PART I

INTRODUCTION AND HISTORY

Chapter 1
INTRODUCTION

Through the medium of newspaper and radio publicity and frequently by direct experience, residents of Seattle and its surrounding communities have become acutely aware of the fact that the metropolitan area is currently faced with serious problems of sewerage and drainage. In addition to the significance of these problems from the standpoint of public health, it is now recognized that they involve such matters as individual safety and comfort, recreational activity, industrial productivity, and the value of land and property. If not resolved, sewerage and drainage deficiencies will become increasingly serious and will emerge sooner or later as a major obstacle to continued growth and development of the entire metropolitan community.

Sewerage and drainage problems are a matter of concern not only to the metropolitan area itself but to the state of Washington and the counties of King, Snohomish and Kitsap. The state is concerned because of its responsibility for the control of water pollution, and because metropolitan Seattle is its most populous, most productive and, economically, its most valuable area. King and Snohomish counties are concerned because they are direct contributors of sewage and drainage and because they are affected directly by any adverse conditions stemming from sewage and industrial wastes disposal operations in the metropolitan area. Kitsap county may be said to be a sideline observer, the interests of which will be affected detrimentally by any failure to resolve present problems. But the position of Seattle is unique. Aside from being the major producer of sewage and drainage, it lies across the major drainage outlets of the metropolitan watershed into Puget Sound and thus is subject to the terminal or cumulative effects of upstream conditions.

IMPORTANCE OF ENVIRONMENTAL WATER

The metropolitan Seattle area enjoys an abundance of diversified water resources unsurpassed anywhere. Large quantities of high quality fresh water in nearby mountain streams insure a plentiful and excellent supply for public use. Numerous fresh water lakes provide outstanding recreational opportunities and fisheries resources. Puget Sound, in addition to being an important recreational and fisheries resource, provides a protected navigational outlet to the sea and contains in its bays and estuaries excellent facilities for docking and shipping operations.

Shore lines adjacent to streams and lakes of the area and to Puget Sound provide excellent sites for homes and parks, for recreational pursuits, and for industrial and commercial developments. From the viewpoints, therefore, of the private citizen, of the business and industrial developer, and of the tourist, these waters represent a community asset of inestimable value. As a consequence, it is imperative that they be protected against degradation resulting from pollution and contamination brought about by discharges of industrial wastes and untreated sewage.

NEED FOR SEWERAGE AND DRAINAGE SURVEY

Among the many factors contributing to the sewerage and drainage problems of the metropolitan Seattle area, both present and future, the most significant are:

Growth of Population

Growth of population in the city of Seattle, and particularly in the surrounding communities is taking place at a rate such that the number of people residing within the metropolitan area can be expected to reach one and one-quarter million by 1980 and to be over two million in approximately 70 years. At the latter time the metropolitan sewerage service area is expected to exceed 500 square miles.

The present trend toward suburban living has extended the problem across political boundaries. As a result, the responsibility for providing sewerage service now rests with 41 separate jurisdictions, including 19 cities and 22 sewerage districts.

Raw Sewage Discharges

Although there are 25 sewage treatment plants in the metropolitan area, raw sewage is discharged through some 60 outfalls scattered along the shore lines of Duwamish River, Elliott Bay, and Puget Sound. Sewage from approximately 425,000 persons, or about 53 per cent of the total population presently residing in the metropolitan area, is discharged without treatment into these waters. As might well be expected, bacteriological analyses of the shore waters indicate that all beaches within the area are subject to dangerous contamination. It can be expected also that continued evidences of raw sewage discharges will have an adverse effect on the use of Puget Sound for boating, fishing and other recreational activities.

Raw Sewage Overflows

Due to summer rain storms, overflows of raw sewage into Lake Washington and Green Lake frequently occur during the recreational season. Studies indicate that, under average rainfall conditions, overflows occur more than 40 times per summer at each of about 30 points of discharge. Following these storms, virtually the entire west side of Lake Washington and all of Green Lake are rendered unfit for swimming.

In addition to the lake discharges, 30 other points of emergency overflow are scattered along the shores of Duwamish River, Elliott Bay, Lake Union, the Ship Canal, and Puget Sound. These overflows also discharge raw sewage following summer storms.

Lake Washington Pollution

Treated sewage from an estimated 80,000 persons now enters Lake Washington through direct discharges from ten community sewage treatment plants, and through indirect discharges from at least 4,000 private septic tanks. Biological and chemical conditions indicate that the lake is in the first stage of degradation due to nutrient enrichment, resulting in part from the discharge of sewage effluents and overflows. If this situation is not remedied, the inestimable value of Lake Washington as a recreational and scenic asset is likely to be greatly reduced, or perhaps even lost completely.

Duwamish River Pollution

Because of the discharge of raw and partially treated sewage and industrial waste, the Duwamish River is approaching the limit of its capacity to receive putrescible material. Tests indicate that the dissolved oxygen content of the river water is reduced at times to the minimum level considered satisfactory for aquatic life.

Suburban Sewerage Problems

About one-third of the total population residing in the metropolitan area is without public sewer service. To keep pace, therefore, with residential development, 6,000 private septic tanks are being constructed each year at a cost of approximately $2 million. Many of these installations are doomed to failure. Furthermore, gradual seepage from septic tanks is aggravating, and will continue to aggravate the already serious condition of nutrient enrichment of Lake Washington. It can be expected also to provoke a similar situation in other lakes within the metropolitan area.

Soil conditions in much of the suburban area are completely unsuitable for septic tank disposal. In situations of this kind, home building is prohibited until public sewers become available.

Combined Sewer Problems

Most of the older areas of Seattle are served by combined sewers which carry both sanitary sewage and storm runoff. Because of inadequate provision for storm flow capacity, these sewers become overloaded during periods of intense rainfall. Even at times of relatively light rainfall, many of them cause basement floodings and discharge sewage into streets through storm water inlets. It is not surprising, therefore, that every heavy rain results in numerous claims for storm water damage.

Metropolitan Aspects of Sewerage and Drainage

Sewerage and drainage problems of the metropolitan area are not restricted to individual cities and communities. Watershed boundaries, which define storm drainage areas and also limit sewerage service areas, are not confined to city, district and county lines. In other words, sewerage and drainage problems of the metropolitan communities are area-wide in scope and solutions must be formulated accordingly. This in turn implies that the construction and operation of trunk and interceptor sewers, major pumping stations, and treatment plants should be delegated to a single area-wide authority.

OBJECTIVES AND SCOPE OF SURVEY

Based on the problems outlined above, it is evident that there is an urgent need for the development of a comprehensive, long-range plan under which provision would be made for the systematic, orderly, economic, and properly integrated construction of necessary sewerage and drainage improvements. Such a plan, of course, calls first for a detailed engineering survey, taking into account all facts pertinent to the sewerage and drainage needs of the entire metropolitan area.

A survey to determine metropolitan needs should be concerned only with trunk and intercepting sewers, major storm sewers, main pumping stations, and treatment and disposal works. It should not, on the other hand, be concerned with local sewers, storm drains, and pumping stations which are not related directly to the development of a long-range metropolitan program. In general, the provision of local sewerage and drainage should be an independent function delegated to and retained in each political entity contained within the metropolitan area.

Objectives of Survey

An engineering survey should culminate in a detailed report setting forth in general, nontechnical language complete information concerning every phase of the required investigation. Such a report would serve throughout the period required for design of the recommended facilities and would be invaluable thereafter as a continuing reference.

Stated briefly, the principal objectives of the survey here reported are:

1. The development of a long-range sewerage plan for the metropolitan Seattle area, including such trunk and intercepting sewers, pumping stations, sewage treatment works, and outfall sewers or other methods of final disposal, as will be required to assure orderly and economic provision of needed services.

