent from the north Chelmsford facility to be applied to the land in Tyngsborough and Dunstable. The bulk of the flow from the Lowell facility would be transported westerly, through Westford, out towards Groton and Ayer, where it would again be split; part of it piped to rapid infiltration systems in Groton, and the remainder going to rapid infiltration basins at Fort Devens.

Billerica, on the other hand, needing less land, could transport secondary effluent southerly, through Billerica, into two rapid infiltration areas in Concord-Carlisle.

c. Sludge Handling & Disposal

A different type of problem regarding sludge incinerator location is encountered in the Northern Middlesex Area because the population is essentially centered in the Lowell area and except for Pepperell, Lowell and Billerica are the only treatment plants that are large enough to warrant incineration facilities. The sludge handling and disposal alternatives for the NMAC are shown on Table 4.

In Pepperell, under Alternate 1, the situation arises in which the plant will be too small to require an incinerator until 1983 when the industrial flow will receive treatment at the municipal plant to conform to the requirement of best available treatment for the industries and best practicable treatment for the town. Until then, the town will use sludge drying beds and bury the dried sludge in a sanitary landfill. In 1983, however, construction will begin on an incinerator to be completed by 1985 when phosphorus removal (producing extra chemical sludge) will be required. Under Alternate 2, Pepperell will not have to construct an

TABLE 4

MERRIMACK WASTEWATER MANAGEMENT STUDY

NORTHERN MIDDLESEX AREA COMMISSION

SLUDGE HANDLING AND DISPOSAL ALTERNATIVES

Community	Current State Program	Alternative 1 (Water) (Decentralized)	Alternative 2 (Water - Partially) (Centalized)	Alternative 3 (Water) (Centralized)	Alternative 4 (Water) (Regional)	Alternative 5 (Land)
Pepperell	-	Incinerator	To Ayer	To Ayer	To Ayer	Incinerator
Dunstable	-	-	-	-	-	-
Tyngsborough	At Lowell	At Lowell	At Lowell	At Lowell	At Lowell	At Lowell
Westford	-	At Lowell	At Lowell	At Billerica	At Lowell	-
Chelmsford						
North	-	To Lowell	At Lowell	At Billerica	At Lowell	At Lowell
South	-	To Billerica	At Billerica	At Billerica	At Lowell	At Billerica
Dracut	At Lowell	At Lowell	At Lowell	At Lowell	At Lowell	At Lowell
Lowell	Incinerator	Incinerator	Incinerator	Incinerator	Incinerator	Incinerator
Tewksbury	At Lowell	At Lowell	At Lowell	At Lowell	At Lowell	At Lowell
Billerica	-	Incinerator	Incinerator	Incinerator	To Lowell	Incinerator

incinerator since the secondary facility is too small and advanced treatment is rendered at the Regional facility in Ayer. In Alternates 3 and 4 no sludge is produced in Pepperell because the raw wastewater will be treated in Ayer. Under Alternates 2, 3, and 4, Pepperell will have to pay for a share of the Ayer incinerator and in Alternate 2, a transportation cost will also be incurred. Under Alternate 5 only secondary sludges are produced since land application requires no phosphorus removal before rapid infiltration. Since Pepperell is part of both this study and the Nashua River Basin study, a recommended course of action for Pepperell will have to await the results of the latter study.

In all alternates except Alternate 4, which will be discussed later, Lowell and Billerica both have incinerators. This is proposed for two main reasons: first, there is an incinerator presently proposed for Lowell, and second because of land restrictions and capacity limitations, it may not be possible for the Lowell incinerator to handle the quantity of sludge that will be generated by the various treatment plants in this RPA. Incineration service for the towns in this area would follow the same pattern as the collection and treatment systems.

In Alternate 4, the combined MVPC-NMAC or regionalized alternate, since Lowell is the population center of the Northern Middlesex area, Lowell will also be the site of the regional incinerator. Under this alternate there will be only two advanced wastewater treatment facilities, one in North Andover and the other in Newburyport. Since Billerica's secondary effluent will receive advanced treatment at the GLSD plant, no incinerator is proposed for Billerica, and after drying the sludge by either vacuum filtration or drying beds, it would be transported to Lowell for incineration. The incinerators in the Merrimack Valley area are proposed for North Andover, Haverhill, and Newburyport.

In Alternate 5, since chemical addition for phosphorus removal will not be necessary due to land application of the effluent, the incinerator siting will be the same as in Alternate 1 but the incinerators will be smaller. Towns such as Westford, which will use spray irrigation as the mode of advanced treatment, will produce no sludge (a full discussion of land application can be found in Appendix III, Section C).

In summary, the location of incineration systems is not as critical as the orientation of treatment systems because it is

easier to truck dewatered sludge or even pump wet sludge to a remote incineration site near a landfill or to an area established as a central or regional solid waste disposal center.

d. Combined Systems

As was discussed for Lawrence and Haverhill, it will be necessary to consider combined system alternatives which include separation, interception, storage, and treatment of combined sewer overflows into the Concord and Merrimack Rivers.

In the preliminary engineering report to Lowell, an intercepting system was proposed that would add eight overflow structures to the two existing ones. It was intended that chlorination facilities be constructed at these overflow chambers to disinfect the stormwater before discharging it to the receiving stream. In light of the new Federal guidelines, this method of combined wastewater treatment is no longer acceptable.

The Lowell treatment plant site is much more limited than in either Lawrence (North Andover plant site) or Haverhill. Consequently, it was not possible to propose an above ground storage option at the treatment plant, leaving Lowell the alternatives of (1) localized detention in which subsurface storage facilities would be located at each of the proposed overflow points to hold the combined wastewater overflow and discharge it back into the system during periods of low flow; (2) construction of a centralized storage facility under the Merrimack River at the treatment plant site; (3) construction of a centralized subsurface storage facility downstream of the treatment plant on the south bank of the Merrimack River; or (4) complete sewer separation. Complete discussion of these alternatives is contained in Appendix III, but basically the first alternate would utilize the proposed collection system while the others would require the construction of a parallel combined sewer overflow intercepting system to transport the wastewater to the centralized detention chamber.

Because of the large quantities of runoff and the unavailability of land in Lowell, construction of many of these storage facilities would have to be done below ground. The proposed site for the detention facility downstream of the treatment plant appears to lend itself to open cut construction.

2. Alternates for the Merrimack Valley Planning Commission

a. Water-Oriented Plans

(1) Decentralized Systems - Alternate 1 (Plate MV-1)

Plate MV-1, Alternate 1 proposes eight treatment facilities situated in North Andover, Haverhill, Merrimac, Amesbury, Salisbury, Newburyport, and in the future, Boxford and Rowley. As previously mentioned, the facilities in North Andover, Haverhill, Amesbury and Newburyport are accepted as givens. The sites in Merrimac and Salisbury are those which have been suggested as possible locations for treatment plants in previous engineering reports. Although there is no indication that, at the present time, the Towns of Boxford, Rowley, and West Newbury require wastewater collection or treatment facilities, in order to make valid comparisons in all of the alternates, it is necessary to locate and cost wastewater collection and treatment for these towns. In these instances, treatment plants in these towns were located as close as possible to existing or anticipated population centers and also to sources for effluent discharge to either land or water.

This decentralized option most closely resembles the current State Implementation Program. Since this program works on a need-to-abate pollution basis, the opportunity for joint or regional treatment seldom presents itself. Consequently, unless a situation similar to the Greater Lawrence Sanitary District arises, in which all towns in an area are required by the State to stop polluting, the result is often local treatment plants to solve individual problems. All of the alternatives proposed carry the State Implementation Program to the ultimate conclusion, zero discharge.

The towns of Andover, Methuen, Lawrence and North Andover formed a regional sewage district, entitled The Greater Lawrence Sanitary District. In January of 1971, bids were accepted for the first phases of wastewater collection and treatment for the district. This program includes an intercepting system in Lawrence, a main influent pumping station, and a secondary activated sludge wastewater treatment facility to be located in North Andover, near the site of the Municipal Airport. This plant will treat present and future flows from the district towns. As proposed in this alternate, future wastewater flows from the northwest part of Boxford would also be pumped into the Greater Lawrence Sanitary District to receive

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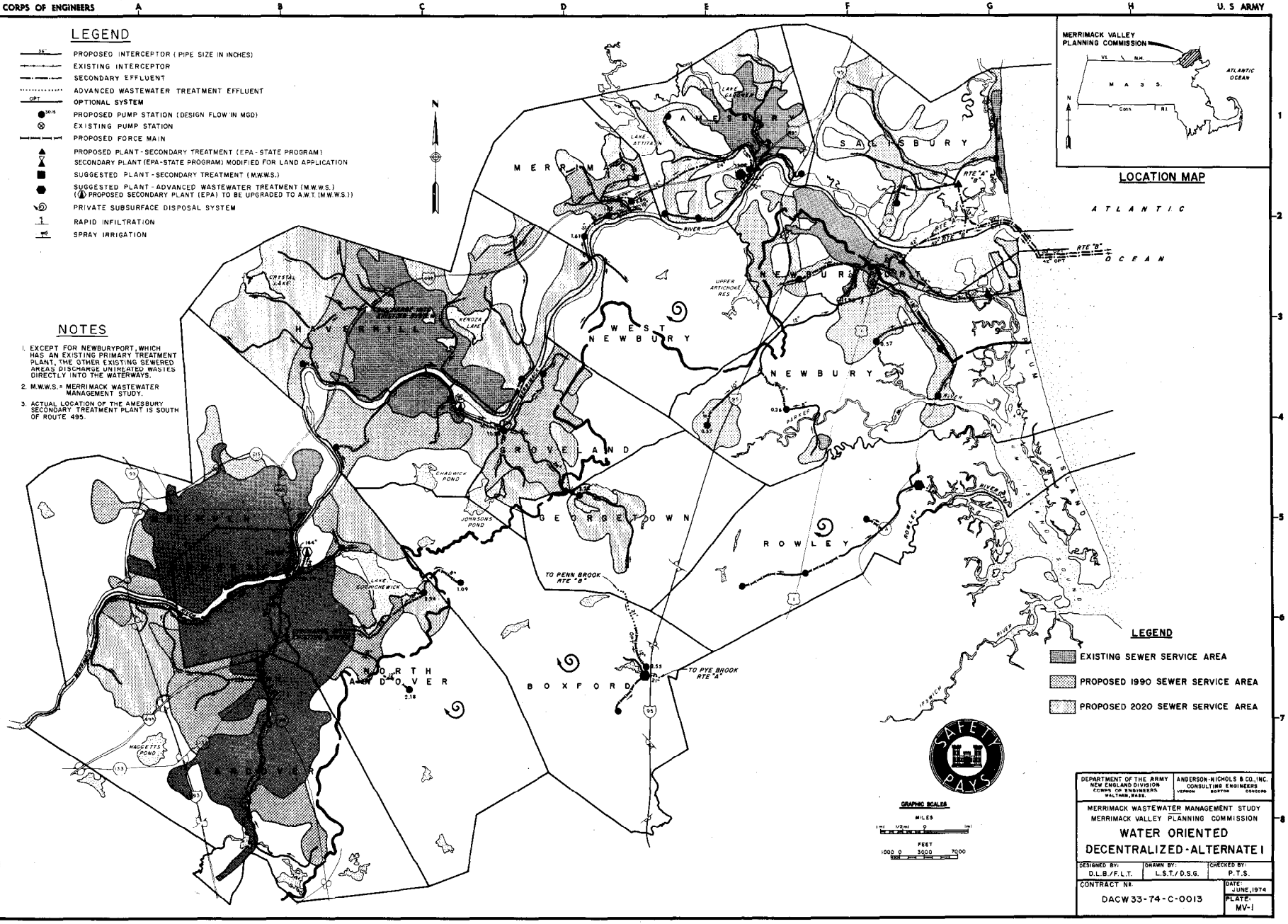
LEGEND

- PROPOSED INTERCEPTOR (PIPE SIZE IN INCHES)
- EXISTING INTERCEPTOR
- SECONDARY EFFLUENT
- ADVANCED WASTEWATER TREATMENT EFFLUENT
- OPT — OPTIONAL SYSTEM
- PROPOSED PUMP STATION (DESIGN FLOW IN MGD)
- EXISTING PUMP STATION
- PROPOSED FORCE MAIN
- PROPOSED PLANT-SECONDARY TREATMENT (EPA-STATE PROGRAM)
- SECONDARY PLANT (EPA-STATE PROGRAM) MODIFIED FOR LAND APPLICATION
- SUGGESTED PLANT-SECONDARY TREATMENT (M.W.W.S.)
- SUGGESTED PLANT-ADVANCED WASTEWATER TREATMENT (M.W.W.S.) ((1) PROPOSED SECONDARY PLANT (EPA) TO BE UPGRADED TO A.W.T. (M.W.W.S.))
- PRIVATE SUBSURFACE DISPOSAL SYSTEM
- RAPID INFILTRATION
- SPRAY IRRIGATION

NOTES

1. EXCEPT FOR NEWBURYPORT, WHICH HAS AN EXISTING PRIMARY TREATMENT PLANT, THE OTHER EXISTING SEWERED AREAS DISCHARGE UNTREATED WASTES DIRECTLY INTO THE WATERWAYS.
2. M.W.W.S. = MERRIMACK WASTEWATER MANAGEMENT STUDY.
3. ACTUAL LOCATION OF THE AMESBURY SECONDARY TREATMENT PLANT IS SOUTH OF ROUTE 495.



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MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION

WATER ORIENTED DECENTRALIZED-ALTERNATE I

DESIGNED BY:	DRAWN BY:	CHECKED BY:
D.L.B./F.L.T.	L.S.T./D.S.G.	P.T.S.

CONTRACT No. DACW 33-74-C-0013

DATE: JUNE, 1974

PLATE: MV-1

treatment at the proposed plant. The southern portion of Boxford, although presently sparsely developed, would eventually construct an advanced wastewater treatment plant near Route 95, discharging to either Pye or Penn Brooks. In the case of Boxford, as well as later in the cases of Rowley, West Newbury and the southern portion of North Andover, these options have been developed for consideration if and when the need for sewerage in these communities is clearly demonstrated. By showing these choices, there is no intention to indicate that action by these towns is imminent. The purpose is merely to plan for the future in the eventuality that sewerage in these communities becomes a need.

The City of Haverhill has developed plans for secondary treatment facilities that will include wastes from the Town of Groveland. The plant will be a secondary activated sludge plant located near Hale's Island between Salem Street and the river, discharging to the Merrimack River. Groveland intends to join with Haverhill in the construction and operation of the joint treatment facility and is in the process of obtaining approval for an intercepting system to convey wastewater flows from Groveland to the treatment facility.

While it is not anticipated that the Town of Georgetown will need sewage collection or treatment within the immediate future, in order to make valid comparisons among alternates, it is proposed that when the time comes, wastewater from the developed portions of town be transported into the Haverhill-Groveland system to receive treatment at the Haverhill treatment plant.

As in Boxford and Georgetown, the Town of Rowley is sparsely developed at this time, however, for cost comparisons it has been proposed that a future advanced wastewater treatment facility be located in the eastern part of Rowley, near the presently built up area of town, discharging to the Rowley River.

In towns like Boxford, Rowley, West Newbury and the southern part of North Andover, although collection and treatment systems have been shown for cost comparison purposes only, it is recommended that the residents of these communities continue to use private on-lot disposal systems for as long as possible.

West Newbury is probably the least developed of all the towns in the Merrimack Valley Planning Commission area, consequently, no treatment facility has been shown for West

Newbury; instead, it is proposed that wastewater originating from the developed portions of the town be collected and transported across the Merrimack River to a proposed secondary treatment plant in Merrimac. In addition, the Rocks Village area of East Haverhill would be served by the Merrimac plant.

The proposed Merrimac treatment plant is located south of Route 495 between North and Broad Streets at a site suggested in a previous engineering report. Wastewater from the developed portions of the town will be collected, treated, and discharged to Cobbler Brook until 1983, when best practicable treatment must be employed. At that time, secondary effluent from the treatment plant will be pumped to Amesbury where an advanced plant will be built to treat the effluent from the Towns of Amesbury, Merrimac, and in the future, West Newbury.

Amesbury is presently constructing a secondary treatment plant located south of Route 495 near the intersection of Main Street and Pleasant Valley Road, discharging to the Merrimack River. This plant will serve the presently built up portions of Amesbury; however, the site of the secondary facility will not permit significant expansion and upgrading to meet 1983 and 1985 goals of zero discharge. Consequently, the advanced portions of the plant would have to be relocated. The site selected for advanced facilities is the area west of and abutting Bailey's Pond. This advanced facility would receive secondary effluent from the Amesbury and the Merrimac secondary plants with ultimate discharge to the Merrimack River.

In the estuary area, a secondary treatment facility has previously been proposed in the interim basin plan for the Town of Salisbury to be located at the end of Dock Lane discharging to the estuary. Final basin plan approval was denied Salisbury, pending the outcome of this Merrimack Wastewater Management Study. Basin plan approval depends on resolution of the question of the best way to handle the Newburyport-Salisbury situation. The four alternatives to wastewater treatment required to be investigated by EPA are as follows:

1. Joint treatment and joint discharge to the Atlantic Ocean.

2. Separate treatment with individual discharge to the Atlantic Ocean.

3. Joint treatment and discharge to the Merrimack Estuary.

4. Separate treatment with individual discharges to the Merrimack Estuary.

The decentralized alternative as shown on sheet MV-1 considers two of the possibilities: separate treatment with both individual discharge to the estuary and individual discharge to the Atlantic Ocean. To determine which method of collection and treatment should be recommended for the estuary area, consideration must be given not only to cost, but in all cases, should include the relative economic values of the estuarian resources. The plan should also include a detailed environmental assessment dealing with the water quality, shellfisheries, and treatment plant sites.