2. The development, insofar as permitted by existing conditions, of a basis of planning major storm drainage facilities throughout the metropolitan Seattle area, including such trunk drain lines, culverts, and combined sewer separation as will be required to provide for future development in each drainage basin.

3. The integration into the long-range sewerage and drainage plans, to the fullest possible extent, of all existing facilities found to be serviceable.

4. The protection of the shores and shore waters of Puget Sound and of Lake Washington and other inland waters, both surface and underground, from pollution, contamination and nuisance caused by discharges either of raw sewage, sewage plant effluents, or industrial wastes.

Scope of Survey

To attain the objectives outlined above, the work of the survey, as stipulated in the agreement cited later, included but was not limited to the following phases:

1. A review of existing reports and data, including previous reports on sewerage and drainage problems, planning reports, topographic surveys and maps, land use studies, climatological reports and data, and studies of lakes and estuaries having special reference to sewage disposal.

2. A study of drainage areas tributary to Lake Washington to determine the nature and degree of their development, both present and future. This phase also included areas tributary to Lake Sammamish, areas draining directly to Puget Sound, and other areas having natural drainage in the direction of metropolitan Seattle.

3. A study and analysis of population data and an estimate of population distribution and density, both present and future.

4. A study of the geographical characteristics of the metropolitan area as they relate to sewerage and drainage planning, including topography, geology, climate, natural resources, and economic and social development.

5. A study of existing sewage collection, treatment and disposal systems and the preparation of maps and diagrams showing the locations and functional details of all such systems. This phase was undertaken primarily for the purpose of determining the extent to which existing facilities could be incorporated, either at present or in the future, in a long-range program of sewerage improvements.

6. An analysis of the quantity and composition of sewages and industrial wastes now being collected in the area and a determination of the probable characteristics of those likely to be collected in the future.

7. A determination of present and future loadings on sewers, storm drains and treatment works, based on analyses of sewages and industrial works in the area and on experience and data secured elsewhere.

8. A study of the rates of storm water inflow and ground water infiltration into separate sanitary sewers, especially in the Lake City area, with the purpose of establishing realistic criteria applicable to the design of trunk sewers, interceptors, and treatment works.

9. A study of the effect of existing sewage disposal practices on the waters of Puget Sound, Duwamish River, and Lake Washington and on other waters in the metropolitan area.

10. A study of future disposal requirements to protect public health, to maintain receiving water quality consistent with its beneficial uses, and to prevent nuisance in the vicinity of disposal areas.

11. The development of design criteria and preliminary costs data for the design of sewerage and drainage facilities.

12. An investigation of problems concerned with the use of sewers carrying combined flows of storm water and sanitary sewage and, insofar as permitted by existing conditions, the development of a realistic, workable plan for storm water separation.

13. The development of all reasonable alternative sewerage and drainage projects and an analysis thereof as to physical and economic feasibility. This phase dealt with such factors as location, area served, population served, and sewage flow, and the location of trunk sewers, storm drains, interceptors, pumping stations and treatment plants.

14. An estimation of costs, both construction and annual, for sewerage and drainage facilities and a comparison of alternative projects.

15. The presentation of recommendations as to the most suitable long-range programs for both sewerage and drainage of the metropolitan area, together with preliminary plans and descriptions giving essential features of the proposed projects.

16. The development of a program of stage or incremental construction of both sewerage and drainage improvements.

17. A discussion of the various methods of financing construction and operation of the recommended sewerage and drainage improvements.

AUTHORIZATION OF SURVEY AND REPORT

On August 29, 1956, the engineering firm of Brown and Caldwell was engaged by the city of Seattle to undertake, in accordance with the foregoing objec-

tives, a comprehensive survey of sewage and drainage in the metropolitan area. The agreement then negotiated provides for financial participation by both the state of Washington, acting through the Pollution Control Commission, and the county of King. It calls also for completion of the project and submission of a report by March 1, 1958. Separate agreements relating to joint participation were subsequently negotiated between Brown and Caldwell and the state and county. Under all three agreements, payment for the work is on a time and expense basis, with the total fee limited to $130,000. Of this total, $90,000 is being contributed by the city, $30,000 by the county, and $10,000 by the state.

In the agreement with the city, it is stipulated that Brown and Caldwell shall prepare and submit 1,000 copies of a written report. This report is to present all information and data developed during the survey, together with descriptions of and estimates of costs for the recommended improvements.

FIELD AND LABORATORY WORK

Field and laboratory work was concerned primarily with the following activities:

1. A determination of the quantities of sewage and industrial waste from all parts of the metropolitan area. This phase of the work was marked by the use, for the first time, of a radioactive isotope technique which greatly simplified the difficult problem of flow measurement in large sewers. Continuous flow records at selected locations on trunk sewers in the city of Seattle were observed with the aid of pneumatic recording equipment developed specifically for the survey. Further details of these methods are given in Chapter 7.

2. A determination of the composition of sewages and industrial wastes from selected locations in Seattle and from outlying communities in the metropolitan area. Samples were collected at each location with the aid of one of two types of automatic sampling equipment. For small sewers and treatment plants, a rotating scoop-type sampler was employed which picked up a representative portion of the flow at ten minute intervals. For deep sewers, a new type of sampler was developed specifically for use during the survey. Detailed descriptions of both types are given in Chapter 7.

Samples collected over 24 hour periods were analyzed by survey personnel in the sanitary engineering laboratories of the University of Washington. Seattle engineering department personnel assisted in setting up the equipment for flow measurements and sampling.

3. A study of the waters of Puget Sound to determine current velocity and direction at selected points along the shore, and to determine the effects of existing sewage disposal practices, particularly in the vicinity of the point of discharge of the North Trunk sewer in Shilshole Bay. For this phase of work, use was made of a boat and crew furnished through the courtesy of the U.S. Coast Guard. Chapter 11 describes the results of the Puget Sound studies.

4. A study of the water of Lake Washington and of other lakes and streams in the area to determine the biological and chemical conditions of nutrient enrichment, and to determine the degree of pollution due to discharge of sewage effluents and raw sewage overflows. This study was carried out in conjunction with similar work being done by the University of Washington, Department of Zoology, under a grant from the U.S. Public Health Service. Samples were collected by survey personnel and university students and were analyzed in the sanitary engineering laboratories of the university. Although a great deal more still needs to be known about Lake Washington, sufficient information is now available to permit conclusions with respect to the effects of sewage effluent discharges and overflows.

5. A survey of the existing sewerage system within the metropolitan area, including trunk sewers, major pumping plants, treatment works and outfalls, or other means of final disposal. Results of this work are summarized in Chapter 6.

6. A field inspection of the routes of trunk sewers and of the locations of pumping stations, treatment plants and special structures. Reconnaissance surveys were made from the ground, by water, and from the air of all such routes and locations. In addition, foundation borings were made at the site proposed for the West Point treatment plant. Aerial reconnaissance and photography were performed through the cooperation of the U.S. Navy.

7. The collection, through numerous field trips, of information on development of the metropolitan area. This information served to establish the pattern and nature of urban growth, and to determine the logical extent of the future area to be served by the metropolitan facilities.

OFFICE WORK

Office work was concerned with the following principal activities:

1. A careful review of all reports, basic data and general information furnished by the staff of the Seattle engineering department, by other cities and districts, by consulting engineers, and by other agencies and individuals.

2. An investigation of the entire subject of present and future population development as to rates, distribution, and total numbers.

3. An estimation of sewage flows and treatment

plant loadings based on field quantitative measurements and on laboratory analyses of representative samples.