Although much of Newbury lies outside the Merrimack River watershed, most of the population of Newbury lies within this hydrologic boundary along the town line with Newburyport. Newbury has an existing package plant serving the Governor Dummer Academy (Byfield Section). This is, by far, too small to handle any population increase in that area. Consequently, it is proposed that wastewater from the developed and potential growth areas of Newbury be collected and transported to the existing primary treatment facility in Newburyport. It is further proposed that this primary facility be expanded and upgraded to secondary treatment with discharge to either the estuary or the ocean. The biological assessment of secondary effluent to the estuary or ocean is presented in Appendix IV-B of this report.

(2) Partially Decentralized Systems - Alternate 2 (Plate MV-2)

This alternate is similar to the previous one with some reduction in the number of treatment plants. The Greater Lawrence Sanitary District and the Haverhill-Groveland complex, will remain the same. For cost comparison purposes, however, the southern part of North Andover, Boxford and Rowley, instead of receiving treatment within the Study area, will transport their wastewater to the M. D. C. study area. Due to the fact that no data on the M. D. C. system is available at this time, it will not be possible to attach a cost to this part of the alternate other than the cost of transporting the wastewater to the respective town lines.

The major difference between the first two alternates occurs in the estuary area. An intercepting system would be built through West Newbury which would connect Merrimac to

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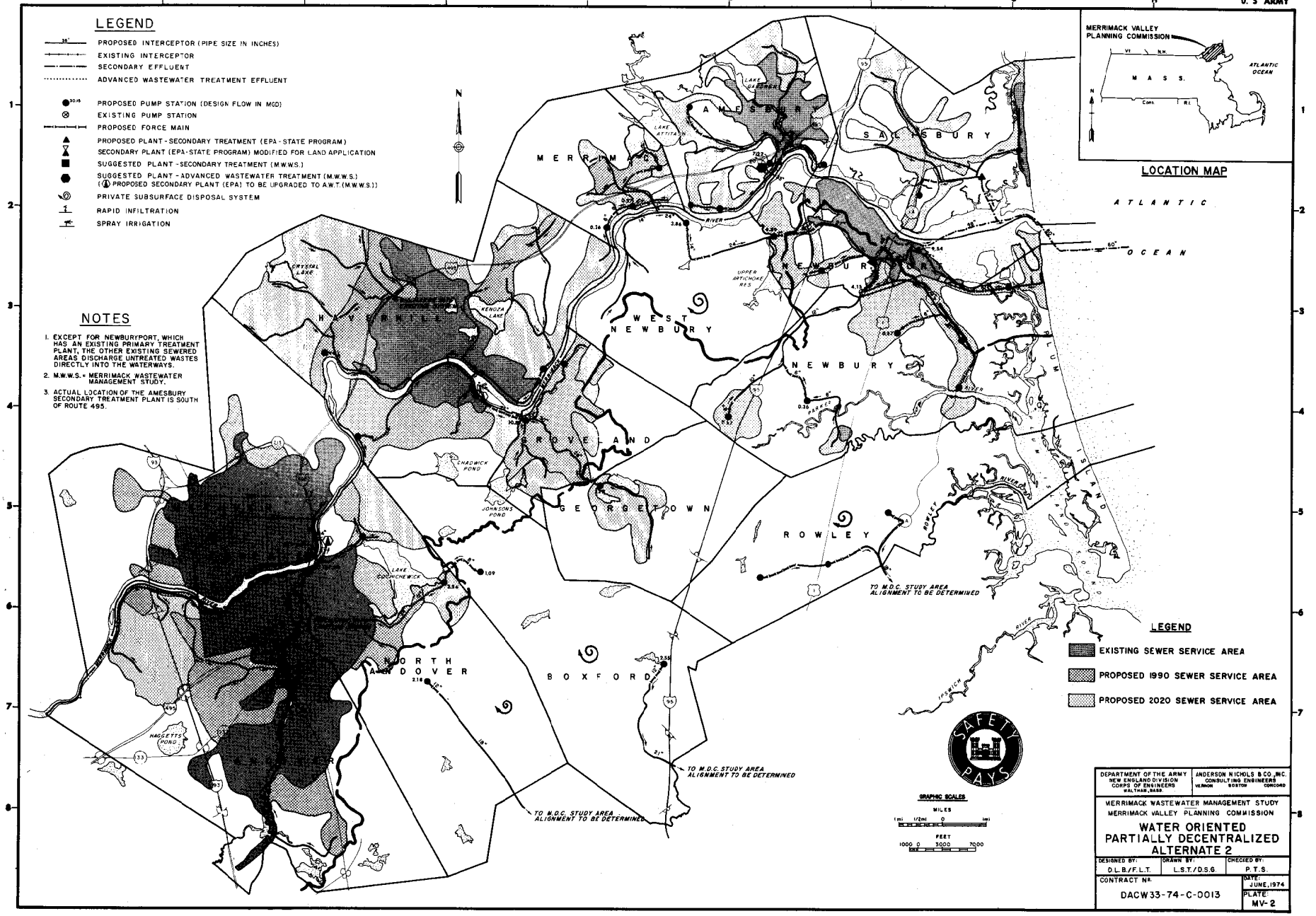

Newburyport for treatment with sufficient pipe capacity for the future needs of West Newbury. Facility siting in Amesbury would be identical to the previous alternate, however, treatment plant capacity would be reduced as treatment would only be provided for waste flow originating within the town.

Investigation of the site of the existing primary treatment plant in Newburyport indicates that there is insufficient land area to expand the treatment plant to treat flows from Merrimac, Newbury, and Newburyport and possible future flows from West Newbury. In addition, it has been suggested that it may be beneficial to the town for the treatment plant to be relocated away from the waterfront and located inland near the proposed Industrial Park near the Pleasant View Airport. Consequently, in order to cost this option a secondary treatment plant with a joint ocean outfall with Salisbury is proposed. Under this alternate, the existing primary treatment plant at Newburyport would be abandoned.

(3) Centralized System - Alternate 3 (Plate MV-3)

In this alternate, there will only be two advanced wastewater treatment facilities: one in North Andover and the other in Newburyport serving the estuary area. The orientation of the collection systems in the towns of the GLSD will remain the same as in the previous two alternates. However, modifications to the Haverhill-Groveland complex will result in the construction of a secondary facility, which will treat wastewater from Haverhill, Groveland, and in the future, Georgetown and the southern part of Boxford (The northern part of Boxford will discharge to the GLSD). In 1983, when best practicable treatment must be applied, discharge of secondary effluent from the Haverhill facility to the Merrimack River will stop and secondary effluent will be transported to the GLSD plant for advanced treatment. As was previously stressed, the sparsely developed towns and sections of towns such as the southern part of North Andover, Boxford, Rowley and West Newbury will continue to utilize on-lot private disposal systems, however, in order to provide an alternate to these towns in the future, and attach a cost to it now, it is necessary to suggest a means of wastewater collection and treatment for the future, if and when the need should arise. Consequently, in Boxford, wastewater would be transported to Georgetown and eventually into the Haverhill facility, and the relocated Newburyport facility would have sufficient future capacity to serve Rowley and West Newbury.

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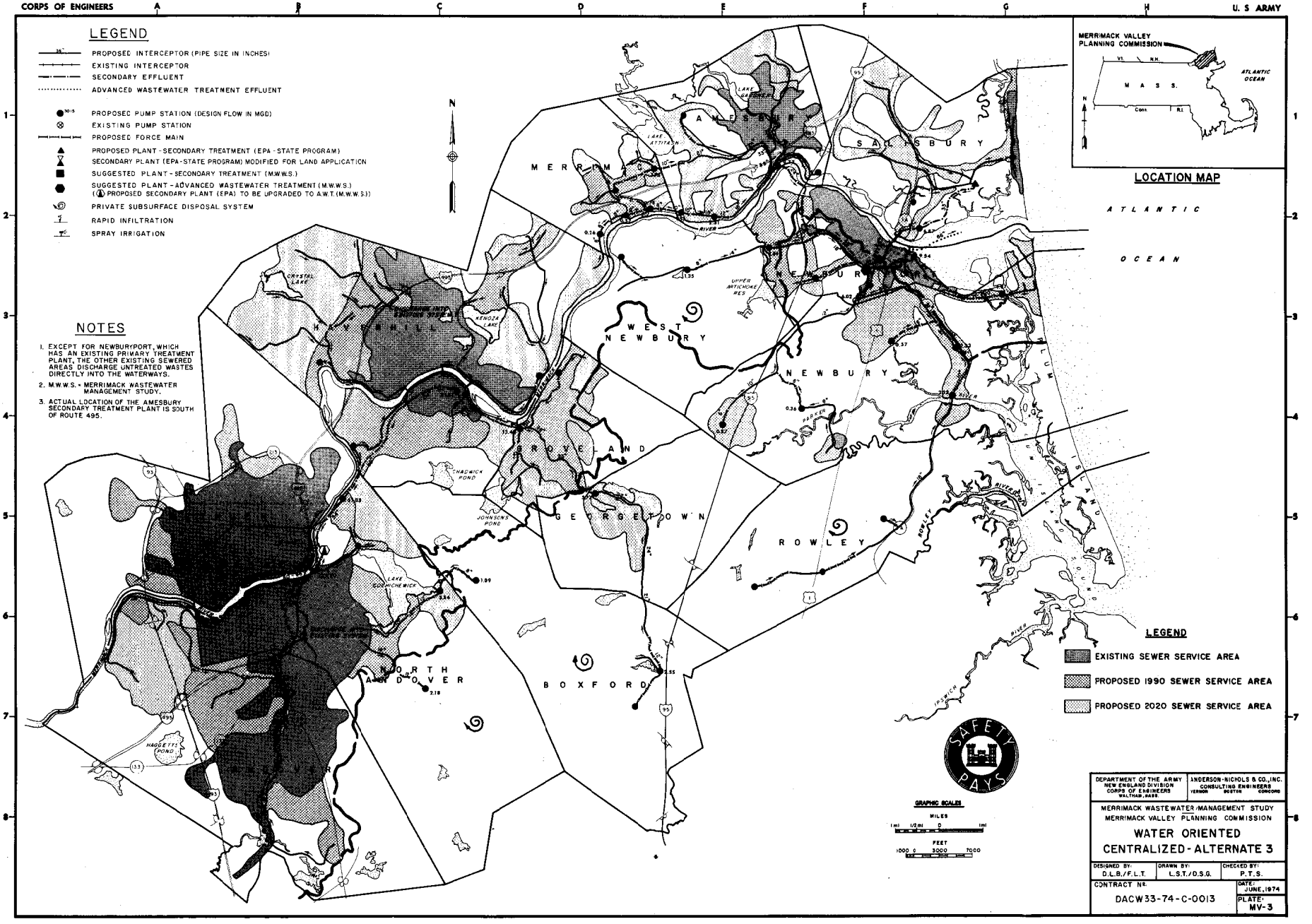

In the estuary area, Newburyport becomes the center of activity and, as was proposed in Alternate 2, the existing primary plant would be removed from the waterfront and a new, secondary and later advanaced wastewater treatment facility would be constructed inland at the site of the Industrial Park discharging to the estuary. For 1983 and 1985, the Newburyport facility would be designed to treat wastewater originating in Newbury and Newburyport, and secondary effluents from Amesbury, which would serve Amesbury and Merrimac and the Salisbury secondary plant.

(4) Regional System - Alternate 4 (Plate MV-4)

This alternate will be presented under Part 3 of this section, "The Combined MVPC-NMAC Alternate."

b. Land-Oriented Plans

(1) Decentralized Systems - Alternate 5 (Plate MV-5)

As was previously mentioned in the introduction to this section, there is little land available in the Merrimack River Basin for land application of secondary effluent, thus it is not possible to recommend a land-oriented system for the Greater Lawrence Sanitary District due to the large amounts of flow that must receive treatment. Consequently, in both land-oriented alternates, collection and treatment layouts for the GLSD will be identical to that described under Alternates 1 and 2. The Haverhill-Groveland complex on the other hand, requiring less land, will employ rapid infiltration as the method of ultimate treatment. Wastewater from Haverhill and Groveland will be treated at the proposed treatment plant site, near Hale's Island. However, instead of being upgraded to an advanced treatment facility, this plant, in 1985, will be modified and the effluent will be initially disposed of to the land in Haverhill, along the Merrimack River. As the treatment plant flow increases, in the future it will be necessary to utilize additional land sites in Groveland, Georgetown and Boxford.

As another possible future solution, treatment facilities have been located in Boxford, Rowley, Georgetown and West Newbury. Since these facilities would be small, even in future years, spray irrigation has been selected as the land application method. The treatment plant location in Boxford will be at the same site (the intersection of Ipswich and Depot Roads) as in the water-oriented alternates and effluent from the secondary treatment plant

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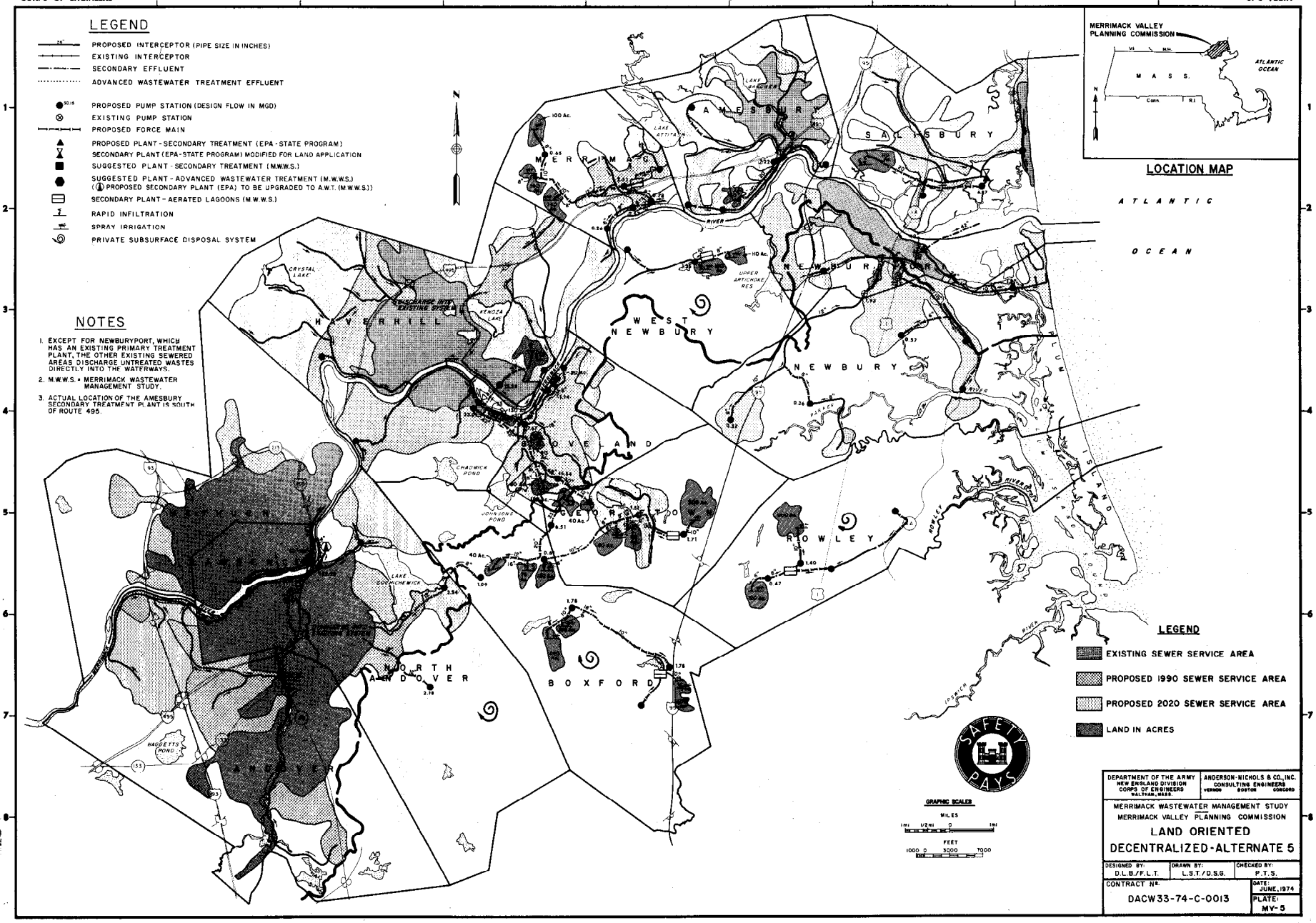

(aerated lagoons) will be applied to the land by spray irrigation at three different sites in Boxford. In Rowley, in order to be reasonably close to both the anticipated population areas and the land application sites, the land intense treatment plant has been located in the western part of the town near the intersection of Rt. 133 and Daniels Road. In Georgetown, as part of the decentralized system, aerated lagoons would be constructed in the Marlboro section of town with the effluent being discharged to the land by spray irrigation. In West Newbury, although a treatment plant has not been indicated in any previous alternate, it appears due to soil conditions that it would be more advantageous for West Newbury to build a treatment plant rather than to transport wastewater to a neighboring community for treatment. Results of the soil studies conducted by Goldberg-Zoino indicate that the land in West Newbury is conducive to advanced treatment by means of spray irrigation. Consequently, it is proposed that for a solution to future problems, aerated lagoons be constructed near the Cardinal Cushing Academy and the land between Rt. 113 and Middle Street opposite the treatment plant site to be used as the spray irrigation site.

In Alternate 1 it was indicated that the site suggested for the Merrimac treatment facility was one proposed in a preliminary report to the town. However, the same report also suggested an alternate site north of Rt. 495 just off Mill Street between Rt. 495 and East Main Street. Since the potential sites for land application (spray irrigation) in Merrimac are in the northwest corner of the town, this alternate site was selected for the location of the aerated lagoons. Until 1985, when spray irrigation of the effluent would begin, a temporary outfall to Cobbler Brook would be needed.