4. A determination of all necessary present and future trunk sewers with respect to the areas to be served, and their routes, capacities and sizes.

5. An investigation of sewage pumping in terms of pumping necessity, location, capacity and economy.

6. An estimation and review of all design factors.

7. The preparation of preliminary layouts for additional main sewers, treatment works and principal appurtenances.

8. The development and assembly of unit costs, and the preparation of necessary construction and total annual costs.

9. The preparation of the final report.

INFORMATION AND DATA AVAILABLE TO SURVEY

Existing reports, maps, plans, specifications, and statistical information relating to the various cities and districts in the area were furnished by city and district officials. Personnel of the Seattle Department of Engineering and engineering personnel of other cities and districts assisted in every way possible. Nevertheless, a great deal of time had to be spent by the survey staff in obtaining from the city engineering files necessary information concerning the existing Seattle sewerage system.

Other public agencies within the metropolitan area have generously made available reports, maps, files and other data. Particularly helpful material was furnished by the Seattle Planning Department, King County Planning Department, Snohomish County Planning Department, Seattle-King County Health Department, State Pollution Control Commission, and State Department of Health. All consulting engineering firms in the area concerned with sewerage graciously cooperated by releasing information and plans from their files and by furnishing facts based on their knowledge of local conditions. Soils engineering firms and many industrial firms cooperated by releasing the results of soil and foundation investigations which had been performed by and for them in the past.

Information was obtained from a number of federal agencies, particularly the U.S. Geological Survey, U.S. Coast and Geodetic Survey, U.S. Weather Bureau, U.S. Census Bureau, U.S. Engineer Corps, U.S. Navy, and the U.S. Public Health Service. Valuable data were obtained also from the Department of Oceanography, the Bureau of Governmental Research and Services, the Department of Civil Engineering, and the Department of Zoology, all of the University of Washington. Other state agencies furnishing information included the Department of Fisheries, Department of Game, Department of Employment Security, Highway Department, Census Board, and the Office of the Secretary of State.

PROGRESS REPORTS

Verbal reports on the progress of the survey were made from time to time to the sponsoring agencies as well as to quasi-official, technical and lay groups. Two reports were presented to the Mayor and City Council of Seattle during 1957, the first in April and the second in October. Additionally, two reports were made to the Mayor and members of the Streets and Sewers Committee, the first in November 1956 and the second in February 1957. A progress report was given also to the State Pollution Control Commission in May 1957. In the same month, a detailed description of the progress being made was presented to the members of the Metropolitan Problems Committee meeting jointly with officials of communities and agencies throughout the metropolitan area.

ACKNOWLEDGEMENTS

The task of assembling and compiling the facts and figures required for a report of the magnitude here presented involved the work of many persons. In addition to the survey staff, numerous individuals contributed, either directly or indirectly, to the preparation of the necessary material.

It is difficult, in retrospect, to recall everyone who, in some measure, contributed to the survey and report. We trust, however, that the list of acknowledgements contained in the appendix is reasonably complete. The help given us by the individuals there listed is deeply appreciated.

Chapter 2
HISTORY OF SEWERAGE PROBLEM

White settlers began arriving in the area that is now Seattle only a little over 100 years ago. Requiring little in the way of public services, they took water from the nearest convenient sources and disposed of sewage by primitive means.

As the settlement grew, water sources became contaminated and nuisances developed. By 1865, the population had reached 300 and the need for public control had become so imperative that the territorial legislature incorporated the little community.

A board of public works, created by Ordinance Number 4 of the new municipal council, undertook construction of the first public sewers in the area. Lacking any semblance of a "system", these early sewers consisted of wood troughs or boxes, which discharged individually at the most convenient point, usually into Elliott Bay and Lake Union. It was not until 1875, by which time the population had increased to about 1,500, that planning and construction of sewers were commenced on an organized basis. Bonds for financing construction were passed the following year but, because the validity of bonds voted under a territorial franchise was questioned, nothing was accomplished until enabling legislation was enacted by the United States Congress in 1882.

The first sewer of more or less permanent character was constructed in 1883. Made of "iron stone", a mixture of clay and iron slag, this sewer was laid in Madison Street from Fifth Avenue to Elliott Bay. Vitrified clay pipes, 12 inches in diameter, were first laid in 1885 when the population of Seattle had grown to over 5,000. By that time, local nuisances had become widespread and pollution of near-shore waters, especially in Lake Union, had become a serious community problem. Finally, the situation became so serious that the city council obtained the services of Colonel George E. Waring, Jr., a sanitary engineer of national repute, to design a comprehensive system of sewers.

The Waring Report

Submitted to the city council in March 1889, Colonel Waring's report presented a plan for a comprehensive system of separate sewers designed to carry domestic sewage only, with no provision for flow resulting from rainfall. On this subject the report stated:

"The system of sewerage adopted is arranged for the removal of foul wastes only. That is to say, it is to receive no rain water from any source whatever. It was found on estimating the sizes needed for carrying roof water that this would add materially to the cost of the work.

"You are so well situated for the removal of surface water that it is not worth while to spend public money for increasing the facilities unless possibly hereafter with reference to certain localities where storm water may accumulate to an inconvenient or dangerous degree."

An important feature of the sewerage problem, as established by the Waring report, was the need for the construction of a tunnel, later known as the Lake Union tunnel, to prevent the discharge of sewage into Lake Union.

Shortly after receipt of the Waring report, interest in public affairs was distracted from normal channels by the great fire of 1889, which destroyed a large part of the city. Preoccupied then with reconstruction of the city, public attention was diverted temporarily from further consideration of the sewerage problem. In the end, the Waring report was rejected, apparently because the proposed sewers were believed to be of insufficient capacity.

Renewing its effort to find a solution to the growing problem, the city council, on November 18, 1889, retained by Benezette Williams, a consulting engineer from Chicago, to prepare plans for a comprehensive sewer system. At the time, Williams was working also on plans for a water supply system for Seattle.

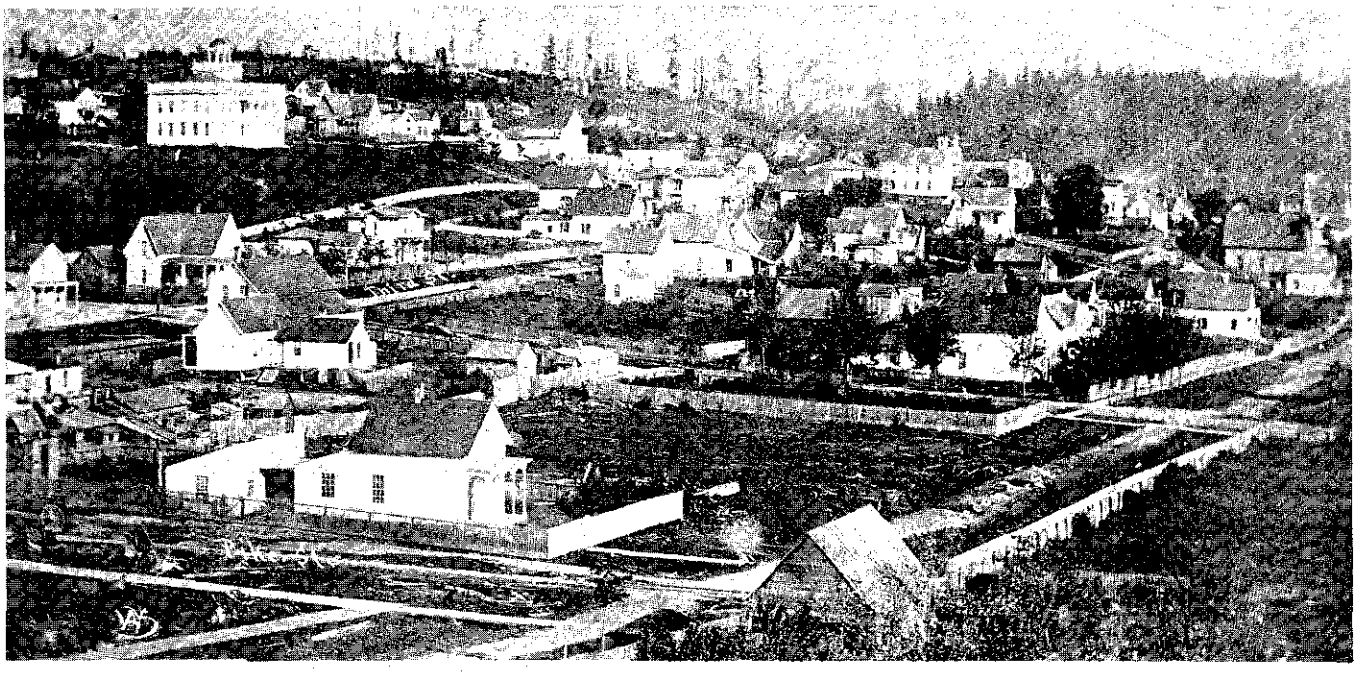
In 1890, while Williams was preparing his report, Washington was admitted to the Union and the new State Legislature granted a municipal charter to the city of Seattle. This charter was adopted at an election held on October 1, 1890.

That the sewerage problem must have been one of the first concerns of the newly chartered city is evidenced by the following statement contained in the 1890 annual report of the Honorable Harry White, Mayor of Seattle, to the City Council:

"Your attention is called to the question of providing additional sewerage facilities especially in the vicinity of Lake Union. I would recommend that a committee be appointed by the Council...and that said committee...report...whether the sewerage from that portion of the city can be disposed of without using Lake Union for the purpose."

The Williams Report

The Williams report was received in August 1891. In contrast to the Waring proposals, Williams recom-



SEATTLE in 1878, about the time the city's first sewerage system was being planned. Street intersection in foreground is 2nd and Pike Streets. The large building at upper left was the University of Washington located on the present site of the Olympic Hotel.

mended a system of sewers to carry both sanitary sewage and storm runoff, thus necessitating pipes and conduits of much larger capacity. Domestic sewage and low storm runoff were to be diverted from the Lake Union, Green Lake, and part of the Lake Washington drainage basins by means of three major systems, each discharging into salt water. During storms, surface runoff mixed with sewage would be discharged to adjacent waterways through a number of overflow and bypass structures located along the principal trunk and intercepting sewer lines.

While the Waring and Williams philosophies were in direct conflict from the standpoint of separate versus combined sewers, it is interesting to note that their proposals were in agreement in one significant respect. Both urged construction of the Union Lake tunnel.

Combined Versus Separate Sewers

The decision to use combined instead of separate sewers in Seattle has had, and will continue to have, an important bearing on Seattle's sewerage problems and the pollution of its surrounding waters. It is desirable, therefore, to review the reasons for the Williams recommendations. These reasons are of particular interest because more recent advisers have recommended separation of the sewer system, at least insofar as existing conditions will permit.

Williams pointed out that surface soils are constantly soaked to saturation during a considerable part of the six rainy months. This condition, together with steep surface slopes, results in rapid runoff and high concentration of storm water in gutters and at street intersections. In his report, Williams stated:

"In short, the accumulated experience of all populous cities and towns leaves no chance for being mistaken in the assertion that the underground removal of storm water is a necessity in a modern city. Any attempt to dispense with it is a retrograde movement, and one not to be tolerated at the present day.

"If sewage and storm water are not removed together by means of a combined system of sewers, underground conduits will have to be provided for rain water, as well as sewers to be used exclusively for organic waste, thus substituting a double system for a single one, and materially increasing the cost.

"Much has been said in advocacy of complete separation of sewage and storm water...but nevertheless the stubborn fact remains that in all cities of large size, it is considered necessary to remove storm water by underground conduits, and in nearly all such cases it has been found most convenient, and the cheapest to do it by means of a combined system of sewers.

"The sanitary plea that is often urged in behalf of the separate system...cannot properly be held sufficient to outweigh the many advantages afforded by the combined system.

"...If a system of sewers is built so small as to be adapted merely to the removal of house sewage, it will be overcharged in a few years, through storm water connections, made perhaps without the knowledge of the city departments."

Treatment of sewage for the prevention of water pollution was not practiced in 1890, and little or nothing was known about it at that time. Probably neither Waring nor Williams fully realized that treatment ultimately would be required. Certainly Williams did not mention the additional cost which would be entailed should it become necessary to intercept and pump sewage combined with storm runoff, and convey the combined flow to treatment sites at some distance from the various outfalls.

Williams was aware of the nuisances which were bound to result from the discharge of sewage into near-shore waters. His report, in the remarks quoted below, recognized that construction of a comprehensive sewer system would probably result in widespread pollution.

"Of the 28 square miles within the city limits, about 10 square miles drain naturally to the salt water Sound, and 18 square miles to the fresh water lakes, Washington, Union and Green. Of the fresh water drainage area, approximately 8 square miles drain to Lake Union and 10 square miles to Lake Washington directly and indirectly.

"It is thus seen that following the natural topography the sewage from about 64 per cent of the city's population would go into fresh bodies of water where it would stagnate, and as it grew in magnitude would become offensive in every way. To prevent this as far as possible, should be one of the main purposes in outlining a sewerage plan.

"As the sewage of the city increases it will become more and more of a problem to dispose of it along the waterfront without creating a nuisance, and the fewer the points of outfall the more readily can some system be adopted to throw the sewage far out in the Sound should it become necessary.

"...When the quality of sewage shall have become large, this stranding (on the beach) of the sewage may become objectionable. It is also a question whether the Bay itself for a considerable way from shore, will not become offensive in the course of years. This, however, cannot be told with any degree of assurance without a full knowledge of the currents occasioned by the ebb or flow of the tides."

Time has proven that William's fears over the possible consequence of discharging sewage along the shorelines were well founded. How best to resolve this problem, in view of the large shows which are experienced during every storm, has perplexed city officials and engineers for nearly fifty years.

Nevertheless, under conditions of sanitary engineering practice in 1890, Williams arguments were convincing and his recommendations were approved. Seattle, therefore, started to construct combined sewers.

Early Trunk and Intercepting Sewers

Construction of the existing Seattle sewerage system may be said to have commenced coincident with the preparation of the reports by Waring and Williams. By the end of 1891, about 14.9 miles of sewers had been constructed, ranging from 8 inches to 20 inches in diameter. The rapidity of the subsequent growth of the sewer system is indicated by the following tabulation of the miles of sewers which had been constructed up to the years indicated:

1891	14.9 miles
1900	60.45 miles
1908	212.32 miles
1924	628.63 miles
1930	802.10 miles
1940	863.15 miles
1950	988.09 miles
1956	1059.59 miles

Full responsibility for the construction of sewers was placed in the hands of R. H. Thompson who, except for a brief period in 1894, served as city engineer from 1892 to 1911. Following in general the plans laid out in the Williams report, Thompson directed the design and construction of major sewers and sewer tunnels which to this day comprise the "backbone" of most of the system. These projects included the Lake Union tunnel system, most of the North Trunk sewer, and the Beacon Hill tunnel system and marked the first important steps in the protection of the fresh water bodies of the area. But beneficial as they were in diverting dry weather flow from Lake Union, Green Lake and parts of the Lake Washington drainage basin to tidal waters, they aggravated conditions along the Elliott Bay waterfront and created a new problem in Puget Sound proper.