In order to provide land oriented alternates for Amesbury and Salisbury, rapid infiltration must be employed since insufficient suitable land areas are available for spray irrigation of the secondary effluent. The secondary plant under construction in Amesbury would be utilized until 1985 when modification to the plant to produce an effluent quality compatible with land application by rapid infiltration would be completed. At this time, the temporary outfall to the Merrimack River would be abandoned and the effluent would be pumped to the rapid infiltration basins located just south of Lone Tree Hill in Amesbury for final treatment. Salisbury would follow the identical procedure except that the rapid infiltration area would be in Salisbury just east of Rt. 95 and south of Elm Street. Spray irrigation was ruled out for both

Salisbury and Newburyport due to the high concentrations of chlorides experienced, presumably from seawater intrusion. Salts have a deleterious effect on the spray irrigation form of land treatment.

In the estuary, land suitability and availability are also critical. As was the case in the GLSD, not enough suitable land can be found to provide a land-oriented alternate for the Newburyport facility. Thus, it was judged that the most feasible approach was to employ the same orientation as shown in Alternate 1 with Newburyport providing secondary treatment for Newburyport and Newbury with discharge to the estuary.

(2) Centralized Systems - Alternate 6 (Plate MV-6)

This alternate is similar to Alternate 5 with the main difference coming in facility siting in the towns of Boxford, Georgetown, West Newbury and Merrimac. In this alternate, in attempt to centralize wastewater treatment, untreated wastewater from Boxford is to be transported to Georgetown, which would utilize an aerated lagoon system for secondary treatment. Due to the increased volumes of flow, in addition to the spray irrigation sites in Georgetown land in Boxford would also be required. Because the spray irrigation sites are potentially very good in West Newbury and since spray irrigation can be used as a method to preserve open land, future wastewater flow from West Newbury would be transported to Merrimac to receive secondary treatment in aerated lagoons. As in Alternate 1, the treatment plant in Merrimac is located south of Rt. 495 with a temporary discharge (until 1985) to the Merrimack River. This secondary treatment site is one which was considered and found acceptable in a previous engineering report done for the Town of Merrimac. For the rest of the planning area, the method of collection, wastewater treatment and final disposal to the land is identical to that shown in Alternate 5.

c. Sludge Handling and Disposal

A generalized program for sludge handling and disposal will be outlined in Appendix III of this report. The proposed treatment consists of either application of sludge to sand drying beds before ultimate disposal, in smaller treatment plants, or gravity thickening, vacuum filtration with chemical conditioning, and multiple hearth incineration of the sludge cake and disposal of

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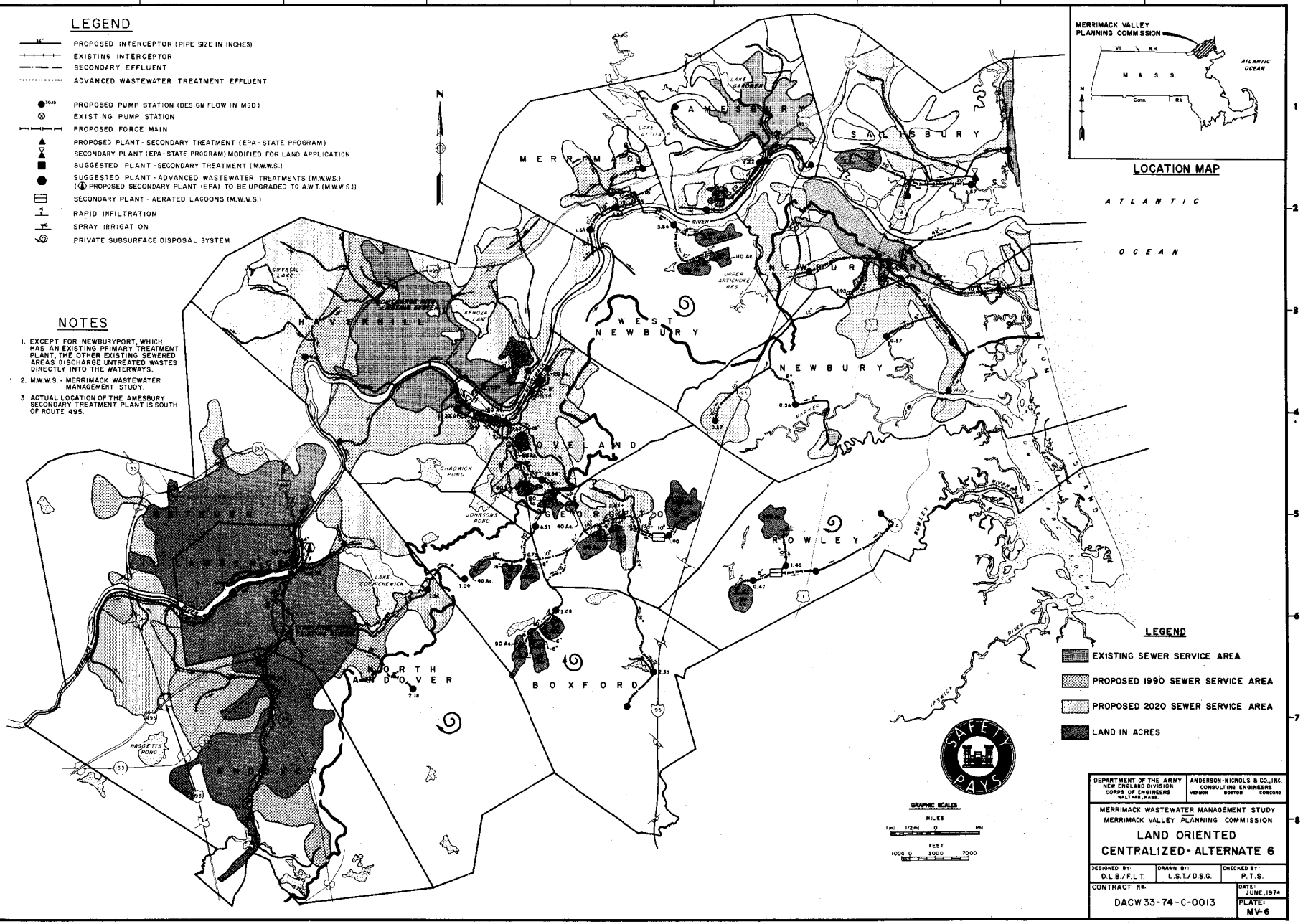
LEGEND

- PROPOSED INTERCEPTOR (PIPE SIZE IN INCHES)
- EXISTING INTERCEPTOR
- SECONDARY EFFLUENT
- ADVANCED WASTEWATER TREATMENT EFFLUENT
- PROPOSED PUMP STATION (DESIGN FLOW IN MGD)
- EXISTING PUMP STATION
- PROPOSED FORCE MAIN
- PROPOSED PLANT - SECONDARY TREATMENT (EPA - STATE PROGRAM)
- SECONDARY PLANT (EPA - STATE PROGRAM) MODIFIED FOR LAND APPLICATION
- SUGGESTED PLANT - SECONDARY TREATMENT (M.W.W.S.)
- SUGGESTED PLANT - ADVANCED WASTEWATER TREATMENTS (M.W.W.S.) (PROPOSED SECONDARY PLANT (EPA) TO BE UPGRADED TO A.W.T. (M.W.W.S.))
- SECONDARY PLANT - AERATED LAGOONS (M.W.W.S.)
- RAPID INFILTRATION
- SPRAY IRRIGATION
- PRIVATE SUBSURFACE DISPOSAL SYSTEM

NOTES

1. EXCEPT FOR NEWBURYPORT, WHICH HAS AN EXISTING PRIMARY TREATMENT PLANT, THE OTHER EXISTING SEWERED AREAS DISCHARGE UNTREATED WASTES DIRECTLY INTO THE WATERWAYS.
2. M.W.W.S. - MERRIMACK WASTEWATER MANAGEMENT STUDY.
3. ACTUAL LOCATION OF THE AMESBURY SECONDARY TREATMENT PLANT IS SOUTH OF ROUTE 495.



DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WALTHAM, MASS.	ANDERSON-NICHOLS & CO., INC. CONSULTING ENGINEERS VERNON BOSTON CONCORD

MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION

LAND ORIENTED CENTRALIZED - ALTERNATE 6

DESIGNED BY:	DRAWN BY:	CHECKED BY:
D.L.B./F.L.T.	L.S.T./D.S.G.	P.T.S.

CONTRACT No. DACW 33-74-C-0013 — DATE: JUNE, 1974 — PLATE: MV-6

of the ash to landfill, in larger facilities.

In the treatment of wastewater as proposed in this study, depending on the degree of treatment utilized, varying amounts of sludge will be produced. Secondary treatment produces two sludges: primary settled and conventional activated sludge. However, by 1985 when phosphorus removal will be required, those plants that have been upgraded to advanced wastewater treatment facilities will be generating approximately 2.5 times more sludge than a secondary facility due to the addition of chemicals (lime and ferric chloride) to reduce phosphorus concentrations to acceptable levels.

As was discussed in Part a of this section, not all of the secondary treatment plants will be upgraded (some will discharge secondary effluent to advanced facilities located elsewhere). In order to derive a workable sludge handling program, it was necessary to develop costs for the transportation of the dried sludge to the incinerator. These costs are discussed in Appendix III under Cost Methodology.

In the Merrimack Valley Planning Commission, as shown on Table 5 incinerators have been located in North Andover, Haverhill and Newburyport since, under all alternates, these are the largest plants. Originally it was intended that incinerators would only be situated at the advanced wastewater treatment facilities but under the more centralized alternates, this would have resulted in long hauling distances as in the case of Haverhill which, under some alternates would have had to transport all of its sludge to the GLSD for incineration. Consequently, it is proposed that the Planning Commission be divided into three areas (GLSD, Haverhill-Groveland, and the estuary area) to reduce the truck traffic by providing closer incineration sites. It is anticipated that the GLSD will incinerate all the sludge generated in the North Andover plant, Haverhill will handle its own sludge plus any originating in Georgetown, Boxford or Rowley (depending on treatment plant location) and the facility at Newburyport would serve the remainder of the towns. An additional motive for providing three incinerator sites was one of anticipated down-time. If, for any reason, one of the incinerators were to be in need of maintenance, there would be two others that could either share or handle the total sludge load from the inoperative facility without transporting the sludge over long distances.

TABLE 5

MERRIMACK WASTEWATER MANAGEMENT STUDY

MERRIMACK VALLEY PLANNING COMMISSION

SLUDGE HANDLING AND DISPOSAL ALTERNATIVES

Community	Current State Program	Alternative 1 (Water) (Decentralized)	Alternative 2 (Water Partially) (Centralized)	Alternative 3 (Water) (Centalized)	Alternative 4 (Water) (Regional)	Alternative 5 (Land) (Decentralized)	Alternative 6 (Land) (Centralized)
Greater Lawrence Sanitary District (GLSD)	Incinerator	Incinerator	Incinerator	Incinerator	Incinerator	Incinerator	Incinerator
Andover, Methuen, Lawrence, No. Andover	AT GREATER LAWRENCE SANITARY DISTRICT						
Haverhill	Incinerator	Incinerator	Incinerator	Incinerator	Incinerator	Incinerator	Incinerator
Groveland	At Haverhill	At Haverhill	At Haverhill	At Haverhill	At Haverhill	At Haverhill	At Haverhill
Boxford	-	-	-	-	-	-	-
Georgetown	-	-	-	-	-	-	-
Newbury	At Newburyport	At Newburyport	At Newburyport	At Newburyport	At Newburyport	At Newburyport	At Newburyport
West Newbury	-	-	-	-	-	-	-
Merrimac	-	To Newburyport	At Newburyport	At Newburyport	At Newburyport	None	None
Amesbury	-	To Newburyport	To Newburyport	To Newburyport	To Newburyport	To Newburyport	To Newburyport
Salisbury	-	To Newburyport	To Newburyport	To Newburyport	At Newburyport	To Newburyport	To Newburyport
Newburyport	-	Incinerator	Incinerator	Incinerator	Incinerator	Incinerator	Incinerator
Rowley	-	-	-	-	-	-	-

analyzed and overflow rates were converted to volumes. Upon completion of the computation of treatment and storage requirements and evaluation of overflow control methods proposed by other engineering firms for these and other similar cities it became evident that the solutions for Lawrence and Haverhill centered around a comparison between providing storage for the overflow volumes, and releasing the stored combined flow to the system during periods of low flow, and complete stormwater separation. Discussed fully in Appendix III, the options for Lawrence are (1) combined wastewater storage at the treatment plant which requires treatment plant expansion by construction of surface concrete holding tanks and the enlargement of the influent pumping station to convey the flow to the storage tanks or (2) subsurface detention ahead of the influent pumping station which would require construction of a below ground detention chamber (due to limited land available) with aeration and pumping capacity to lift the stored combined flow into the collection system during periods of low flow. This option would not require the enlargement of the pumping station as the flow would be equalized before introduction to the collection system.

Haverhill has the same alternates and an additional one - construction of above ground aerated lagoons at the treatment plant site for combined wastewater detention. This alternate is possible in Haverhill because the proposed Haverhill facility will be located in a sparsely populated area and more land can be obtained without any relocation of houses. This alternate would also necessitate the enlargement of the influent pumping station to be able to pass the collection system capacity.

In addition to collection of combined overflows, the possibility of system separation was considered. Data was gathered on similar separation projects and recommendations made in the preliminary reports to these cities were evaluated. Although separation of the combined systems in Lawrence and Haverhill would significantly reduce the volume of flow requiring treatment thus reducing the size of the pipes in the intercepting system, a sewer separation program is a long term project spanning many years, and involving major distruption of traffic patterns and business in the downtown area.

The designs and costs associated with the combined system alternates are more fully discussed in Appendix III, Sections D and E.

3. The Combined MVPC-NMAC Alternate (Alternate 4)

This regionalized alternate was proposed in an attempt to determine if the economy of scale could be applied to a large area and result in a significant reduction in total project cost. The base for this orientation is the six "given" treatment plants listed in the beginning of this section.

Since the cost of meeting the goal of zero discharge is so high, it was decided to reduce the number of treatment plants to the feasible minimum and provide advanced treatment only at the most centralized locations. It was determined that at least two advanced treatment plants would be required, one to serve the western part of the study area and one for the eastern portion. Since over 90% of the existing population of the study area is centered in the Lowell-Lawrence-Haverhill area, this was selected as the site of one of the advanced treatment plants. Lowell was eliminated as a potential site since there is not enough land available. North Andover was chosen as the site because there appears to be sufficient land available, it is the center of the three population areas, it will be the first to complete its treatment facility (mid-1977), and the volume of flow to be treated at this facility is by far the largest of any plant in the study area. In addition, the Greater Lawrence Sanitary District is already recognized as an independent entity and it was judged that if the option were to become the recommended plan, it would be less difficult to implement.

Newburyport was chosen as the site for the other advanced wastewater treatment facility as Amesbury's secondary plant is nearing completion and the site is not readily expandable; there exists a need to upgrade the existing primary facility in Newburyport; and a desire by some of the inhabitants of the town to restore the waterfront area which would include the removal or relocation of the treatment plant. As stated before, there is a prime site for a new treatment plant away from the waterfront west of Route 1 in a proposed industrial park. Although both Salisbury and Newburyport have an immediate need for wastewater treatment facilities, the larger percentage of the flow originates in Newburyport. Since Newburyport would, based on flow alone, be assessed the greater portion of all costs, it was judged that it would be more feasible to locate the plant in Newburyport rather than pumping the larger flow across the Merrimack River to Salisbury.

The alternate as shown on Plates NM-4 and MV-4 would retain secondary treatment facilities in Lowell and Billerica. The Lowell facility would serve Lowell, Dracut, Tewksbury and the eastern part of Tynsborough. The plant in Billerica would treat waste streams originating in Billerica, Westford, Chelmsford, and in the future, West Tyngsborough and East Dunstable.