Concern regarding the discharge of sewage from numerous small systems along the Elliott Bay waterfront was expressed in the city engineer's report of 1901 which stated:

"More than six years ago sewage from a large portion of Renton Hill was carried down Twelfth Avenue to Lane Street, where it is turned to the west and is discharged at the foot of Lane Street into the waters of Elliott Bay...The sewage cast upon the flats at the foot of Lane Street becomes extremely offensive, and will soon be the occasion of public uprising unless some steps are taken to abate the nuisance."

Although corrective steps have been taken from time to time, discharges of raw sewage into near-shore salt waters have increased steadily and today constitute principal problems. Among the most serious are the discharges from the major systems constructed in the early 1900's, namely, the North Trunk sewer to the sound in the vicinity of West Point, the Lake Union tunnel system to Elliott Bay near Denny

Way, and the Rainier Valley system to the Duwamish River at Harbor Island.

While these early and important developments were taking place in Seattle, events of historical significance were occurring elsewhere in the area. In Ballard, which was not a part of Seattle until 1907, four large trunk sewers with outfalls into Salmon Bay were constructed during 1903 and 1904. Although these sewers still serve the Ballard district, an interceptor was constructed in 1937 and the dry weather flow is now conveyed to the North Trunk sewer through a siphon laid along the bottom of Salmon Bay.

In 1910, construction of sewers commenced in the cities of Auburn and Renton. Discharging, respectively, into the Green and Cedar rivers, these were the first of many systems to follow which would discharge to the fresh waters of the area at numerous and scattered points. Meanwhile, the principal developments continued to center in Seattle where the sewerage system was being expanded rapidly throughout the city. Much of this expansion consisted of small systems with independent discharges.

In 1920, a major intercepting sewer was constructed along Henderson Street from Forty-Second Avenue South to its point of discharge into Lake Washington. This line served the lower Rainier Avenue and Empire Way areas and, upon its completion, provided the developed sections of Seattle a moderately adequate network of sewers.

Overloaded Sewers

Because of the rapid growth of the city, and the attendant extension of tributary areas served by the various combined sewer systems, many trunk sewers soon became overloaded. As a consequence, numerous problems were subsequently encountered and many opinions, expert and otherwise, were frequently expressed. Here, briefly, are some typical examples:

1. A flow measurement at an overflow manhole on Roanoke Street on January 5, 1914 showed a depth of flow of over two feet, indicating that the entire length of the main sewer was overloaded from the Lake Union tunnel to Roanoke Street.

2. In a report to the city engineer made in 1921, it was stated that, on September 8, 1916, the Lake Union tunnel backed up and that water flowed from the manholes in Roy Street.

3. A report in 1927, prepared in the office of W. D. Barkhuff, city engineer, listed a large number of inadequate sewers in the city and called for "immediate relief either by sewers paralleling the existing sewers or by the construction of a single sewer of the proper dimensions."

4. In a letter dated September 27, 1927, A. H. Dimock, who had previously served as city engineer for 12 years, commented upon a recommendation regarding relief of overloaded sewers: "A more realistic approach now will be to start providing separate storm sewers."

5. In 1928, W. D. Barkhuff, city engineer, recommended "the construction of a separate system of storm water sewers to give the necessary relief for present and future development."

6. Dr. Abel Wolman, in his report to the City Council in 1948, recommended "The policy should be promptly adopted....prohibiting any further extension ....of combined sewers. The continuing installation of combined sewers will aggravate the disposal problems....when excessive amounts of storm water, sullied by domestic sewage in combined sewers, will create major fiscal problems."

Numerous other engineers, employed by the city and in private practice, have expressed themselves as favoring either complete or partial separation of the Seattle sewer system.

The Lake Washington Interceptor System

Although the North Trunk and Bayview tunnel systems were designed to divert the dry weather flow from parts of the Lake Washington drainage basin, they did not, initially, serve areas lying along the easterly slope of the ridge in Seattle which extends along practically the entire Lake Washington shoreline. Consequently, a number of small systems was constructed in those areas, each discharging raw sewage into the lake. Several large trunks, all with lake discharges, were also constructed. Others were added from time to time until there were 30 raw sewage outfalls to the lake by 1922.

To correct these undesirable conditions, a plan was devised during the term of J. D. Blackwell as city engineer which called for construction of five pumping plants and a system of intercepting sewers which would divert some of the flow from the Lake Washington basin to salt water. This plan also included a new tunnel under Hanford Street to relieve flooding and backups, which were occurring frequently in Rainier Valley because the capacity of the Bayview tunnel was no longer sufficient to serve the tributary area. Since, however, the estimated cost of $4,200,000 was considered to be too high, an alternative plan was developed by the city engineer. The latter contemplated the construction of 16 sewage treatment plants along the lake front which, with their connecting sewers, were estimated to cost about $2,500,000.

In reviewing both plans, the State Department of Health wrote to the city of Seattle in August 1922, stating among other things:

"Accordingly, if it is contemplated to construct a combined storm and septic sewer system, the treatment works should be adequate to take care of all the effluent of the sewer, including both septic and

storm sewage; but if it is preferred to build two separate systems, one for the storm water and one for the septic sewage, the storm water will not have to be treated.

"This Department cannot permit any increase in the pollution of Lake Washington which affords the only possible water supply for certain settlements on its shore..."

Despite what appears to have been a valid stand on the part of the Department of Health, permission was granted subsequently for the construction of plants to treat combined sewage. Three such plants, comprising Imhoff tanks only, were constructed in 1924, one each at Perry Street, Alaska Street, and Massachusetts Avenue.

A resolution of the King County Board of Health, dated October 20, 1925, stated that from and after November 1, 1925 any sewage discharged into Lake Washington must be so purified that it will not contain the germs of human diseases, and will conform with the United States Public Health Service bacteriological standard for drinking water. Meanwhile, however, the State Department of Health had, in effect, withdrawn from its earlier stand by approving plans for sewage treatment plants which were incapable of meeting the demanded standard.

By Resolution Number 2005 of October 1925, the King County Board of Commissioners condemned the use of Lake Washington for the disposal of sewage. This resolution also required that any effluent discharged into the lake should meet the standards of the United States Public Health Service for drinking water.

In 1925, strong complaints about nuisances arising from the plants already constructed were expressed by residents of nearby areas. Finally, conditions became so offensive that suit was brought to enjoin their operation. With public sentiment turned against these plants, a bond issue of $2,125,000 was voted on March 6, 1926 for the construction of intercepting sewers and pumping stations to divert sewage from the lake, apparently along the lines first recommended by Blackwell.

While the above controversy was in progress, the city council employed A. H. Dimock to develop a plan for abating pollution of Lake Washington. A statement contained in his report of May 17, 1926 bears repeating in the light of subsequent developments:

"The population of Seattle will soon overflow its present boundaries both north and south. It will jump across the lake and its eastern shores will become urban property. And, coincident with the growth of Seattle, there will be a corresponding growth in population and industries throughout the entire habitable watershed. The area to the north and northeast, together with other tracts will become suburban property. This area will comfortably house, without crowding, some 2 or 3 millions of people. This will be a long time ahead, but it is manifest that an increasing population will deliver a constantly increasing amount of contamination to the lake.

"It is my opinion, therefore, that sewage even after treatment should not be disposed of in the waters of Lake Washington within the limits of the city of Seattle, but should be removed completely..."