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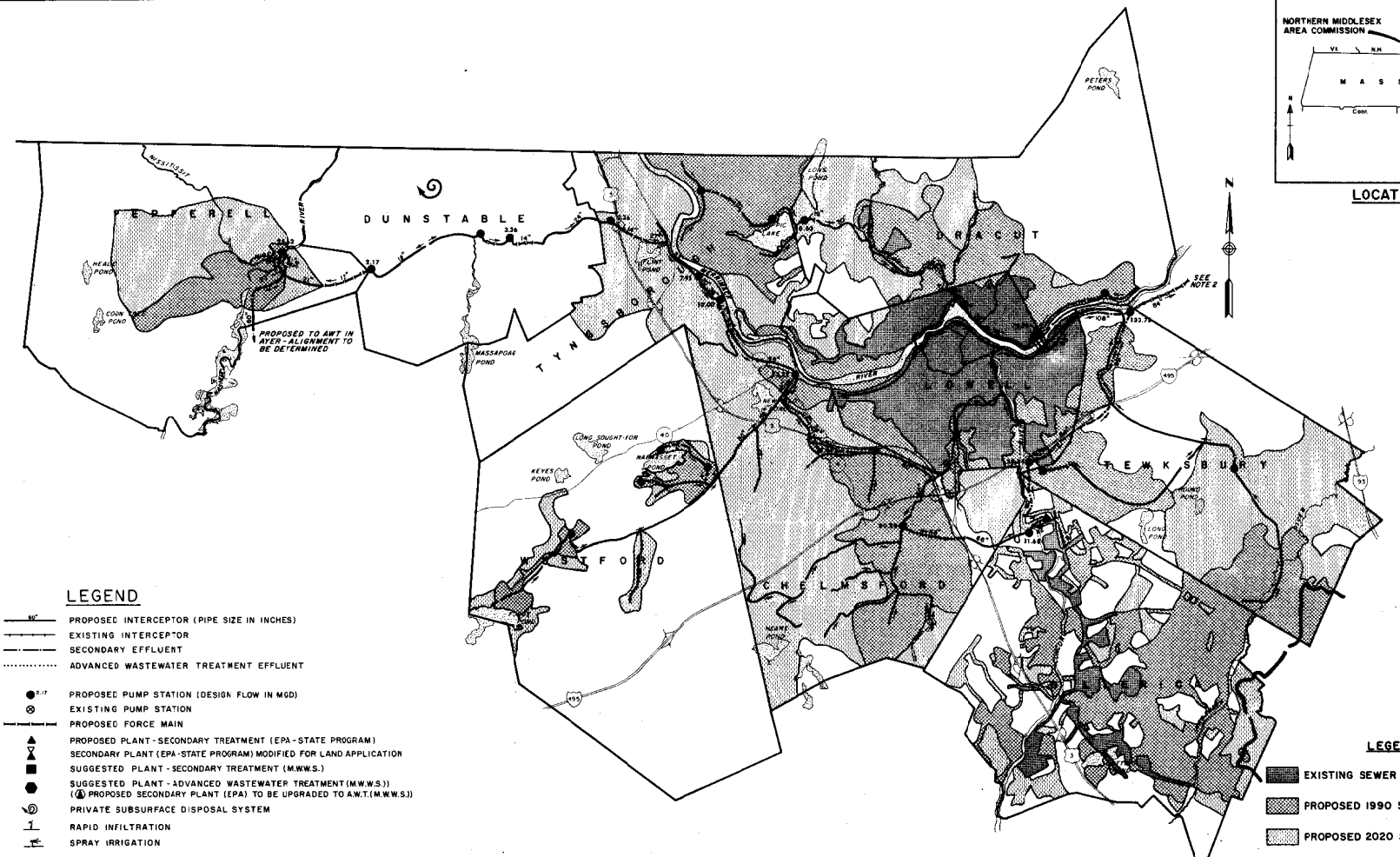

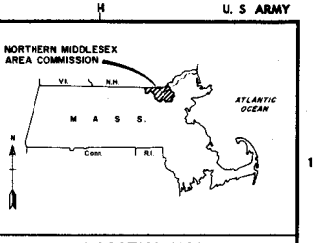

LOCATION MAP

LEGEND

- PROPOSED INTERCEPTOR (PIPE SIZE IN INCHES)
- EXISTING INTERCEPTOR
- SECONDARY EFFLUENT
- ADVANCED WASTEWATER TREATMENT EFFLUENT
- PROPOSED PUMP STATION (DESIGN FLOW IN MGD)
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- PROPOSED FORCE MAIN
- PROPOSED PLANT - SECONDARY TREATMENT (EPA - STATE PROGRAM)
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- PRIVATE SUBSURFACE DISPOSAL SYSTEM
- RAPID INFILTRATION
- SPRAY IRRIGATION

LEGEND

- EXISTING SEWER SERVICE AREA
- PROPOSED 1990 SEWER SERVICE AREA
- PROPOSED 2020 SEWER SERVICE AREA

NOTES

1. M.W.W.S. = MERRIMACK WASTEWATER MANAGEMENT STUDY
2. FOR CONTINUATION OF FORCE MAIN TO NORTH ANDOVER SEE ALTERNATE 4 MERRIMACK VALLEY PLANNING COMMISSION - WATER ORIENTED - REGIONAL.
3. EXCEPT FOR BILLERICA, WHICH HAS AN EXISTING SECONDARY PLANT, THE OTHER EXISTING SEWERS DISCHARGE UNTREATED WASTES DIRECTLY INTO THE WATERWAYS.

GRAPHIC SCALES

MILES: 1 mi 1/2 mi 0 1 mi

FEET: 1000 0 3000 7000

SAFETY PAYS

DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WALTHAM, MASS.	ANDERSON-NICHOLS & CO., INC. CONSULTING ENGINEERS VERNON BOSTON CONCORD

MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION

WATER ORIENTED REGIONAL-ALTERNATE 4

DESIGNED BY:	DRAWN BY:	CHECKED BY:
D.L.B./F.L.T.	L.S.T./D.S.G.	P.T.S.

CONTRACT Nº	DATE
DACW33-74-C-0013	JUNE, 1974
	PLATE: NM-4

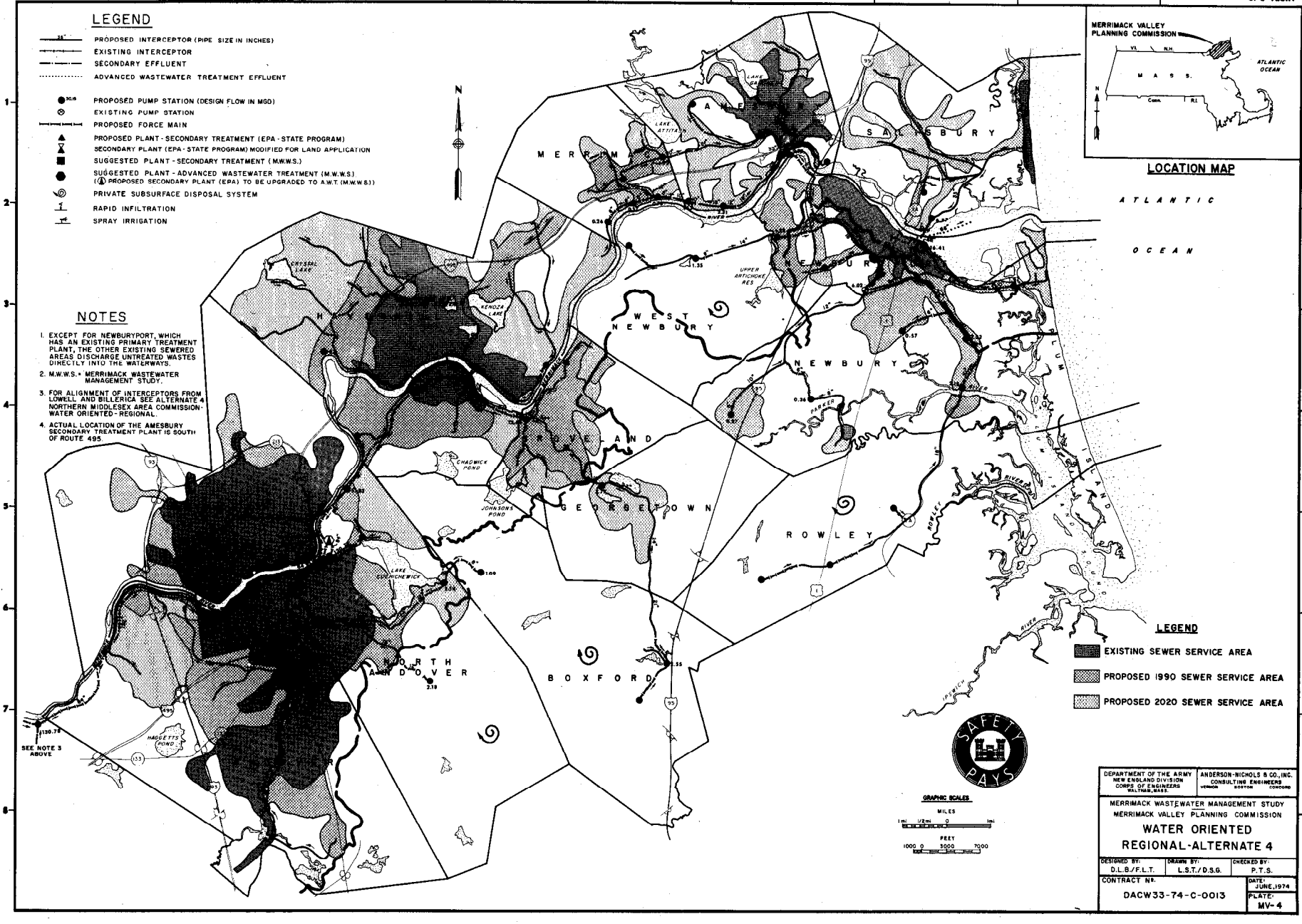
CORPS OF ENGINEERS U. S. ARMY

LEGEND

- PROPOSED INTERCEPTOR (PIPE SIZE IN INCHES)
- EXISTING INTERCEPTOR
- SECONDARY EFFLUENT
- ADVANCED WASTEWATER TREATMENT EFFLUENT
- PROPOSED PUMP STATION (DESIGN FLOW IN MGD)
- EXISTING PUMP STATION
- PROPOSED FORCE MAIN
- PROPOSED PLANT - SECONDARY TREATMENT (EPA - STATE PROGRAM)
- SECONDARY PLANT (EPA - STATE PROGRAM) MODIFIED FOR LAND APPLICATION
- SUGGESTED PLANT - SECONDARY TREATMENT (M.W.W.S.)
- SUGGESTED PLANT - ADVANCED WASTEWATER TREATMENT (M.W.W.S.) (PROPOSED SECONDARY PLANT (EPA) TO BE UPGRADED TO A.W.T. (M.W.W.S.))
- PRIVATE SUBSURFACE DISPOSAL SYSTEM
- RAPID INFILTRATION
- SPRAY IRRIGATION

NOTES

1. EXCEPT FOR NEWBURYPORT, WHICH HAS AN EXISTING PRIMARY TREATMENT PLANT, THE OTHER EXISTING SEWERED AREAS DISCHARGE UNTREATED WASTES DIRECTLY INTO THE WATERWAYS.
2. M.W.W.S. = MERRIMACK WASTEWATER MANAGEMENT STUDY.
3. FOR ALIGNMENT OF INTERCEPTORS FROM LOWELL AND BILLERICA SEE ALTERNATE 4 NORTHERN MIDDLESEX AREA COMMISSION-WATER ORIENTED-REGIONAL.
4. ACTUAL LOCATION OF THE AMESBURY SECONDARY TREATMENT PLANT IS SOUTH OF ROUTE 495.



DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WALTHAM, MASS.	ANDERSON-NICHOLS & CO., INC. CONSULTING ENGINEERS VERNON BOSTON CONCORD

MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION

WATER ORIENTED REGIONAL-ALTERNATE 4

DESIGNED BY:	DRAWN BY:	CHECKED BY:
D.L.B./F.L.T.	L.S.T./D.S.G.	P.T.S.

CONTRACT Nº. DACW33-74-C-0013 DATE: JUNE, 1974 PLATE: MV-4

Pepperell, as in the other centralized alternates, would pipe its raw wastewater to the proposed regional advanced facility in Ayer.

In 1983, after receiving secondary treatment, the effluent from the Billerica plant will be transported to a point near the Tewksbury-Andover town line where it will join the pipeline carrying secondary effluent from the Lowell plant. This combined flow would then be transported to North Andover for advanced treatment.

In the Merrimack Valley Planning Commission, the GLSD plant would be the center for advanced wastewater treatment. As in the previous alternates, the GLSD plant would initially be constructed as a secondary treatment plant serving the member towns and the northern portion of Boxford in the future. By 1985 the plant will have been upgraded to an advanced plant treating secondary effluents from the Northern Middlesex Area and from the Haverhill plant before discharging to the Merrimack River.

Haverhill, under this alternate, would construct a secondary treatment plant serving Haverhill and Groveland, and in the future Georgetown and the southern portion of Boxford. In 1983 when best practicalble treatment must be applied, secondary effluent from this facility will be piped to the advanced plant in the GLSD for future treatment.

As was discussed under the other alternates, the recommended action for the towns of Boxford, Rowley and West Newbury is to remain on private systems. However, Plate MV-4 shows what the alternative for these towns would be under a regional system. In addition to Boxford's wastewater being treated at North Andover and Haverhill, Rowley and West Newbury when a need for wastewater collection and treatment arises, would construct pipelines to transport untreated wastewater to the Newburyport regional facility.

In the estuary area, the secondary plant in Amesbury, would continue to treat flow from Amesbury and Merrimac. When the time for more sophisticated degrees of treatment arrives, the secondary effluent from the Amesbury facility will be transported to the advanced plant in Newburyport which will also treat wastewaters originating in Newburyport, Newbury, Salisbury and in the future West Newbury. Under this option, discharge of advanced treatment effluent will be to the estuary.

4. The Least Cost Alternates

The least cost alternates have been determined solely on the basis of cost. These costs and the reasons behind each choice for each municipality will be discussed in Appendix III, Section G3, "Wastewater Systems."

It should be noted that in a number of municipalities the need for sewerage has not been demonstrated. Until that need arises, those towns will continue with on-lot disposal.

a. Northern Middlesex Area Commission

Plate NM-6 details the least cost wastewater systems for this area. The Lowell sanitary system, which includes Lowell, Dracut, Tewksbury and that portion of Tyngsborough located east of the Merrimack River, will provide advanced wastewater treatment at the Duck Island plant with discharge to the Merrimack River. This is the same system as shown for Alternate 1.

Alternate 1 is also the least cost alternate for North Chelmsford, Westford, the western portion of Tyngsborough, and the eastern portion of Dunstable. An advanced treatment plant will be constructed in North Chelmsford to serve these towns and discharge their treated wastewater to the Merrimack River. Initially only North Chelmsford and Westford will utilize this plant until the areas in Dunstable and Tyngsborough show a need for sewerage.

The Billerica advanced wastewater treatment plant, serving Billerica and South Chelmsford, will differ slightly from Alternate 1 in that South Chelmsford will send raw wastewater instead of secondary effluent to the Billerica treatment plant. Discharge from the plant will be to the Concord River.

Pepperell's least cost alternate is the same as Alternate 5 which calls for a secondary treatment plant in Pepperell and land application of its secondary effluent by rapid infiltration. The western portion of Dunstable will connect to this system when their need for sewerage is demonstrated.

b. Merrimack Valley Planning Commission

Merrimack Valley Planning Commission Plate MV-7 details the least cost wastewater systems for this area. As with all previous alternates, the Greater Lawrence Sanitary District serving

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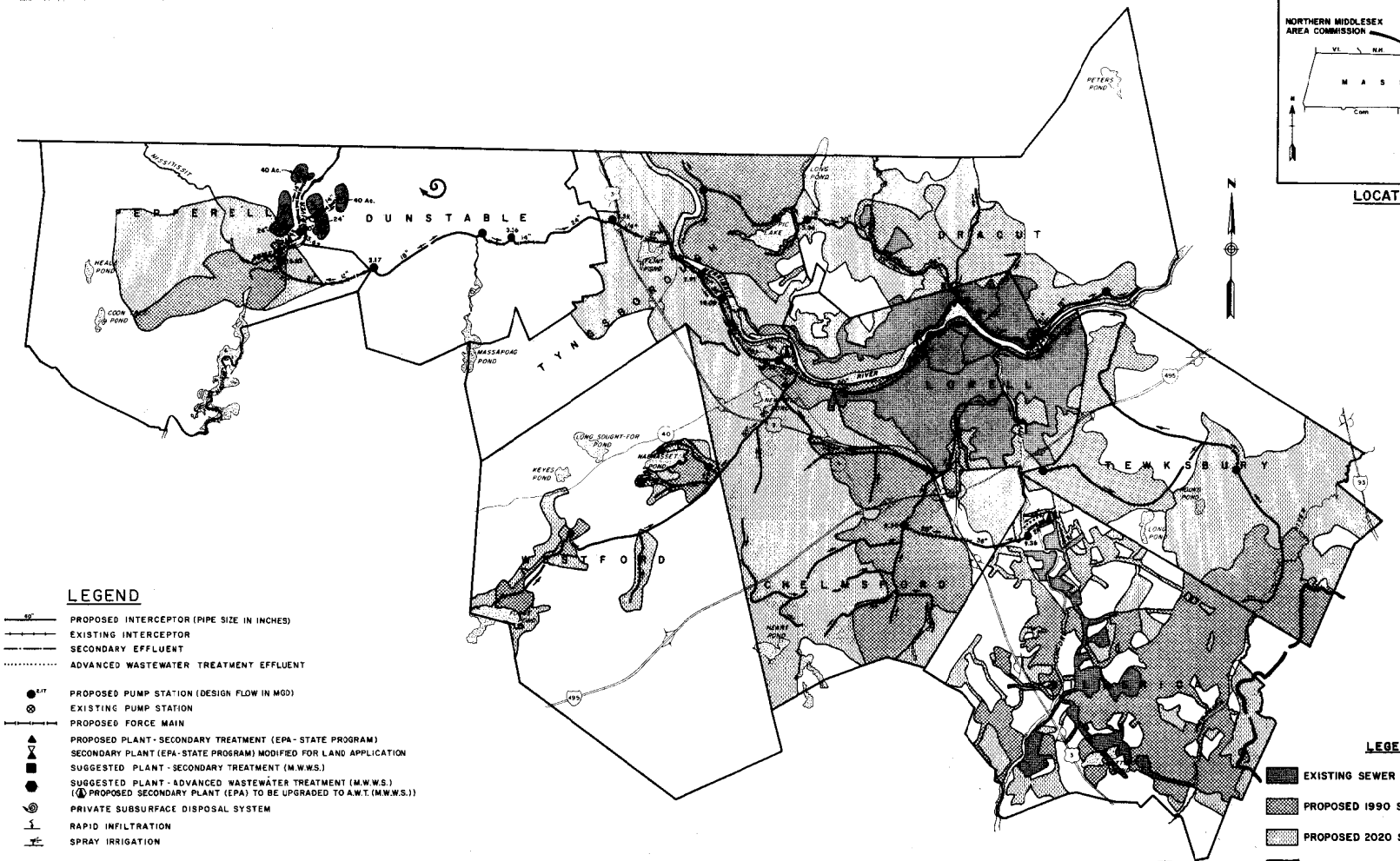

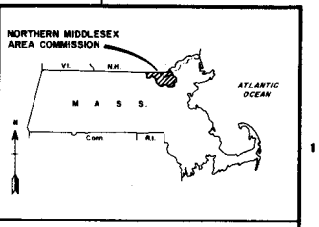

LOCATION MAP

LEGEND

- PROPOSED INTERCEPTOR (PIPE SIZE IN INCHES)
- EXISTING INTERCEPTOR
- SECONDARY EFFLUENT
- ADVANCED WASTEWATER TREATMENT EFFLUENT
- PROPOSED PUMP STATION (DESIGN FLOW IN MGD)
- EXISTING PUMP STATION
- PROPOSED FORCE MAIN
- PROPOSED PLANT - SECONDARY TREATMENT (EPA - STATE PROGRAM)
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- PRIVATE SUBSURFACE DISPOSAL SYSTEM
- RAPID INFILTRATION
- SPRAY IRRIGATION

NOTES

1. M.W.W.S. = MERRIMACK WASTEWATER MANAGEMENT STUDY
2. EXCEPT FOR BILLERICA, WHICH HAS AN EXISTING SECONDARY PLANT, THE OTHER EXISTING SEWERS DISCHARGE UNTREATED WASTES DIRECTLY INTO THE WATERWAYS.