Estimated to cost $3,000,000, the plan recommended by Dimock called for an intercepting sewer system along the shoreline of Lake Washington from twelve pumping stations, and for a tunnel through Beacon Hill under Hanford Street to replace the Bayview tunnel. Interceptors were to be constructed in three separate sections: (1) a northerly section with pumping stations to lift sewage into the North Trunk system; (2) a central section with pumps to lift the flow into the Hanford Tunnel system; and (3) a southerly section with pumps to lift flow to a new Henderson Street system which would convey it to the south end of Beacon Hill where construction of a treatment plant was contemplated. Storm water overflows were to be provided at intervals along the interceptor system and the existing Henderson Street intercepting sewer was to become an overflow outfall. After considerable controversy over the relative merits of the various plans that had been proposed, the Dimock plan was adopted and has since been followed to a substantial degree.

The principle of eliminating and preventing the discharge of sewage into Lake Washington had now become so well established that by 1936 all outfalls to the lake had been intercepted. Storm overflows, however, could not be avoided and continue to occur at some 30 scattered points along the lake, even during relatively light rainfalls.

Final Stages in Development of Existing Sewerage System

At the time the south Lake Washington intercepting sewer system was being planned, it had become apparent that an interceptor was needed also to protect the waters of Duwamish River. Under the Dimock plan, it was contemplated that dry weather flow from the new Henderson Street system would ultimately be treated at a plant south of Beacon Hill. In view, however, of the concurrent need for an interceptor along the Duwamish, a plan was devised whereby the Henderson Street sewer would be routed around the south end of Beacon Hill to a junction with the proposed Duwamish interceptor. The latter would then convey sewage along East Marginal Way to a treatment plant at Diagonal Avenue. This change was approved and construction of the system was completed about 1940.

Design of the East Marginal Way interceptor was based on serving the Henderson Street system only

until its full capacity would be required by developments along the Duwamish. It that event, the plan was to construct the proposed treatment plant south of Beacon Hill.

Sewerage construction slackened during World War II, being confined principally to the provision of facilities needed to serve war housing areas. In 1945, a major program of sewer system extensions was recommended by the office of the city engineer. Involving construction over the following ten years and a bond issue of $3,000,000, this program was approved by the voters at a general election.

As the volume of raw sewage being discharged and the number of points of discharge increased, state and local health authorities, the Pollution Control Commission, and other state and local agencies interested in water resources expressed increasing concern. Numerous surveys of conditions in the waste receiving waters were conducted, out of which came warnings regarding the growing menace to the public health and the urgent need for corrective action. For instance, a letter from the State Department of Public Health, dated July 12, 1945 stated in part:

"In the spring of 1941 and again in 1944 extensive bacteriological investigations were made of the waters at Alki and Golden Gardens bathing beaches. These studies were made by the State and City of Seattle Health Departments. Conclusions of both investigations were that the beaches were seriously polluted. The outfall sewers mainly responsible for these conditions were the Ballard and North Trunk at Golden Gardens; and Jersey Street, Arkansas Street, and Fifty-Third Avenue, southwest at Alki.

"These bacteriological studies revealed coliform bacteria concentrations as high as 10,000 per 100 c.c. and average values of over 1,000 per 100 c.c. Although no national standard has been adopted establishing the maximum limit of quality of water in which it is safe to swim, it is generally indicated by the several standards in use that 50 coliform organisms per 100 c.c. is desirable, but in a few instances, upper limits of 1,000 per 100 c.c. have been set to permit swimming when other quality of water was unavailable. Therefore, it is indicated that the public bathing at Alki and Golden Gardens bathing beaches have been made unsatisfactory by the discharge of city of Seattle sewage.

"While only two established city bathing beaches have been discussed, all the salt water bathing beaches within the city limits of Seattle must also be considered, on the basis of their location with reference to city sewer outfalls, as unsatisfactory for bathing purposes.

"Other factors of concern are: There are continual complaints arising from floating solids, scum and slick throughout all of Elliott Bay and extensive stretches of the Sound, depending on tide conditions. Also, preliminary studies of the Duwamish Waterway reveal that at times the dissolved oxygen is depleted to such an extent that fish life cannot exist. This situation is attributable in part to the city of Seattle sewer outfalls into these waters."

The Wolman Report

Manifestly unsatisfactory sewerage conditions and a lack of unanimity in proposals for their solution led the city council, in 1947, to authorize the city engineer to engage expert advice. The services of Dr. Abel Wolman, Professor of Sanitary Engineering at Johns Hopkins University and a widely recognized authority on sanitary engineering matters, were then obtained.

Dr. Wolman submitted his report on September 25, 1948. A condensation of his recommendations follows:

"The capacity of the North Trunk sewer should be increased to carry three times the dry weather flow, without overflows, and its outlet should be extended into a depth not less than 75 feet. All sewage, before discharge into the Sound, should be subjected to fine comminution. Whether grease or solids should be removed should wait on results with comminution. Land should be purchased for the installation of comminution facilities and plain settling.

"All sewers discharging into Elliott Bay should be extended into deeper water.

"All sewers into Puget Sound at the south of Alki Beach should be extended into at least 35 feet of water. For the time being comminution is not recommended for these areas.

"The policy should be promptly adopted of prohibiting any further extension of combined sewers.

"An industrial waste survey must be instituted and maintained.

"Vigilant administrative checking should be conducted to detect on-shore pollution as a result of breaks in outfalls, over-balancing of assimilative capacities, and other indices of good or bad performance.

"A master plan for progressive sewer extension and for controlled sewage disposal should be developed for Seattle and those environs, outside the city limits, which would normally empty into the same surface waters."

The Wolman report was approved in a letter from the city engineer to the city council on November 17, 1948. This letter stated: "This department is in hearty accord with Dr. Wolman's findings. This department recommends: That Dr. Wolman's report be adopted as the future policy governing our sewage disposal."

Approval was expressed also by the Director of the State Department of Public Health who, in a letter addressed to the city council on December 20, 1948,

stated: "We see no valid technical reasons, public health, engineering or otherwise, why these recommendations should not be acceptable to all concerned."

In November 1948, a brochure was published by the State Pollution Control Commission in which the Wolman report was severely criticized. The following quotations are indicative of the tenor of the publication:

"It was the understanding of the Pollution Control Commission that the purpose of the Wolman Report was to provide the city of Seattle with a basis for future planning for sewage and industrial waste collection, treatment and disposal, and to furnish detailed information as to methods of accomplishment. The report does not give any of the expected details. The basis for future planning seems to hinge on the interpretation of the recommendations. Some first interpretations have appeared in the newspapers to the effect that Seattle will never need to provide sewage treatment facilities. Since this is a far reaching conclusion and affects not only Seattle but all of the salt water areas in the state, it appears advisable to consider all of Wolman's recommendations and conclusions and not only those which appear to recommend no treatment.

"It will be the requirement of the Pollution Control Commission that the minimum acceptable degree of treatment for the sewage and industrial wastes of the city of Seattle will be primary treatment."

Public officials, civic groups and the citizenry were disturbed and confused by the conflict of opinions and recommendations. Some urged the appointment of a board of engineers to advise the city council on a solution.

In an effort to resolve differences and to provide a basis for action, the city engineer commenced an investigation of overload, overflow and pollution problems and the development of a long term program of improvements. At the same time, the Pollution Control Commission undertook investigations to evaluate the extent and effect of pollution and nuisances in Puget Sound.

The Sylvester Report

In 1949, the Pollution Control Commission employed Professor R. O. Sylvester and associates of the Department of Civil Engineering, University of Washington, to conduct a comprehensive survey of pollution conditions in Puget Sound and its tributaries. Among other things, the report on this survey discusses (1) the various beneficial uses of the waters of the Sound, Elliott Bay, Shilshole Bay, the Ship Canal and the Green-Duwamish River; (2) the various points where wastes were being discharged into these waters; (3) the conditions found as they relate to the beneficial uses; and (4) the suitability of possible sites for waste disposal.