LEGEND

- EXISTING SEWER SERVICE AREA
- PROPOSED 1990 SEWER SERVICE AREA
- PROPOSED 2020 SEWER SERVICE AREA
- LAND IN ACRES

SAFETY PAYS

GRAPHIC SCALES

MILES: 1 mi, 1/2 mi, 0, 1 mi

FEET: 1000, 0, 3000, 7000

DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WALTHAM, MASS.	ANDERSON-NICHOLS & CO., INC. CONSULTING ENGINEERS VERNON BOSTON CONCORD

MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION

LEAST COST ALTERNATE

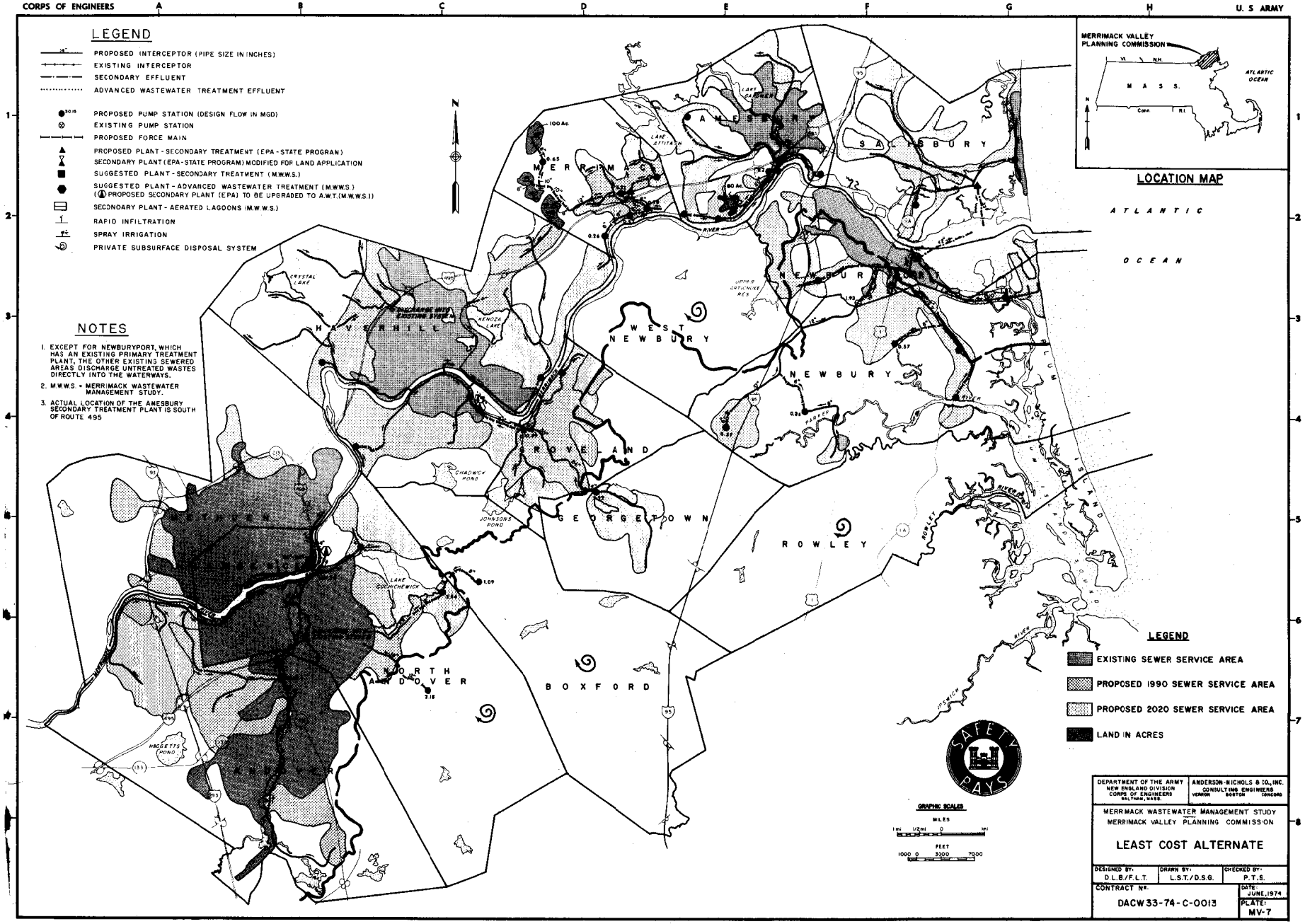
DESIGNED BY:	DRAWN BY:	CHECKED BY:
D.L.B./F.L.T	L.S.T./D.S.G.	P.T.S.

CONTRACT Nº. DACW33-74-C-0013

DATE: JUNE, 1974

PLATE: NM-6

CORPS OF ENGINEERS U. S. ARMY



Methuen, Lawrence, Andover, and North Andover will consist of a water-oriented, advanced wastewater treatment plant discharging to the Merrimack River. In the future, when the need for sewerage is demonstrated, the southern portion of North Andover and the northern portion of Boxford will connect to the Greater Lawrence System.

Haverhill is presently constructing a secondary treatment plant to serve Haverhill and Groveland with discharge to the Merrimack River. To meet the 1983 and 1985 effluent guidelines, the least cost system is one that upgrades the existing secondary plant to an advanced wastewater treatment facility. While all previous water-oriented alternates included Georgetown in the Haverhill-Groveland system, the need for sewerage has not yet been demonstrated there. When the need arises, Georgetown will connect to the Haverhill-Groveland system.

Separate land systems are the least cost choices for Merrimac and Amesbury. Merrimac with a future connection from the Rocks Village area of Haverhill will construct a secondary treatment plant north of I-495, near Turkey Hill. Spray irrigation for the secondary effluent will occur on three sites in western Merrimac. Amesbury will utilize its secondary treatment plant, presently under construction, and discharge to a rapid infiltration site near the Merrimack River as in Alternates 5 and 6.

The least cost alternate for Newburyport, Newbury and Salisbury is the same as Alternate 1 (i. e., a secondary treatment plant at Newburyport serving that town and Newbury and a secondary facility in Salisbury). Both treatment plants would discharge to the Merrimack River estuary.

The remaining towns: Rowley, West Newbury and the southern portion of Boxford will continue with on-lot disposal until the need for sewerage is demonstrated.

c. Sludge Handling and Disposal

In the Northern Middlesex Area Commission, incinerators were located at Billerica, Lowell and Pepperell. While the communities that they serve varies according to the system, the alignment of the sludge handling systems is not critical in determining the least cost alternates - rather the treatment system is important. Therefore, the least cost sludge alternate follows the orientation of the treatment systems. Incinerators will be located in Lowell, Billerica, and Pepperell and service the communities as outlined in Table 6.

TABLE 6

MERRIMACK WASTEWATER MANAGEMENT STUDY

SLUDGE HANDLING AND DISPOSAL SYSTEMS

LEAST COST ALTERNATES

MVPC Community	System
Greater Lawrence Sanitary District (GLSD)	Incinerator
Andover	At GLSD
Methuen	At GLSD
Lawrence	At GLSD
No. Andover	At GLSD
Haverhill	Incinerator
Groveland	At Haverhill
Boxford	--
Georgetown	--
Newbury	At Newburyport
West Newbury	--
Merrimac	To Newburyport
Amesbury	To Newburyport
Salisbury	To Newburyport
Newburyport	Incinerator
Rowley	--

NMAC Community	System
Pepperell	Incinerator
Dunstable	--
Tyngsborough	At Lowell
Westford	To Lowell
Chelmsford	
North	To Lowell
South	At Billerica
Dracut	At Lowell
Lowell	Incinerator
Tewksbury	At Lowell
Billerica	Incinerator

In each of the six alternates in the Merrimack Valley Planning Commission, three incinerator sites were selected, the GLSD, Haverhill and Newburyport, to serve the same communities outlined in Table 6.

Table 6 presents the sludge handling and disposal systems for the least cost alternates in both planning areas.

5. Alternates for the Nashua River and Sudbury-Assabet-Concord River Areas

Wastewater management alternatives for the Nashua River Basin, a sub-basin of the Merrimack River Basin, is included in the report prepared by the Nashua River Program under the jurisdiction of the New England Interstate Water Pollution Control Commission.

Wastewater management alternatives for the Sudbury-Assabet and Concord River Basins (SUASCO), which are also sub-basins of the Merrimack River Basin, are included in the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study prepared jointly by the Commonwealth of Massachusetts (Metropolitan District Commission) and the Corps of Engineers.

D. THE PREFERRED ALTERNATES BY LOCAL INTERESTS

From the selected alternates discussed in Section C, least cost alternates for both the Northern Middlesex and Merrimack Valley planning areas were developed. Least cost is the lowest total expenditure considering both capital and operating costs that can be achieved by combining elements of the various alternates. The methodology and theory of this concept will be discussed in more detail in Appendix III; at this point it is sufficient to note that the least cost alternate involves land application for all treatment facilities with the exception of those in Billerica, Lowell, Greater Lawrence Sanitary District, Haverhill, Newburyport and Salisbury. In addition, it will be noted that the least cost alternates are generally characterized by a utilization of decentralized wastewater treatment facilities as shown in Alternates 1 and 5 (for land and water-oriented technologies, respectively). Figures 3 and 4 display the elements of the least cost alternates for the Northern Middlesex Area Commission and Merrimack Valley Planning Commission, respectively. These least cost alternates are a significant factor in the selection of preferred alternates of each planning area.

1. Northern Middlesex Area Commission Preferred Plan

Figure 5 is the preferred plan of the Northern Middlesex Area Commission. It will be noted that this figure is identical to Alternate 1 as described in Section C. The plan is the most decentralized of any of the water-oriented alternates in the Northern Middlesex Area. The Commission staff favors this plan because it most closely fits into the Commission's water and sewer plans, and because the type of water-oriented wastewater treatment proposed in Alternate 1 is more consistent with existing and proposed land use than is land application. Particular concern was expressed over proposed land application sites for Pepperell and North Chelmsford. Sentiment in Billerica appears to be against a regional solid waste or wastewater treatment facility in that community, although the preferred plan indicates that the treatment of secondary effluent from South Chelmsford would be acceptable for advanced wastewater treatment in Billerica.

2. Merrimack Valley Planning Commission Preferred Plan

The preferred plan of the Merrimack Valley Planning Commission is presented in Figure 6. The plan is an amalgam of Alternates 1, 3 and 6, and includes several elements of the least cost alternate. Specific portions of this plan worthy of note (because they vary from the least cost alternate) include a joint ocean outfall for

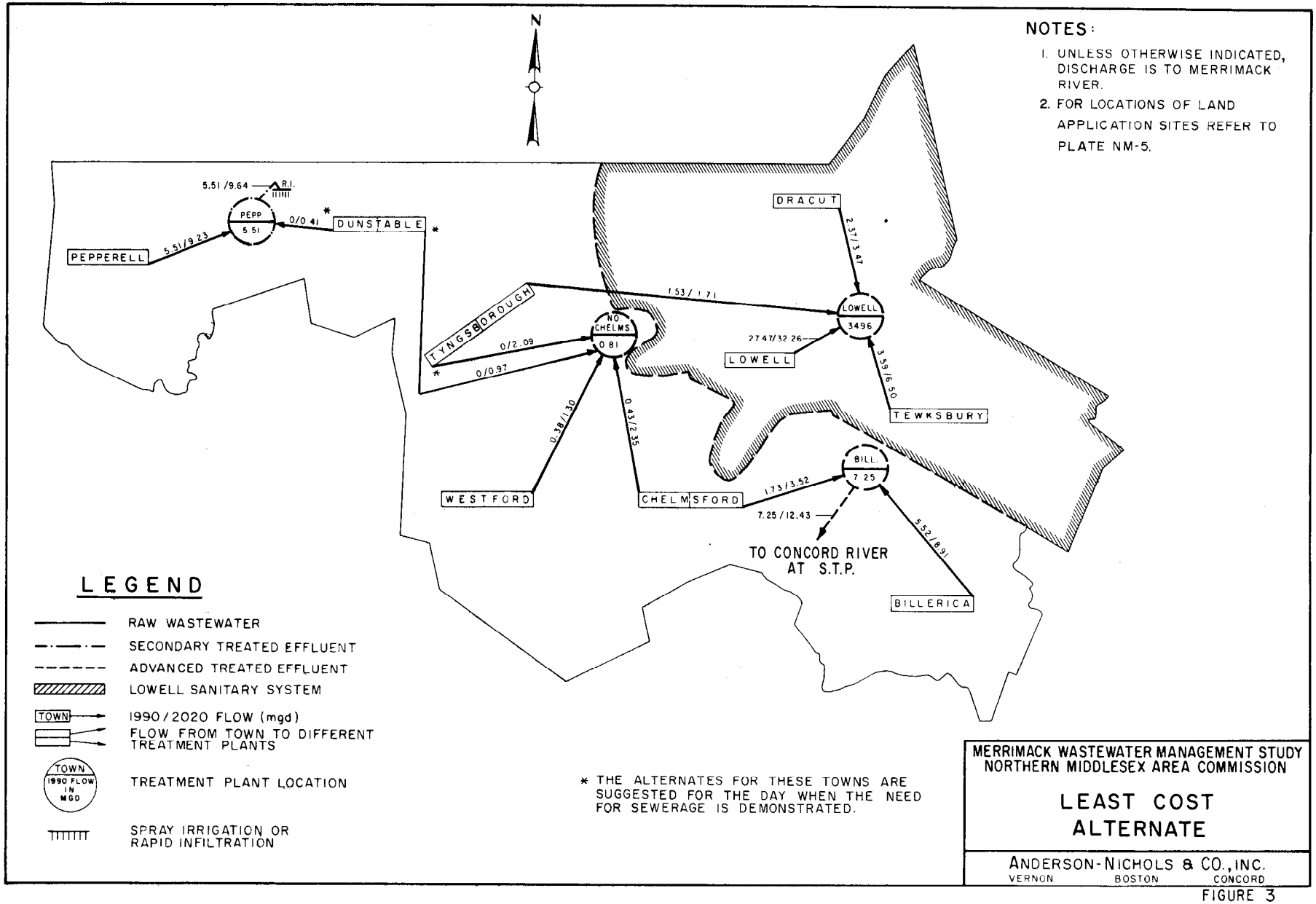

N
NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
2. FOR LOCATIONS OF LAND APPLICATION SITES REFER TO PLATE NM-5.
5.51/9.64
R.I.
PEPP
5.51
0/0.41
DUNSTABLE
PEPPERELL
5.51/9.23
DRACUT
2.37/3.47
1.53/1.71
LOWELL
3496
TYNGSBOROUGH
NO CHELMS
0.81
0/2.09
0/0.97
27.47/32.26
LOWELL
3.59/6.50
TEWKSBURY
0.38/1.30
0.43/2.35
WESTFORD
CHELMSFORD
BILL.
7.25
1.73/3.52
7.25/12.43
TO CONCORD RIVER AT S.T.P.
5.52/8.91
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
SPRAY IRRIGATION OR RAPID INFILTRATION
* THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
LEAST COST ALTERNATE
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 3

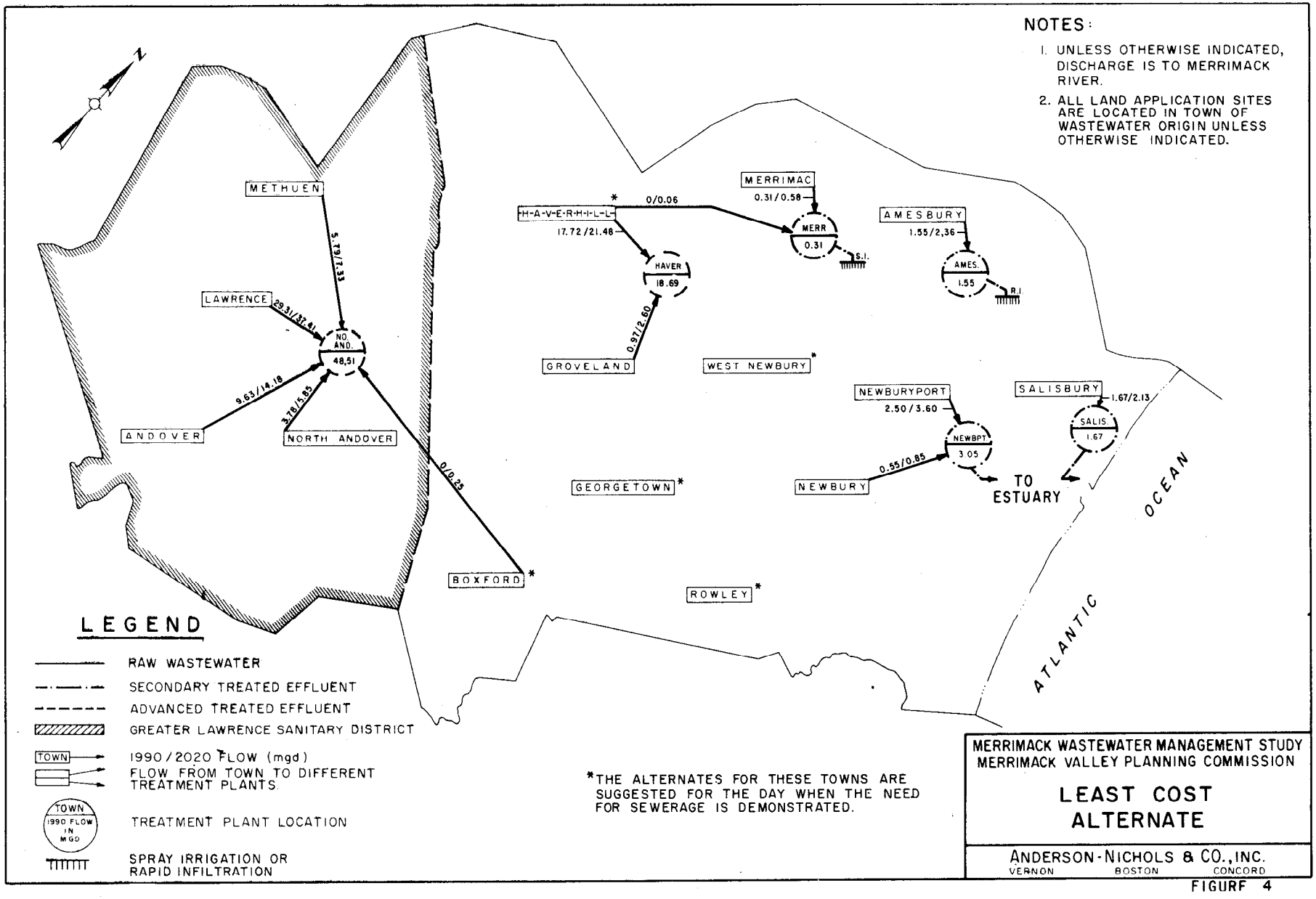

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
2. ALL LAND APPLICATION SITES ARE LOCATED IN TOWN OF WASTEWATER ORIGIN UNLESS OTHERWISE INDICATED.
METHUEN
5.73/7.33
LAWRENCE
29.31/37.41
NO. AND.
48.51
9.63/14.18
3.78/5.85
ANDOVER
NORTH ANDOVER
0/0.25
BOXFORD*
H-A-V-E-R-H-I-L-L
*
0/0.06
17.72/21.48
HAVER
18.69
0.97/2.60
GROVELAND
MERRIMAC
0.31/0.58
MERR
0.31
S.I.
AMESBURY
1.55/2.36
AMES.
1.55
R.I.
WEST NEWBURY*
NEWBURYPORT
2.50/3.60
NEWBPT.
3.05
0.55/0.85
NEWBURY
SALISBURY
1.67/2.13
SALIS.
1.67
TO ESTUARY
GEORGETOWN*
ROWLEY*
ATLANTIC OCEAN
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
SPRAY IRRIGATION OR RAPID INFILTRATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
LEAST COST ALTERNATE
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 4

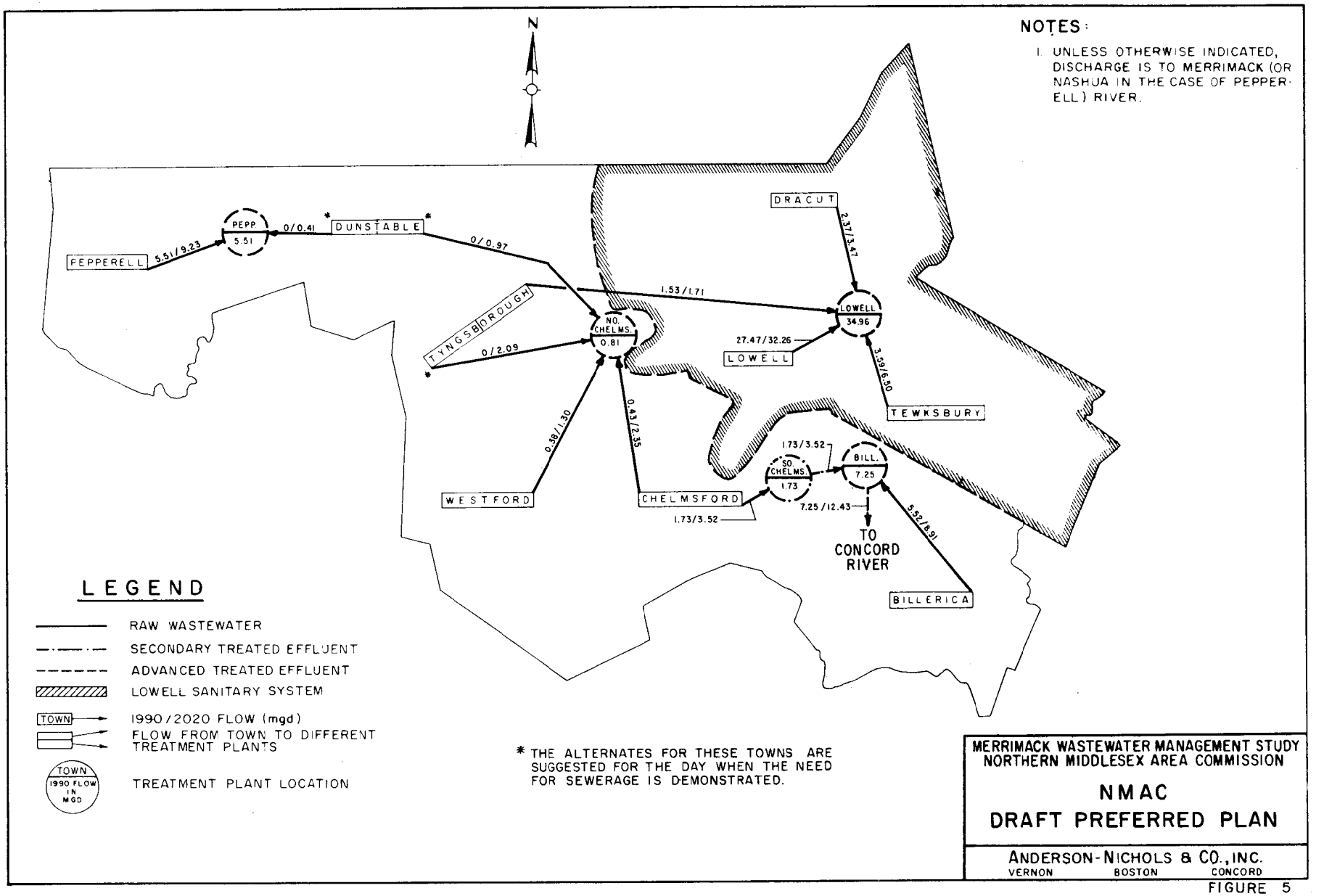

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER.
N
PEPPERELL
5.51/9.23
PEPP
5.51
0/0.41
DUNSTABLE
0/0.97
TYNGSBOROUGH
0/2.09
NO. CHELMS.
0.81
1.53/1.71
DRACUT
2.37/3.47
LOWELL
34.96
27.47/32.26
LOWELL
3.59/6.50
TEWKSBURY
0.38/1.30
WESTFORD
0.43/2.35
CHELMSFORD
1.73/3.52
SO. CHELMS.
1.73
1.73/3.52
BILL.
7.25
7.25/12.43
TO CONCORD RIVER
5.52/8.91
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
* THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
NMAC
DRAFT PREFERRED PLAN
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 5

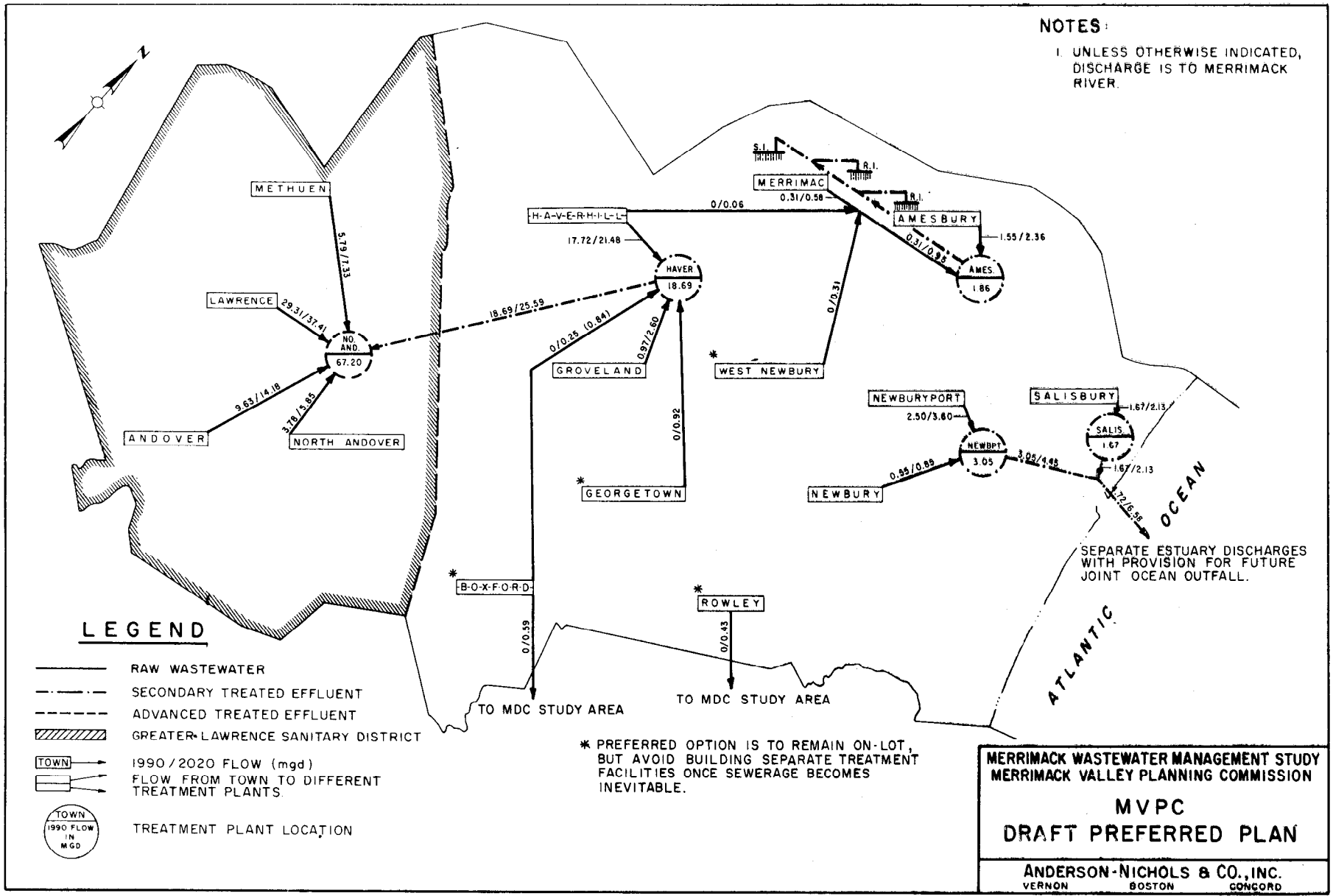

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
N
METHUEN
5.79/7.33
LAWRENCE
29.31/37.41
NO. AND.
67.20
ANDOVER
9.63/14.18
3.78/5.85
NORTH ANDOVER
18.69/25.59
HAVERHILL
17.72/21.48
HAVER
18.69
0/0.06
0/0.25 (0.84)
0.97/2.60
GROVELAND
0/0.92
GEORGETOWN
BOXFORD
0/0.59
TO MDC STUDY AREA
ROWLEY
0/0.43
TO MDC STUDY AREA
S.I.
R.I.
MERRIMAC
0.31/0.56
AMESBURY
1.55/2.36
0.31/0.98
AMES
1.86
0/0.31
WEST NEWBURY
NEWBURYPORT
2.50/3.60
NEWBPT
3.05
0.95/0.89
NEWBURY
3.05/4.45
SALISBURY
1.67/2.13
SALIS.
1.67
1.67/2.13
7.2/6.58
OCEAN
ATLANTIC
SEPARATE ESTUARY DISCHARGES WITH PROVISION FOR FUTURE JOINT OCEAN OUTFALL.
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
* PREFERRED OPTION IS TO REMAIN ON-LOT, BUT AVOID BUILDING SEPARATE TREATMENT FACILITIES ONCE SEWERAGE BECOMES INEVITABLE.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
MVPC
DRAFT PREFERRED PLAN
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 6

the Salisbury and Newburyport secondary treatment plants, joint treatment by Amesbury and Merrimac with final effluent disposal by spray irrigation (during the growing season) and rapid infiltration during cold weather, and advanced wastewater treatment of secondary effluent from the Haverhill treatment plant at a regional advanced wastewater treatment plant of the Greater Lawrence Sanitary District. In addition, the plan calls for West Newbury, Georgetown, Boxford and Rowley to retain, if possible, their on-lot disposal systems. If, however, the need for sewerage does arise, the plan envisions Rowley and South Boxford connecting to sewer systems within the MDC Study Area, North Boxford and Georgetown to the Haverhill system, and West Newbury to the Merrimac - Amesbury facility.

The joint Salisbury and Newburyport ocean outfall was recommended as a method of eliminating the estuary outfall while accommodating the expressed desire of Salisbury not to enter into a sanitary district with Newburyport. Joint treatment by Amesbury and Merrimac was suggested as a means of improving cooperation between the two communities, particularly in relation to the protection and improvement of Lake Attitash, and as a way of enabling both Amesbury and Merrimac to participate in the combined rapid infiltration and spray irrigation disposal system (Amesbury, if it were to treat its wastes alone, would have only rapid infiltration as a land option). The advanced treatment of secondary effluent from Haverhill at the Greater Lawrence facility would eliminate a large volume of discharge from tidal waters, and the discharge could be used to augment flow in the river between Lawrence and Haverhill. In addition, such a plan would create a transmission corridor along the river which could be utilized for recreation or land planning.

3. Impact Plan

The wastewater treatment systems recommended for the two regional planning agencies as a result of impact evaluation, (those elements producing the most positive or least adverse impacts in each of the four disciplines studied), are shown in Figures 7 and 8. The evaluation of the different alternates is based upon impacts of the plan more universal than those dealing with cost or regional preferences. The general criteria that was used involves energy requirements, hygienic impacts, aesthetic, socio-economic and biological considerations and treatment plant reliability. As shown in Figures 7 and 8, criteria favor land application and decentralized facilities. Resource requirements for land treatment are less than for water-oriented treatment. Decentralized systems are favored since the long pipelines and pumping facilities required by regional treatment alternates

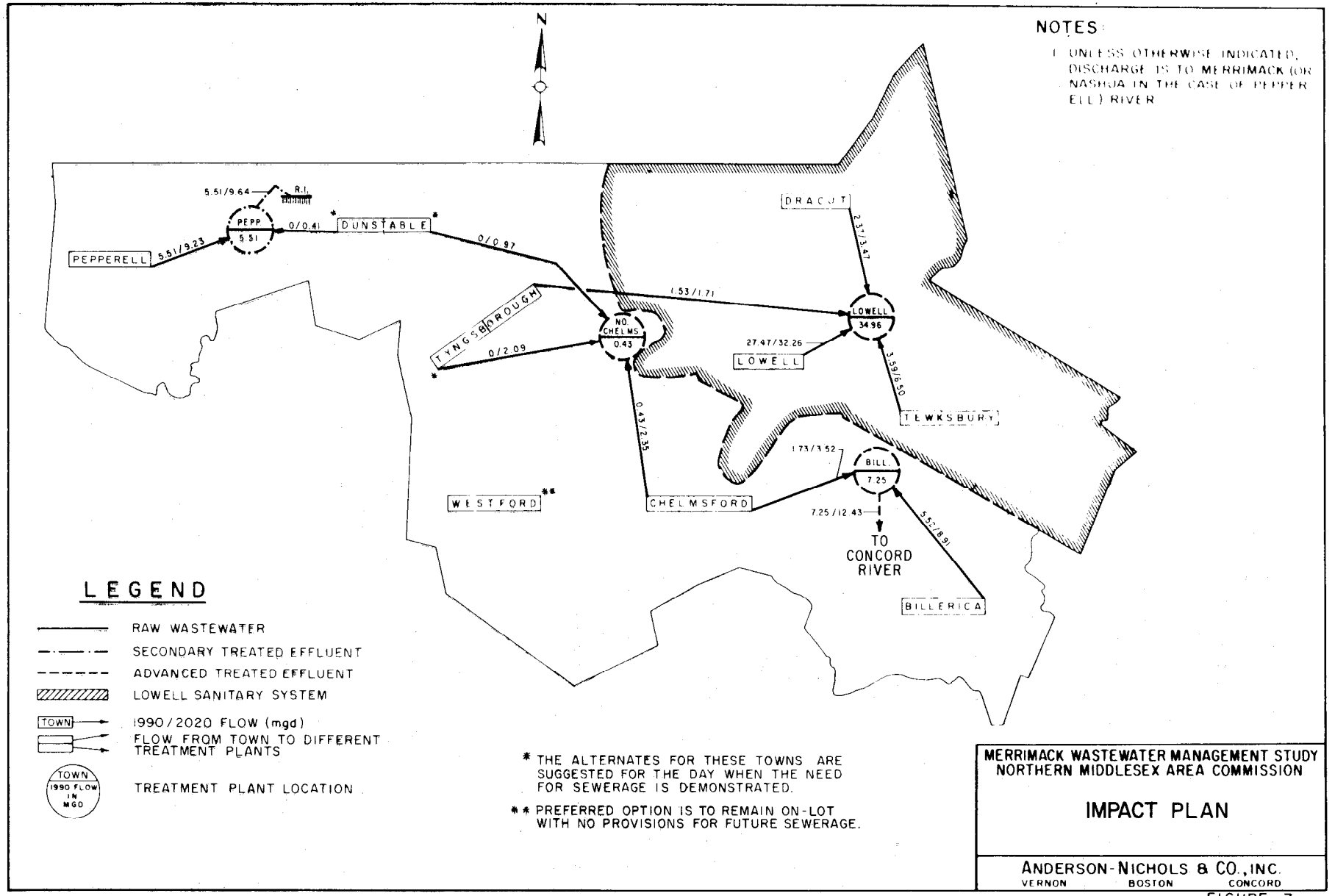

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER
N
PEPPERELL
5.51/9.23
PEPP
5.51
5.51/9.64
R.I.
0/0.41
DUNSTABLE
0/0.97
TYNGSBOROUGH
0/2.09
NO. CHELMS.
0.43
1.53/1.71
DRACUT
2.37/3.47
LOWELL
34.96
27.47/32.26
LOWELL
3.59/6.50
TEWKSBURY
0.43/2.35
CHELMSFORD
WESTFORD
1.73/3.52
BILL.
7.25
7.25/12.43
5.52/8.91
TO CONCORD RIVER
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
* THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
** PREFERRED OPTION IS TO REMAIN ON-LOT WITH NO PROVISIONS FOR FUTURE SEWERAGE.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
IMPACT PLAN
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 7