Details as to the conditions in the receiving waters, as described by Silvester, will be set forth elsewhere in this report. As a matter, however, of historical interest, it is pertinent here to include the following summary of some of the more important findings:

"1. The biochemical conditions of the Lake Washington Ship Canal system is not satisfactory.

"2. All of the bathing beaches surveyed at times show sewage pollution (presence of coliform organisms) to be in excess of the standard established by the State Pollution Control Commission and the State Department of Public Health.

"3. The following beaches would not be recommended for bathing...due to either high coliform counts or the observed presence of sewage materials in the beach area: Carkeek Park..., Ballard Beach, West Point Beach, Magnolia Bluff in the vicinity of Thirty-Second Avenue West, the major portion of Alki Beach, the major portion of the entire beach from Alki Point south to the city limits, and the beach at Salmon Creek.

"4. The Green-Duwamish River is receiving heavy discharges of polluting materials from Auburn north to its confluence with Elliott Bay. The bacteriological condition is very poor in the river stretch past the city of Kent. In the Duwamish Waterway the dissolved oxygen depletion...is particularly severe during...August and September.

"5. In spite of the extension of eight Seattle outfalls, the conditions of beach pollution are not satisfactory."

Recent Reports of the City Engineer

One of the most urgent problems pointed up by the Wolman and Sylvester reports was the pollution of West Seattle recreational beaches. In 1948, following refusal of the Pollution Control Commission to grant permission for the construction of a storm water overflow device in West Seattle, the city agreed to proceed with planning for an interceptor system and a sewage treatment plant which would eliminate the discharge of raw sewage from numerous independent systems. Three years later, in 1951, the city engineer presented a predesign report for this project.

In preparing the predesign report, careful consideration was given to the Wolman and Sylvester reports and to tentative agreements reached with the State Pollution Control Commission. Based on these and other pertinent studies, it was recommended that an area of 3,843 acres be served by two interceptors with a total length of about five miles, by seven pumping stations, and by a primary type treatment plant to be constructed at Alki Point. Raw sludge removed in sedimentation tanks at the treatment plant was to be mixed with salt water and pumped at a slow rate through an outfall separate from the effluent outfall.

Under this plan, sludge was to be pumped into a depth of 100 feet of water at low tide and at times of favorable current conditions in the sound. Disposal of sludge in this manner was considered to be experimental and was to be tried for the purpose of determining the validity of the Wolman recommendations for deep-water assimilation of raw sewage. As matters turned out, the proposal ended in controversy and construction of the West Seattle system was delayed.

In 1952, the city engineer issued a report entitled "Planning and Progress, Seattle City-Wide Sewage Disposal Problem". This report points out that "Subsequent to 1949, and with the aid of 1946 sewer bond funds, an intensive sewer rehabilitation program has been undertaken by the Engineering Department to overcome the decline in progressive sewer planning for the city that set in with the depression of the 1930's and reached its lowest point during the war period (1941-1945). To overcome the recession period, and to modernize the system, the spending of approximately $25,000,000 will be necessary to create a network of sewers to serve the sanitary requirements of Seattle's growing population."

Information is presented regarding results of sewage characteristic and pollution surveys, studies of overflows into Lake Washington, and studies of sewer capacities. On the subject of sewer capacity, it is said:

"These studies have revealed some startling facts that tend to account for failures in the past, and are now the basis for not allowing sewer permits to be issued for connection to systems already overloaded. This policy in the past has piled trouble onto existing trouble, when new relief sewers should have been constructed. The results of this survey will help to reduce claims against the city for damages from sewer backups into basements and save maintenance funds from being wasted on temporary repairs to undersized sewers."

A further effort to initiate necessary action came in 1954 with the holding of an election to authorize issuance of $5,000,000 in general obligation bonds for financing construction of sewerage additions and improvements. This program, however, failed to receive voter approval.

With reference to new construction, the 1952 report summarizes a proposed program as follows:

"The program, which is planned for progressive construction stages over a 10-year period, will involve the construction of 29 pumping plants with their associated force mains, to provide new low level, shoreline sewer interception to existing higher sewers, approximately 8 miles of new interceptors and replacement sewers to concentrate existing sewers in conformance with this plan, and a minimum of four sewage treatment plants."

Three new treatment plants were to be constructed, one each at Alki Point, Fort Lawton and West Denny Way. In addition, the existing Diagonal Avenue plant was to be enlarged.

The 1956 Bond and Service Charge Election

In 1955, the city council passed an ordinance which provided for extensive improvements and additions to the sewerage system and the issuance of revenue bonds in the amount of $6,250,000. Another ordinance provided for a sewer service charge, setting a fixed fee of $1.00 per month for a single family residence and a fee for larger contributors based on water use. These actions were approved by the voters at an election held on March 13, 1956. As a result, the service charge is now in effect and the proposed improvements and additions are in various stages of design and construction. Among these are:

1. Construction of the West Seattle interceptor system and sewage treatment plant. This program involves an intercepting sewer with sufficient capacity to limit the number of overflows to twelve per summer. The sewage treatment plant, employing primary sedimentation and separate sludge digestion, is being constructed at Alki Point as originally proposed.
2. Construction of an interceptor to eliminate raw sewage discharges in the vicinity of Golden Gardens.
3. Enlargement of the Lake City Sewage Treatment plant, and improvements to other systems located in the area between Eighty-Fifth Street and One Hundred and Forty-Fifth Street, which was annexed to the city in 1954.

Growth and Problems of the Suburbs

Engineering reports dealing with Seattle's sewerage problem have given increasing attention to the relationship between the problems of the city and those of the outlying areas. Between 1890 and the beginning of World War II, eight communities were incorporated within what is now the metropolitan Seattle area and much of the unincorporated fringe area surrounding the city became heavily populated. During the war, a sharp growth in population occurred and has since continued.

As is the case in most of the major population centers in the United States, recent heavy growth has been coupled with a desire on the part of people to live in the suburbs. In consequence of that trend, large areas to the north and south of Seattle, and east across Lake Washington, have become heavily developed. Since the war, ten cities have been incorporated within a 15 mile radius of downtown Seattle and the unincorporated area within this radius has become urbanized to such an extent that the demand for public sewerage service has brought about the formation of

22 sewerage districts. As a result, 26 independent sewerage systems and as many sewage treatment plants now operate within the metropolitan Seattle area. Yet, nearly a third of the population is without public sewerage service. Furthermore, because of unfavorable soil conditions, there are frequent instances in unsewered areas when household wastes flow over the ground surface and along street gutters or stagnate in pools.

Problems of the unsewered areas are discussed in a report published in 1952 by the Pollution Control Commission entitled, "The Sewage Disposal Problem in the Seattle Metropolitan Area". This report states in part:

"The movement of people from cities to suburban areas has created a multitude of problems. Included among these is the difficult one of providing adequate sewer systems and sewage treatment plants. In the initial stages of the development of suburban areas, septic tanks and drain fields may solve the initial household problems. As the areas develop further, health and sanitation problems are created and, eventually, community sewerage systems become a vital necessity. Such is the condition in much of the Seattle metropolitan area.

"...The hodge-podge development of sewerage facilities in the suburban Seattle area during the past decade has been a matter of concern to all interested in or affected by sewage collection and disposal. Sewer districts have been and are being formed to include only that immediate area, no matter how irregular in patterns, needing and desiring sewers at the moment...Little regard has been given to the nearby sewer districts or intervening areas when a new district is established. Construction of sewerage facilities in this fashion is expensive, as many small treatment plants and trunk sewers will have to be abandoned eventually in favor of other units designed for the entire drainage basin or basins."