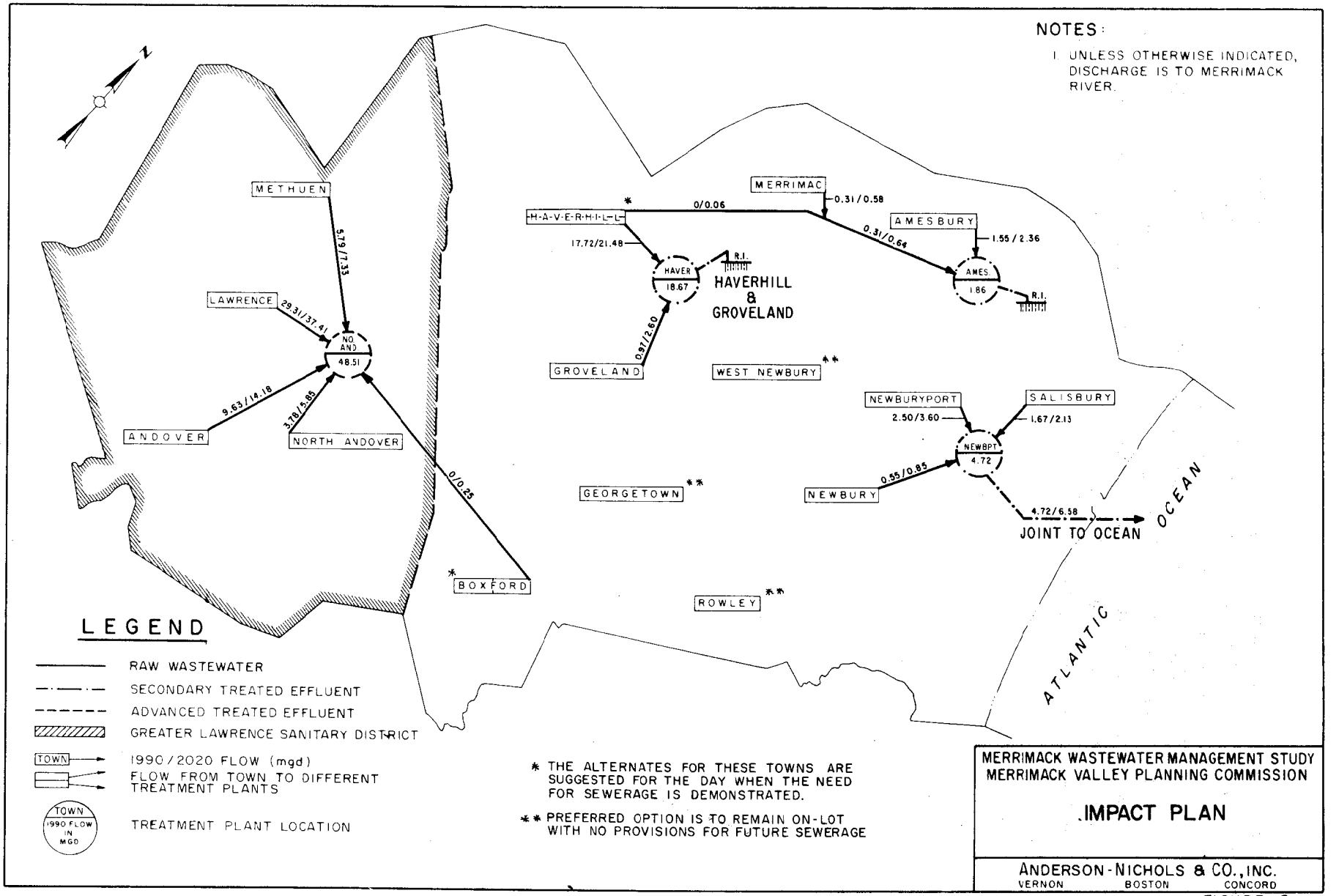

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
METHUEN
5.19/7.33
LAWRENCE
29.31/37.41
NO. AND
48.51
ANDOVER
9.63/14.18
3.78/5.85
NORTH ANDOVER
0/0.25
BOXFORD
MERRIMAC
0.31/0.58
HAVERHILL
0/0.06
AMESBURY
1.55/2.36
17.72/21.48
HAVER
18.67
R.I.
HAVERHILL & GROVELAND
0.97/2.60
GROVELAND
WEST NEWBURY
AMES.
1.86
R.I.
NEWBURYPORT
2.50/3.60
SALISBURY
1.67/2.13
NEWBPT
4.72
0.55/0.85
NEWBURY
GEORGETOWN
4.72/6.58
JOINT TO OCEAN
OCEAN
ATLANTIC
ROWLEY
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
* THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
** PREFERRED OPTION IS TO REMAIN ON-LOT WITH NO PROVISIONS FOR FUTURE SEWERAGE
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
IMPACT PLAN
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 8

are a potential source of system failure, and because the impact that a transmission line or treatment plant failure might have is related to the quantity of flow in the system, and decentralized systems have smaller flows than do centralized ones. Wastewater discharge by land application enables the buffering action of the soil and groundwater to be used against treatment plant upset, and the removal of a direct discharge to a waterway eliminates any negative hygienic impact that such a discharge might have.

E. THE PREFERRED PLAN

Introduction

As noted throughout this appendix, the process of arriving at a "preferred plan" has been an iterative one which commenced with a comprehensive "laundry list" of all possible options. This listing was then subjected to a series of technical screenings conducted with the active participation of the public through formal public hearings, workshops, meetings with individual citizens and town officials, and input and guidance from the Citizen's Advisory Group. The result of the technical screenings was a set of final alternatives (six in the Merrimack Valley Planning Commission and five in the Northern Middlesex Area Commission) upon which designs were based and costs developed. On the basis of cost alone (capital and operation and maintenance), a least cost alternate was prepared for each of the two regional planning agencies.

At the same time as the final alternates were being costed by the contractor for the engineering and systems designs, other contractors were preparing the biological, socio-economic, legal and institutional, aesthetic, and hygienic impact assessments of each of the final alternates. The costs, assessments and input from the public participation program were integrated into the Preferred Plan presented in this section.

In those cases where the costs and the various impact assessments favored differing alternates, the communities involved were extended the opportunity to present their personal preference to the Merrimack Technical Sub-committee. In most cases the Least Cost Alternate satisfied the treatment orientation preferred by the affected communities, however, in some communities, such as Amesbury and Merrimac where the two towns desired joint treatment with land disposal, the Preferred Plan is very different from any of the alternates previously considered. Other communities in which the Preferred Plan differs from the Least Cost Alternate are Boxford, Newburyport and Salisbury. In the future, if sewerage is needed sewage from Boxford would be transported to Haverhill instead of to the GLSD facility as proposed in the Least Cost Alternate. Salisbury would discharge to land application by rapid infiltration rather than discharging secondary effluent to the estuary; and Newburyport would construct a conventional advanced treatment facility.

The Preferred Plan which is presented in detail in the following pages was developed jointly by all of the members of the study team taking the following into consideration:

- Public participation, including: comments made at public hearings; correspondence from private citizens and public officials; meetings with citizens and public officials; and input from the Regional Planning Agencies.

- Cost data on each of the technical alternates, including the Least Cost Alternate.

- Impact assessment including: environmental, socio-economic, technical, hygienic, aesthetic, and legal and institutional. These assessments were expressed in the form of a Minimum Impact Alternative.

1. The Preferred Plan

The information on the following pages presents by Town a description of the Preferred Plan which includes collection and treatment proposals for dealing with combined flow as well as domestic/industrial wastewater.

a. Northern Middlesex Area Commission

The Preferred Plan for the Northern Middlesex Area Commission is presented on Figure 9.

Billerica - The EPA-State Implementation Program calls for secondary treatment of wastewater from Billerica. This is presently provided by a 0.8 mgd (to be expanded to 1.6 mgd in 1974) extended aeration treatment plant in Billerica. A wastewater collection system is gradually being expanded to meet the future needs of the town. Since there are no combined interceptors, separate stormwater is discharged to local waterways. The Preferred Plan, shown in Figure 9 is the same as the Least Cost Alternate (i.e., the treatment plant at Billerica will be upgraded to provide advanced wastewater treatment and expanded to handle wastewater from south Chelmsford and the expected increased flow from Billerica). Under the conceptual design for this study (see Appendix III), it is proposed that secondary treatment capacity be provided for all towns with existing collection systems or with systems expected to be constructed by 1990. Since the expansion of Billerica's plant is near completion, it is anticipated that the plant will have adequate capacity for the gradual construction and expansion of the collection system in Billerica and south Chelmsford. By 1983, multi-media filters will be added for use until 1985,

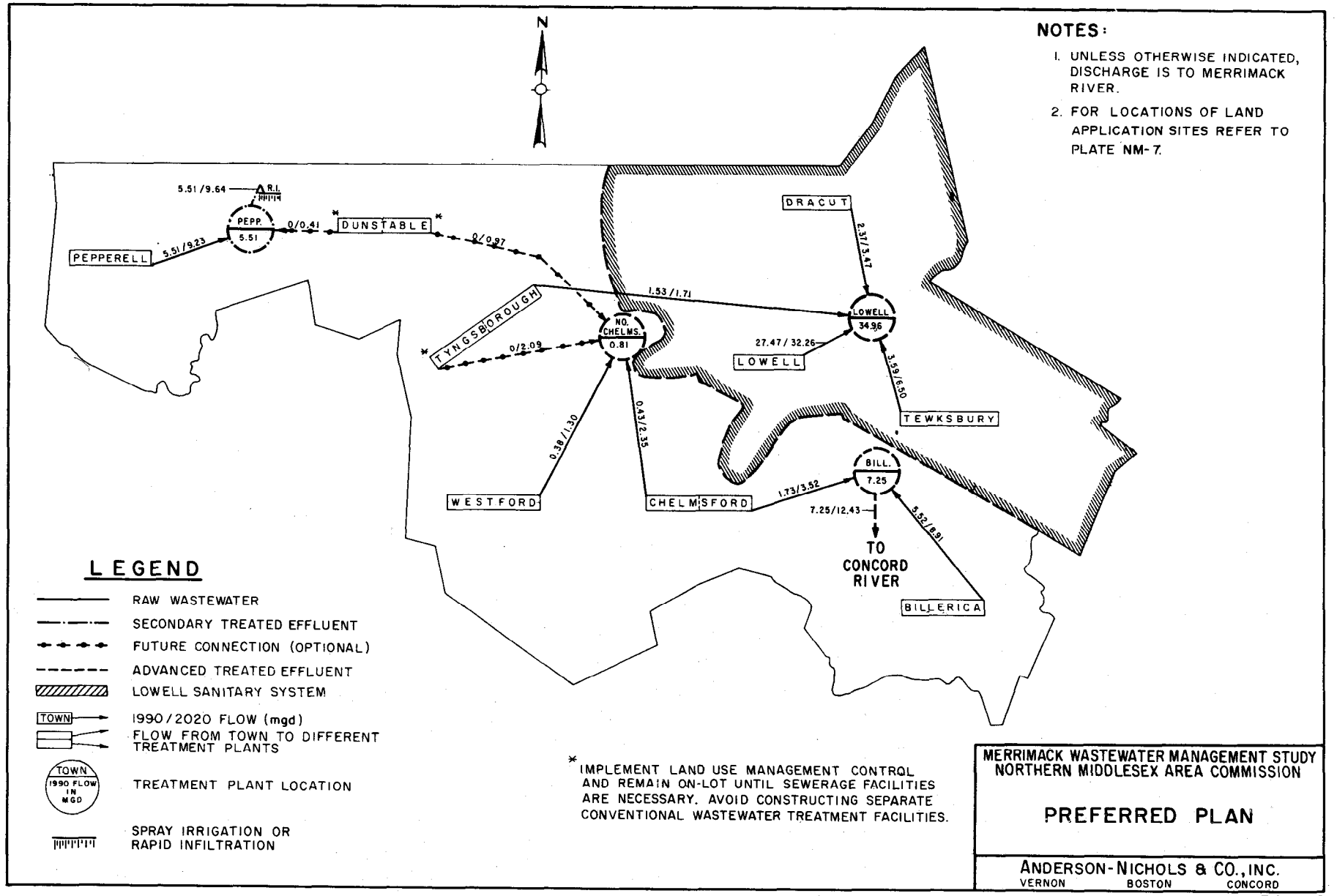

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
2. FOR LOCATIONS OF LAND APPLICATION SITES REFER TO PLATE NM-7.
N
PEPPERELL
5.51/9.23
5.51/9.64
R.I.
PEPP.
5.51
0/0.41
DUNSTABLE
0/0.97
TYNGSBOROUGH
0/2.09
NO. CHELMS.
0.81
1.53/1.71
DRACUT
2.37/3.47
LOWELL
34.96
27.47/32.26
LOWELL
3.59/6.50
TEWKSBURY
0.38/1.30
WESTFORD
0.43/2.35
CHELMSFORD
1.73/3.52
BILL.
7.25
7.25/12.43
TO CONCORD RIVER
5.52/8.91
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
FUTURE CONNECTION (OPTIONAL)
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
SPRAY IRRIGATION OR RAPID INFILTRATION
* IMPLEMENT LAND USE MANAGEMENT CONTROL AND REMAIN ON-LOT UNTIL SEWERAGE FACILITIES ARE NECESSARY. AVOID CONSTRUCTING SEPARATE CONVENTIONAL WASTEWATER TREATMENT FACILITIES.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
PREFERRED PLAN
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 9

when the secondary units will be expanded along with construction of new advanced treatment units. While the costs have to be calculated on this phasing of the plan, advanced treatment should be considered prior to 1985 in this particular case due to the low flow conditions in the Concord River.

Chelmsford (North) - The EPA-State Implementation Program for Chelmsford initially recommended the discharge of 5.0 mgd to the Lowell treatment plant with any excess flow to be treated at a plant in north Chelmsford. As an alternative to this system a plant located in north Chelmsford and treating all of Chelmsford's wastewater was investigated and found to be comparable in cost to the regional plan. Chelmsford is presently awaiting the results of this study and the State's Merrimack River Basin Plan before further local action is initiated. The Preferred Plan recommends the system presented as the Least Cost Alternate (i.e., construct an advanced wastewater treatment plant in north Chelmsford serving north Chelmsford and parts of Westford and the western portion of Tyngsborough and east Dunstable should they demonstrate a need for sewerage sometime in the future). The phased construction calls for completion by 1977 of secondary treatment facilities to handle north Chelmsford and Westford wastewater, and a collection system and interceptors to receive wastewater from north Chelmsford, Westford, Tyngsborough, and Dunstable. In 1983 best practicable treatment will be provided followed in 1985 by advanced wastewater treatment.

A long outfall discharging into the Merrimack River at a point downstream from the Lowell water treatment plant intake has been included in the Preferred Plan.

Chelmsford (South) - As discussed under Chelmsford (north), the EPA - State Implementation Program is not finalized for Chelmsford. The Preferred Plan recommends that the Least Cost Alternate be adopted (i.e., raw wastewater is discharged to Billerica for advanced treatment). While costs have been calculated on the basis of complete sewering of the 1990 service area by 1977, it is expected that the collection system will be constructed gradually. The expansion of the secondary plant in Billerica makes it possible for the two communities to delay expansion of the secondary plant until 1985.

Dracut - The EPA - State Implementation Program specifies that Dracut connect its collection system to Lowell's collection system

for secondary treatment at the proposed Lowell treatment plant. Construction of the Lowell plant will be underway in the near future; while final design is being completed upon Dracut's sewerage system which will also accept a portion of Tyngsborough's wastewater.

The Preferred Plan is the same as the Least Cost Alternate in which raw wastewater from Dracut and east Tyngsborough is discharged to Lowell for advanced wastewater treatment. The interceptor system connecting east Tyngsborough to Dracut to Lowell should be constructed by 1977. The remaining collection laterals can be constructed as the need arises. The scheduling for treatment is discussed under Lowell.

Dunstable - At this time, there are no requirements for sewerage in Dunstable under the EPA - State Implementation Program since private subsurface disposal systems are presently adequate. The Preferred Plan calls for continued use of these systems providing that proper land use controls are introduced and enforced to maintain the low industrial, commercial and residential densities.

Should Dunstable decide to accelerate and concentrate its growth patterns, resulting in a need for sewerage, the Preferred Plan recommends that west Dunstable, the area west of Massapoag Pond, construct a sewer network to discharge into Pepperell's system for secondary and best practicable treatment followed in 1985 by application to the land via rapid infiltration basins. East Dunstable would construct its collection system to discharge to Chelmsford via Tyngsborough for advanced wastewater treatment at a treatment plant located in north Chelmsford.

Lowell - As part of the EPA - State Implementation Program construction has begun on a secondary treatment plant located on Duck Island and serving Lowell, Dracut, Tewksbury, and a portion of Tyngsborough. The collection interceptors in Lowell are sized at 3.5 times the Lowell dry weather flow in 2015 plus wastewater flow from the other three communities. During intense storms, combined flow would overflow the system and discharge directly to the Merrimack River.

Under the Preferred Plan both wastewater and combined flow systems are the same as in the Least Cost Alternate. The wastewater collection system will carry the peak dry weather flow from all four towns, while an independent combined system serving Lowell alone will carry a two year frequency storm to subsurface combined flow storage tanks. Collection and secondary treatment of combined

and dry weather flow will be provided by 1977. For best practicable treatment by 1983 and advanced wastewater treatment in 1985, the treatment area will be expanded by filling a portion of the Merrimack River next to the existing plant site.

Pepperell - Under the EPA - State Implementation Program, a secondary treatment plant discharging to the Nashua River is proposed to service Pepperell.

For the Preferred Plan, which is the same as the Least Cost Alternate, a secondary plant is proposed to be on line by 1977 followed in 1983 by best practicable treatment. In 1985, land application via rapid infiltration basins would be provided to accomplish advanced wastewater treatment.

While the treatment facilities will be sized to handle only wastewater from Pepperell, the collection system will be sized to accommodate west Dunstable which may require sewerage at some future date.

Tewksbury - As discussed under Lowell, the EPA - State Implementation Program calls for Tewksbury to connect to the Lowell collection system for secondary treatment in Lowell. The Preferred Plan is the same as the Least Cost Alternate which recommends secondary treatment in Lowell by 1977, best practicable treatment by 1983, and advanced wastewater treatment by 1985.

Tyngsborough (East) - As discussed under Lowell and Dracut, in the EPA - State Implementation Program, a portion of Tyngsborough will connect to the Dracut collection system for secondary treatment at Lowell.

The Preferred Plan is the same as the Least Cost Alternate. While the immediate need for sewers is in the Mascuppic Lake area, the Preferred Plan provides for sewerage of all areas of Tyngsborough lying east of the Merrimack River. By 1977 secondary treatment will be provided at the Lowell plant, followed in 1983 by best practicable treatment and in 1985 by advanced wastewater treatment.

Tyngsborough (West) - At this time there are no requirements for sewerage in west Tyngsborough which is that area lying west of the Merrimack River, since private subsurface disposal systems are presently adequate. The Preferred Plan calls for continued use of these systems providing that land use controls are applied.

Should west Tyngsborough decide to accelerate and concentrate its growth patterns, resulting in a need for sewerage, the Preferred

Plan recommends that its wastewater be discharged to north Chelmsford for advanced wastewater treatment. If agreements can be made with Dunstable, the collection system should be sized to accommodate the additional flow from east Dunstable.

Westford - There is no sewer system proposed for Westford under the EPA - State Implementation Program.

The Preferred Plan proposes that wastewater from Westford be discharged to the Chelmsford collection system for treatment at the north Chelmsford plant.

The collection system proposed under the Preferred Plan is to carry flow from Westford with initial construction of interceptors connecting to Chelmsford in 1977 and gradual expansion of the rest of the system as the need arises. Since sewerage problems presently exist only in the limited developed areas of Westford, it is proposed that proper land use control be developed and implemented to limit the need for future sewer system expansion.

b. Merrimack Valley Planning Commission

The Preferred Plan for the Merrimack Valley Planning Commission is presented on Figure 10.

Amesbury - The EPA - State Implementation Program calls for secondary treatment of wastewater from Amesbury. The town is presently constructing a 1.9 mgd secondary treatment plant and new interceptors to connect the existing collection system to the plant.

The Preferred Plan for Amesbury is quite different from the Least Cost Alternate. The secondary treatment plant will service by 1977 Amesbury and Merrimac with multi-media filters being added in 1983 to provide best practicable treatment. In 1985, the temporary outfall to the Merrimack River will be abandoned and the treated effluent discharged to rapid infiltration basins in Amesbury and spray irrigation sites located in Amesbury and Merrimac. Rapid infiltration will occur 6 months of the year, from mid-October to mid-April, followed by spray irrigation during the growing season.

The intercepting system connecting Merrimac to the Amesbury treatment plant must be constructed by 1977. Collection laterals may be constructed as the need arises.

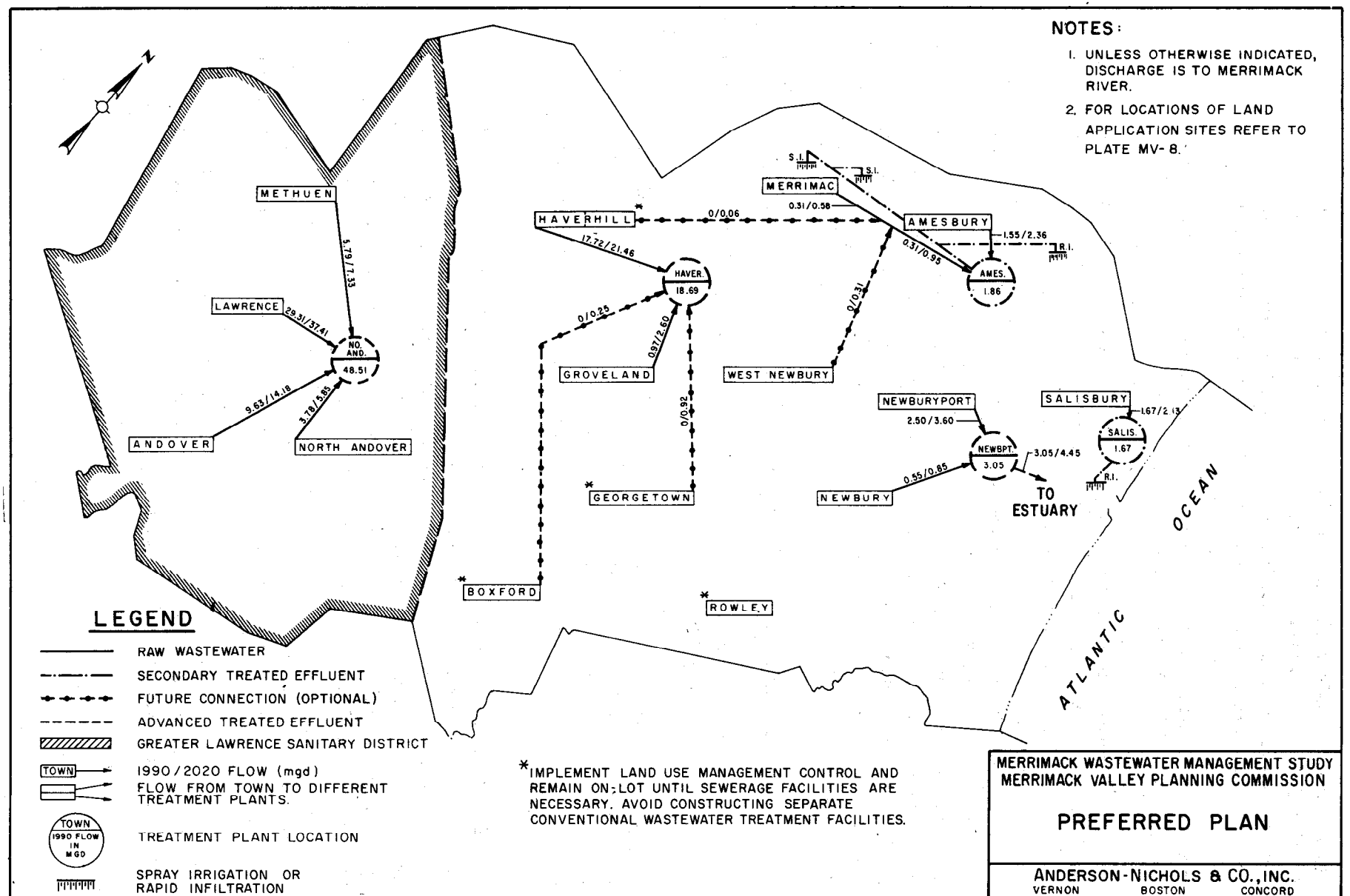

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
2. FOR LOCATIONS OF LAND APPLICATION SITES REFER TO PLATE MV-8.
METHUEN
1.79/7.33
LAWRENCE
29.31/37.41
NO. AND.
48.51
9.63/14.18
3.78/5.85
ANDOVER
NORTH ANDOVER
HAVERHILL
0/0.06
17.72/21.46
HAVER.
18.69
0/0.25
0.97/2.60
0/0.92
GROVELAND
GEORGETOWN
BOXFORD
ROWLEY
MERRIMAC
S.I.
0.31/0.58
AMESBURY
1.55/2.36
R.I.
0.31/0.95
AMES.
1.86
0/0.31
WEST NEWBURY
NEWBURYPORT
2.50/3.60
NEWBPT.
3.05
3.05/4.45
0.55/0.85
NEWBURY
TO ESTUARY
SALISBURY
1.67/2.13
SALIS.
1.67
R.I.
ATLANTIC
OCEAN
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
FUTURE CONNECTION (OPTIONAL)
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS.
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
SPRAY IRRIGATION OR RAPID INFILTRATION
*IMPLEMENT LAND USE MANAGEMENT CONTROL AND REMAIN ON-LOT UNTIL SEWERAGE FACILITIES ARE NECESSARY. AVOID CONSTRUCTING SEPARATE CONVENTIONAL WASTEWATER TREATMENT FACILITIES.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
PREFERRED PLAN
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 10

Andover - The town is a part of the Greater Lawrence Sanitary District (GLSD) which under the EPA - State Implementation Program is now constructing a 52.0 mgd secondary treatment plant in North Andover. Other towns included in the GLSD are Lawrence, Methuen, and North Andover. Interceptors along the Merrimack and Shawsheen Rivers will carry the flow from Andover through Lawrence to the treatment plant.

Under the Preferred Plan, Andover connects to the GLSD by 1977 as proposed in the EPA - State Program. To upgrade the secondary plant to meet the goals of PL 92-500, multi-media filters will be added in 1983 followed by advanced wastewater treatment units in 1985.

Boxford - At this time there are no requirements for sewerage in Boxford since private subsurface disposal systems are adequate. The Preferred Plan calls for continued use of these systems provided that land use controls be implemented.

Should Boxford decide to accelerate and concentrate its growth patterns, resulting in a need for sewerage, the Preferred Plan recommends that the southern portion of Boxford connect to proposed regional wastewater treatment facilities in Hamilton, Massachusetts while north Boxford should connect to the Georgetown sewer system for conveyance and advanced treatment in Haverhill.

Georgetown - At this time there are no requirements for sewerage in Georgetown under the EPA - State Implementation Program since private subsurface disposal systems are presently functioning adequately. The Preferred Plan calls for continued use of these systems with the implementation of strict land use controls.

Should Georgetown decide to accelerate and concentrate its growth patterns, resulting in a need for sewerage, the Preferred Plan recommends that Georgetown construct a sewer system to carry flow from north Boxford and Georgetown to the Groveland sewer system for advanced treatment in Haverhill.

Groveland - As part of the EPA - State Implementation Program, Groveland is proposed to connect to the 18.11 mgd secondary treatment plant presently under construction in Haverhill. The initial phase of interceptors, pumping station, and force main connecting to the plant are now also under construction.

Under the Preferred Plan, it is recommended that Groveland connect to the Haverhill treatment plant by 1977 but that allowance be made in the intercepting system to handle future flows from Georgetown and the northern part of Boxford. In 1983, best practicable

treatment of Groveland's wastewater will be provided in Haverhill, followed by advanced treatment in 1985. Collection laterals can be constructed gradually as the need arises; while the interceptor system connecting Georgetown and Groveland can be constructed either when sewage collection in that area of Groveland is needed or when Georgetown is ready to construct a sewer system.

Haverhill - Under the EPA - State Implementation Program construction has started on an 18.11 mgd secondary treatment plant in Haverhill as well as interceptors along the Merrimack River.

The Preferred Plan for Haverhill recommends construction by 1977 of new interceptors to carry combined and dry weather flow to combined flow storage tanks ahead of the secondary treatment plant which will handle the dry and equalized wet weather flows. Best practicable and advanced wastewater treatment units will be added in 1983 and 1985, respectively.

In the Rocks Village area, of east Haverhill, under both the EPA-State Implementation Program and the Preferred Plan there are no requirements for sewerage. Should sewerage become necessary for this area, the Preferred Plan recommends that the flow be connected to Merrimac's sewer system for conveyance and treatment in Amesbury.

Lawrence - This city has proceeded under the EPA-State Implementation Program to join the Greater Lawrence Sanitary District which is presently constructing a 52.0 mgd secondary treatment plant in North Andover, a pumping station and force main to lift all dry weather wastewater to the plant, and interceptors in Lawrence to carry all dry weather and combined flow from Andover, Lawrence, Methuen, and North Andover to the pumping station.

The Preferred Plan considers these units as "given", but for 1977 recommends that combined flow storage tanks be constructed to detain the combined flow for discharge to the wastewater collection system after the peak storm flow has passed. In addition, best practicable treatment and advanced wastewater units will be added in 1983 and 1985, respectively. Outlying collection laterals will be constructed as needed.

Merrimac - Under the EPA - State Implementation Program Merrimac was to construct a 0.53 mgd secondary treatment plant serving Merrimac alone.

The Preferred Plan recommends that Merrimac and Amesbury join together by 1977 to treat their wastewater at a secondary treatment plant now under construction in Amesbury. Multi-media filters would be added by 1983. In 1985, a program of land application using the techniques of rapid infiltration during the cold months, mid-October thru mid-April, and spray irrigation during the remaining months would provide advanced treatment.

The interceptor system extending from Merrimac to Amesbury would be constructed by 1977 and would contain an allowance for future connections from east Haverhill and West Newbury. Local collection laterals could be constructed after 1977 as the need arises.

Methuen - A member of the Greater Lawrence Sanitary District, Methuen, under the EPA - State Implementation Program, will use the 52.0 mgd secondary treatment plant in North Andover, the pumping station and force main lifting wastewater into the plant, and interceptors in Lawrence carrying all flow to the pumping station.

The Preferred Plan for Methuen is the same as for Lawrence, Andover, and North Andover in which the secondary plant will be upgraded to best practicable treatment in 1983 and advanced wastewater treatment in 1985. Interceptors connecting Methuen to the Lawrence collection system must be constructed by 1977, while outlying collection laterals may be constructed as the need arises.

Newbury - The EPA - State Implementation Program calls for Newbury to enter a proposed 3.40 mgd secondary treatment plant in Newburyport. The Preferred Plan likewise recommends construction of an intercepting system that connects to Newburyport for secondary treatment by 1977. This Plan proposes that the Newburyport plant then be upgraded to best practicable treatment by 1983 and advanced wastewater treatment by 1985.

Newburyport - As mentioned under Newbury, the EPA - State Implementation Program designates that a 3.40 mgd secondary treatment plant be constructed in Newburyport to upgrade an existing primary treatment facility. New collection facilities are proposed to carry all dry weather and combined flow to the proposed plant.

The Preferred Plan also recommends a secondary plant, one constructed by 1977, and adds multi-media filtration and advanced wastewater treatment for 1983 and 1985, respectively, with discharge of the treated wastewater into the Merrimack River estuary.

Interceptor facilities sized to carry Newbury and Newburyport wastewater will be constructed in 1977, while outlying collection laterals connecting to the existing system can be constructed at a later date.

Should Salisbury's proposed rapid infiltration system not be acceptable to the State, the Preferred Plan recommends that its secondary treated effluent be connected directly to the advanced treatment units at Newburyport.

North Andover - As part of the Greater Lawrence Sanitary District, North Andover will have its wastewater treated at a 52.0 mgd facility being constructed in North Andover.

The Preferred Plan recommends that the GLSD facility be upgraded to best practicable treatment in 1983 and advanced wastewater treatment in 1985. No new interceptors to the GLSD interceptors are required but proportionate costs for these interceptors will be paid by North Andover.

In the southern portion of North Andover, sewerage is not required under the Implementation Program or the Preferred Plan, since private subsurface disposal systems are presently adequate. Should sewerage become necessary, this portion of North Andover would connect to the existing North Andover collection system.

Rowley - At this time there are no requirements for sewerage in Rowley under both the EPA - State Implementation Program and the Preferred Plan, since private subsurface disposal systems are adequate at this time. The Preferred Plan calls for continued use of these systems as long as strict land use controls are implemented.

Should Rowley select to accelerate and concentrate its growth patterns, resulting in a need for sewerage, evaluation of the Rowley situation should be made by others under the proposed Parker River Basin Planning Study.

Salisbury - To comply with the EPA - State Implementation Program, a 1.5 mgd secondary treatment plant has been proposed for Salisbury. Under the Preferred Plan secondary treatment is proposed for 1977, followed by multi-media filtration in 1983 and land application of the effluent via rapid infiltration basins in 1985. Some major interceptors and collection laterals will be constructed by 1977 but much of the collection system will be constructed as the need arises.

Should the State find the technique of rapid infiltration unacceptable in this instance, the secondary effluent would be pumped across the river to Newburyport for best practicable and advanced wastewater treatment.

West Newbury - At this time there are no requirements for sewerage in West Newbury under the EPA - State Implementation Program since private subsurface disposal systems are presently adequate. The Preferred Plan calls for continued use of these systems provided that strict land use controls are implemented.

Should West Newbury decide to accelerate and concentrate its growth patterns, resulting in a need for sewerage, the Preferred Plan proposes that its wastewater be connected to the Merrimac sewer system for conveyance and ultimate treatment in Amesbury followed by land application via rapid infitration and spray irrigation.