On the same subject, a report issued in 1956 by the Bureau of Governmental Research and Services at the University of Washington, entitled "Government in the Metropolitan Seattle Area" states in part:

"A geographic concentration of population carries with it a need for basic services...The current significant movement to the surrounding suburban unincorporated areas and small incorporated municipalities produces a large number of communities which do not have the governmental machinery to provide the basic services necessary in urban areas. Consequently, the residents of the unincorporated areas form special districts to obtain the necessary urban services. Each district is formed separately under its own state laws and has its own budget. The result is layers of government...each performing certain specific services to the residents of its particular area. This jig saw, patch-work pattern has been appropriately called 'fractionated' government...From an overall view, the difficulties experienced by the present small, scattered sewer districts in attempting to solve the problems of adequate sewage facilities are:

"(1) Small districts are unable to cope with the sewage problem. Eighty per cent of the present districts have an area less than two square miles. Generally, a sewer district is formed only when there is an acute sewage problem, and then only the immediate area is considered in solving the problem. When formed inland, the district is faced with the next-to-impossible task of financing long outfall lines for the disposal of sewage.

"(2) Future planning in sewer system designed by small districts for the Lake Washington drainage basin is very difficult, if not impossible. The boundaries of sewer districts are not drawn according to topography to create a unit capable of economical and efficient operation. In King County, there are 60 sewer district commissioners and 139 city councilmen concerned with sewerage problems. Each governmental unit has its engineers and legal advisers. Coordination of plans with adjacent units is extremely difficult; planning for the entire area is virtually impossible.

"(3) Contractors building large housing developments would often like to install a central sewer system, but do not, as they have no information on how their system might be coordinated with the surrounding areas' future sewerage development. The abandonment of many of the small sewage treatment systems that have been built by contractors now appears to be imminent if they do not fit into the comprehensive plan of trunk sewers and treatment plants being developed for the area as a whole.

"(4) Treatment plant and outfall sewer sites become increasingly difficult and more expensive to obtain as the areas increase in development.

"(5) Furthermore, there is at present no legal method for the 73 square miles in Snohomish County to cooperate with the development of sewage facilities to prevent the deterioration of the lake, even if the area were to form a sewer district."

The difficulties discussed above were underscored in 1956 when the Bellevue Sewer District proposed a program for removing sewage and sewage effluent from Lake Washington by contracting with other sewer districts and jointly financing a trunk sewer to serve the communities on the east side of the lake. Estimated to cost between 2.5 and 3 million dollars, this program called for the construction of an intercepting sewer from Houghton to Renton, with the treatment plant discharging its effluent to the Duwamish River. In the initial stage, service was to be provided for the

Bellevue Sewer District, Three Points Annexation, Enatai and Beaux Arts Annexation, Eastgate, Houghton, Mercer Island Sewer District, East Mercer Sewer District as well as the new Safeway Industrial Center and the proposed Overlake Commercial Development. In later stages, facilities were to be constructed whereby it would be possible eventually to serve the entire Lake Washington - Lake Sammamish area.

At about the same time as the east side project was proposed, the State Department of Health and the State Pollution Control Commission adopted similar statements of policy with respect to the discharge of sewage into Lake Washington. Plans for the intercepting sewer apparently met all requirements set down by these authorities.

On August 8, 1956, before the Bellevue plan could be consummated, the Lake Hills Sewer District proposed an alternative plan involving the construction of a 24-inch effluent line under Lake Washington to discharge ultimately into tide water in Shilshole Bay. Under this plan, the Lake Hills Sewer District was to build a treatment plant at Yarrow Bay and the Bellevue District was to deliver its sewage thereto under a contractual arrangement. Construction was to be undertaken by such a time as 6,000 properties were under contract to utilize the proposed facility. This project, however, has fallen by the wayside because the several agencies involved therein have been unable to reach a mutually satisfactory agreement.

Limitations on Discharge of Sewage into Lake Washington

Coincident with urbanization of the area surrounding Lake Washington, several sewage treatment plants were constructed with the outfalls into the lake. To safeguard domestic water supplies being taken from the lake, the State Department of Public Health and the Pollution Control Commission adopted regulations requiring that all treatment plants discharging thereto must provide facilities for secondary treatment and thorough disinfection. While not entirely satisfactory from a domestic water supply standpoint, it was believed that the degree of sewage treatment thus attained would safeguard the recreational and aesthetic values of the lake.

Recent experiences in similar situations in other parts of the country have focused attention on the fact that the nutrient substances contained in sewage and sewage effluents can cause algal and other biological activities of nuisance proportions in waste receiving waters. Reports of investigations by the Pollution Control Commission and by Dr. W. T. Edmundson and associates of the University of Washington have indicated that increased biological activity is presently taking place in Lake Washington. As a result, heavy emphasis has been placed on the need for removal of sewage and sewage effluent discharges from the Lake Washington drainage basin.

As part of the abatement effort, the Pollution Control Commission, in 1956, established a policy aimed at progressive correction of the discharge condition. Attendant publicity regarding this and the threatened deterioration of Lake Washington, coupled with the inability of independent agencies to unite on an effective program, has impressed upon public officials and residents of the metropolitan Seattle area the need both for comprehensive sewerage planning and for a central sewerage authority.

Central Sewerage Authority

Creation of a central sewerage authority has been advocated from time to time for many years. In 1934, E. French Chase, former sewerage maintenance engineer of the city of Seattle, stated in a public address, "Since 1915...I have advocated the formation of a metropolitan sewer district to include the entire area around Lake Washington." In a report of May 17, 1926, previously cited, A. H. Dimock stated that a central sewerage authority was needed in the Seattle area. To that end, he commented in part as follows:

"It is clear that the problem is far larger than Seattle alone can solve. It outruns our authority but not our interest...Whatever may be reasonable and necessary to preserve the purity of the lake should be done through the watershed as well.

"There is at present no provision for a central authority to deal with the problems arising from the sanitation of a single watershed...It is quite evident that a divided authority...is incapable of formulating and carrying out a unified program which requires scientific study, engineering skill, and sound financing."

In the 1948 publication of the State Pollution Control Commission commenting on the Wolman report, the following statement appears:

"There is urgent need for the establishment of a competent utility organization within the city of Seattle whose sole purpose is the administration of the sewerage problem...It is expected that this utility organization might later be expanded to include surrounding territory forming a metropolitan sewer area."

State, city, county and sewer district officials, chambers of commerce, the Municipal League, and other civic organizations have expressed themselves as favoring some form of centralized sewerage authority. Early in 1956, former Governor Langlie appointed a committee to consider and to assist in the development of a solution to the metropolitan sewerage problem. Concurrently, the mayor of Seattle, and the commissioners of King County appointed a

metropolitan problems committee to consider area-wide problems and to make recommendations for their solution. In so doing, the sewerage situation was cited as a principal reason for the appointment of the committee. With the support of the Board of Commissioners of King County, the committee was later expanded to include representatives of the entire metropolitan area.

Community pressure, together with efforts of interested agencies and the appointed committees, culminated in the passage, by the 1957 State Legislature, of an enabling act providing for the formation of Metropolitan Municipal Corporations. Under this act, such corporations are empowered to plan, finance and administer certain services, including sewerage, on a metropolitan basis.

As a final note in recounting the history of the sewerage problem, it should be recognized that the assistance and support of the appointed committees played an important part also in the decision of the state, county and city of Seattle to finance jointly the conduct of the survey here reported.